Maintenance Human Factors Leaders Workshop Proceedings

William B. Johnson, Ph. D.

Chief Scientific and Technical Advisor
Human Factors in Aviation Maintenance
US Federal Aviation Administration

This workshop was conducted under funding from the AVS Chief Scientific and Technical Advisor Program and supported by the Human Factors Research Division of the Civil Aerospace Medical Institute and the ATO Human Factors Research and Engineering Group.

September 15, 2010

Final Report

Acknowledgments

This report summarizes the proceedings of the first AVS Maintenance Human Factors Leader's Workshop held at the Civil Aerospace Medical Institute in Oklahoma City, Oklahoma, August 4 & 5, 2010. This report documents a lasting legacy that will benefit the U.S. and international aviation maintenance community.

Dr. Bill Johnson, Chief Scientific and Technical Advisor for Human Factors in Maintenance, facilitated the workshop for key AVS and selected industry and international personnel responsible for developing and delivering maintenance human factors (MX HF) information relevant to Parts 65, 91,121, 135, and 145. Workshop delegates participated in guiding organizational human factors initiatives and curricula development based on their experience in human factors R&D, operations, or investigation.

We wish to thank the workshop delegates for wholehearted participation and responsiveness to coordination requests. Their contributions will advance the knowledge and understanding of Maintenance Human Factors in the industry.

Special thanks to Drs. Robert Johnson and Melchor Antunano of the Civil Aerospace Medical Institute and to the Human Factors Research Division for the use of their training facility, to Joy Banks and Dr. Katrina Avers for coordinating the workshop and report, to Tara Bergsten for transcribing the presentations, to Darin Nei for analysis and administrative support, to Lena Dobbins and Erin McManus for administrative support, and to Janine King and Suzanne Thomas for final proofing and formatting of the report.

Delegates

Victoria Anderson	AVP	Bill Johnson	AIR
Richard (Rick) Anglemyer	SCSI	Carl (Steve) Keesey	ASW
Katrina Avers	AAM	Terry Kleiser	AGL
Joy Banks	AAM	Ken Larcher	AAM
Mark Brock	ANM	Martin Maurino	Transport Canada
Brian T. Capone	ASW	Guy Minor	AWP
Greg Carroll	ASO	Dwayne Pittsenbarger	ASO
Jennifer Ciaccio	AFS	Bill Rankin	Boeing
Fred Etheridge	Gulfstream	Bobby Reed	ACE
Keith A. Frable	ASO	Mary Schooley	ANM
Victoria Frazier	AIR	John Sims	AAL
Kevin Gildea	AAM	Vickie A. Stahlberg	AWP
Jim R Hein	AWP	Michele Wallentine	ANM
John (Jay) Hiles	AFS	Katherine Wilson	NTSB
Bill Huntley	AAR CORP	Nadine Yeager	ACE

Executive Summary

Thirty delegates, mostly from the FAA's Office of Aviation Safety (AVS), but also from U.S. industry, the National Transportation Board (NTSB), and Transport Canada assembled for two days, at the Civil Aerospace Medical Institute (CAMI) in Oklahoma City. The workshop was hosted by the Chief Scientific Technical Advisor's (CSTA) program to discuss challenges and potential solutions associated with human factors in aviation maintenance. The workshop was the first formalized gathering of such personnel with this dedicated focus. The meeting format combined key presentation topics (i.e., fatigue, maintenance event data reporting, maintenance accidents, calculating the return-on-investment (ROI) in human factors, human factors training, and the Original Equipment Manufacturer/Maintenance Repair Overhaul (OEM/MRO) industry perspective) with extensive discussion.

The rank order, based on significant deliberation, of the top eight significant challenges included:

1) Use of Technical Publications
2) Fatigue/Alertness
3) Safety Culture
4) Event Data (MEDA, LOSA, ASAP)
5) ROI for Human Factors
6) Prioritization of Human Factors
7) Professionalism and Generational Issues
8) Attention to Required Inspection Items (RII).

The workshop delegates felt that the FAA is addressing some of these challenges, but there is substantial opportunity to increase attention to each of these topics.

The consensus opinion was to increase attention to the top eight challenges both with research and development as well as with operational funding. Challenges surrounding technical publications continue to be a significant contributing factor to maintenance events. This issue crosses many FAA airworthiness organizations including Flight Standards and Aircraft Certification. It is a major challenge that will require significant effort.

The group believed that maintenance fatigue risk management issues should be addressed immediately, with the emerging flight crew regulations. The attention to maintenance fatigue rulemaking should be elevated while the maintenance fatigue risk management applied research is delivering significant educational materials. The group consensus was that continued efforts should be supported by FAA research and operational funds.

A well established safety culture is a critical foundation that must be in place before many of the human factor challenges can be addressed effectively. The group members agreed that safety culture is a significant challenge in current operational environments and will require substantial effort. Ultimately, the group felt that it was difficult to separate safety culture from the other seven high priority challenges and attention to the seven challenges will address safety culture.

Voluntary reporting systems, like the Aviation Safety Action Program (ASAP), Boeing's Maintenance Error Decision Aid (MEDA), and the evolving maintenance and ramp line operations safety audits (LOSA), are critical for the proactive and predictive risk assessment necessary for Safety Management Systems (SMS). Attention to these programs should increase.

A number of the maintenance events, presented by accident investigators, evidenced numerous causal factors associated with attention to Required Inspection Items (RIIs). A combination of situational awareness, personal responsibility, critical workplace culture and communication, and adherence to technical publications are factors that affect compliance and safety to RII. Group members agreed human factor (HF) programs can and must address this issue.

There were a number of additional topics discussed and recommended. The list includes, but is not limited to:

- creation of a maintenance (MX) HF audit system,
- revision of the Advisory Circular 120-72 on MX HF,
- expansion of the MX HF presentation system and other support media, and
- creation and support of a process to calculate on-going cost and safety ROI in HF programs.

There was also discussion about rebranding the term maintenance human factors. Finally, there were repeated suggestions that the communication and coordination value of this first AVS MX HF Leaders' Workshop warrants a regularly scheduled annual meeting. All suggestions are detailed in the following report.

Table of Contents

Section 1.0 Workshop Proceedings 1
1.1 Background 1
1.2 Workshop Delegates 2
1.3 Workshop Format 3
1.4 Workshop Presentations – Day 1 3
1.4.1 Welcome Session 3
1.4.2 Workshop Introductions 3
1.4.3 MX HF Requirements in the Canadian Aviation Regulations. 4
1.4.3.1 Actions from Mr. Maurino's Presentation. 4
1.4.4 International Perspective on MX HF with Special Emphasis on Event Reporting Systems 5
1.4.4.1 Actions from Dr. Rankin's Presentation 5
1.4.5 Fatigue Risk Management for Aviation Maintenance: A Status Report 6
1.4.5.1 Actions from Dr. Avers Presentation 7
1.4.6 Current Aviation Safety Inspector Training and Discussion of Recurrent Training Ideas. 7
1.4.6.1 Actions from Mr. Anglemyer's Presentation 8
1.4.7 Maintenance Repair Overhaul (MRO) Presentations 8
1.4.7.1 Human Factors from the AAR Corporation Perspective 8
1.4.7.2 Human Factor Challenges at an Original Equipment Manufacturer (OEM) with Multiple Repair Stations 9
1.4.7.3 Actions from MRO Presentations from AAR and Gulfstream Aerospace 9
1.5 Day 2 Presentations 10
1.5.1 Maintenance-related Accidents 10
1.5.2 Maintenance-related Factors in Alaska Airlines Flight 261 11
1.5.3 Recent Accidents Involving Maintenance 11
1.5.4 Actions from the Three Accident Investigation Presentations 12
1.5.5 The Technical Community Requirements Group (TCRG) Process 13
1.5.5.1 Actions from Dr. Johnson's Presentation 14
1.5.6 Proactive Safety Management: Maintenance and Ramp Line Operations Safety Audit (LOSA) 14
1.5.6.1 Actions from Dr. Gildea's Presentation 15
1.5.7 Maintenance Human Factors Rulemaking 16
1.5.7.1 Actions from Mr. Hiles Presentation 16
1.5.8 Demonstrating Safety or Financial Return-on-Investment from HF Programs 17
1.5.8.1 Actions from Dr. Johnson's Presentation 18

Section 2.0 Workshop Recommendations 19
2.1 Pre-Workshop Activity and Concerns 19
2.1.1 Technical Knowledge and Skill 19
2.1.1.1 Solutions for Technical Knowledge and Skill Deficiencies 20
2.1.2 Workplace Pressure 20
2.1.2.1 Solutions for Workplace Pressure 20
2.1.3 General Work Environment 21
2.2 Post-Workshop Prioritization of Concerns 21
2.2.1 Use of Technical Publications 22
2.2.1.1 Actions to Address Use of Technical Publications Challenges 23
2.2.2 Fatigue/Alertness 23
2.2.2.1 Actions to Address Fatigue/Alertness Challenges 24
2.2.3 Safety Culture in Maintenance 24
2.2.3.1 Actions to Address Safety Culture in Maintenance 24
2.2.4 Event Reporting 25
2.2.4.1 Actions to Address Event Reporting Challenges 25
2.2.5 Return-on-Investment in MX HF 25
2.2.5.1 Actions to Address Return-on-Investment in MX HF 26
2.2.6 Establish MX HF as a Priority 26
2.2.6.1 Actions to Establish MX HF as a Priority 26
2.2.7 Professionalism and Generational Issues 27
2.2.7.1 Actions to Address Professionalism and Generational Issues 27
2.2.8 Attention to Required Inspection Items 27
2.2.8.1 Actions to Address Attention to Required Inspection Items 28
2.3 Other Actions Recommended by the AVS MX HF Leaders 28
Section 3.0 Workshop Evaluation and Comments 29
3.1 Evaluations of Workshop Content 29
3.2 Evaluations of Participation Benefits 29
3.3 Evaluations of Overall Quality 30

Table of Appendices

Appendix A: Workshop Agenda

Appendix B: MX HF Requirements in the Canadian Aviation Regulations (Mr. Martin Maurino)

Appendix C: International Perspective on MX HF with Special Emphasis on Event Reporting Systems (Dr. William Rankin)

Appendix D: Fatigue Risk Management for Aviation Maintenance: A Status Report (Dr. Katrina Avers)

Appendix E: Current Aviation Safety Inspector Training and Discussion of Recurrent Training Ideas (Mr. Rick Anglemyer)

Appendix F: Human Factors from the AAR Corporation Perspective (Mr. Bill Huntley)

Appendix G: Human Factor Challenges at an Original Equipment Manufacturer (OEM) with Multiple Repair Stations (Mr. Fred Etheridge)

Appendix H: Maintenance-related Accidents (Dr. Katherine Wilson)

Appendix I: Maintenance-related Factors in Alaska Airlines Flight 261 (Ms. Victoria Anderson)

Appendix J: Recent Accidents Involving Maintenance (Mr. Martin Maurino)

Appendix K: The Technical Community Requirements Group (TCRG) Process (Dr. Bill Johnson)

Appendix L: Proactive Safety Management: Maintenance and Ramp Line Operations Safety Audit (LOSA) (Dr. Kevin Gildea)

Appendix M: Demonstrating Safety or Financial Return-on-Investment from HF Programs (Dr. Bill Johnson)

Appendix N: Workshop Summary Slides and MX HF Concerns Discussion Transcript

Appendix O: AVS MX HF Leadership Workshop Evaluation Form

Appendix P: AVS MX HF Leadership Workshop Evaluation Item Report and Suggestions for Improvement

Section 1.0 Workshop Proceedings

1.1 Background

The Office of Aviation Safety (AVS) has a long-standing research and development initiative related to human factors in aviation maintenance. The program was initiated in 1988 from Washington D.C., Headquarters of the Office of Aviation Medicine. Since that time the program has been administrated by the Aircraft Maintenance Division (AFS 300) of the Flight Standards Service (AFS).

AFS 300 is the primary initiator of requirements and commits an Aviation Safety Inspector (.50 FTE) working with AFS 330 to serve as the point of contact in Washington Headquarters. The CSTA for Aircraft Maintenance Systems works closely with AFS 300, AFS 330, and other FAA entities (e.g., FAA Safety team) to collaborate on the direction of MX HF activities. Many of these activities are conducted by contractors and other FAA organizations, such as the Civil Aerospace Medical Institute. Program funding is primarily provided by the ATO Human Factors Research and Engineering Group. Selected applied projects are funded through AFS operational funds. Recently, funds from the AVS Chief Scientific and Technical Advisor's (CSTA) program have also been allocated to selected projects.

Since 1988 the FAA has taken a leadership role to conduct an annual maintenance human factors conference. From 1997 to 2002 responsibility for these meetings were shared and rotated among FAA, Transport Canada, and the Civil Aviation Authority (CAA) of the United Kingdom. There was a short period, in 2003 and 2004, when the conferences were not held. Starting in 2005, the FAA teamed with the U.S. Air Transport Association to co-sponsor the meeting. In 2010 the meeting returned to the United Kingdom. The annual meetings have ranged in size from 30, in 1988, to over 400 in the year 2000. Delegates typically represent the international industry and regulators. FAA participation usually represents 15% of the delegates.

The annual MX human factors conferences are always highly rated for not only the technical content but also the external and inter-FAA networking and communication that foster the success of all human factors programs. However, the large size of the meeting has restricted the format to formal lectures, some Q&A, and minimal discussion. For some time there has been a lingering notion that key FAA MX human factors personnel need to have a small action-oriented meeting made up of FAA personnel who have taken human factors leadership roles in their respective FAA organizations. After many years of discussing such a meeting, the CSTA office funded the MX HF Leadership Workshop and made it a reality (Figure 1).

Figure 1. The AVS MX HF leaders in action

1.2 Workshop Delegates

Invitations to attend the workshop were sent to individuals with a reputation of maintenance human factors leadership both internationally and within AVS (Figure 2). Although the majority of invitees were from AFS, the meeting planners extended a number of invitations to industry leaders, scientists, and international representatives. Thirty invitees participated in the workshop and all of them brought considerable human factors knowledge and experience to the workshop. For example, several of the AFS delegates were members of the FAA Safety team and had extensive experience delivering human factors presentations. Many of the delegates were integrally involved in multiple maintenance related accident investigations while others were involved in maintenance human factors research or aviation safety inspector training. Clearly, this workshop was not a conventional human factors training, but instead, a meeting of the AVS MX HF leaders.

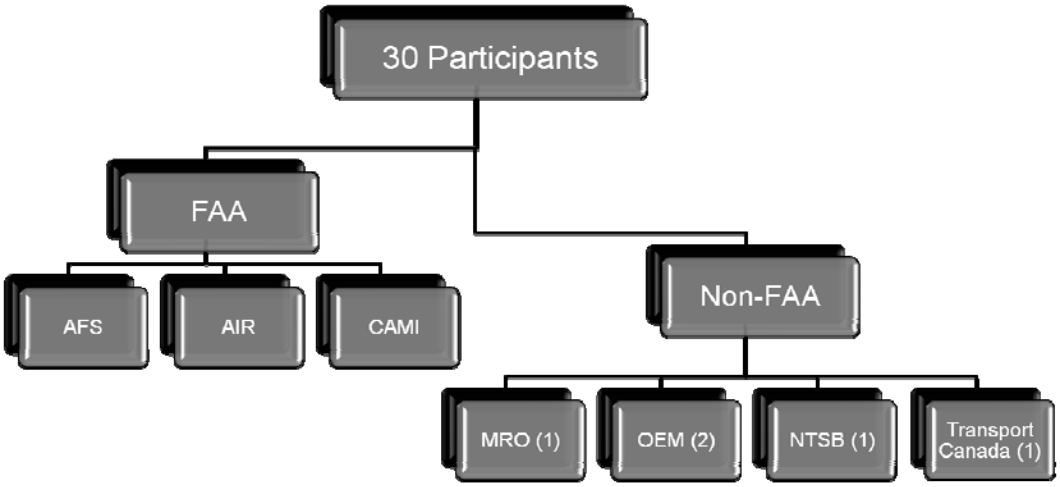


Figure 2. A depiction of attendee affiliation

1.3 Workshop Format

The workshop was designed to foster discussion, analysis, and recommendations regarding MX HF challenges and solutions. Prior to the workshop meeting, each attendee was asked to consider MX HF challenges and identify their "top 5" concerns. These concerns formed the basis for workshop introductions and discussions. Twelve formal presentations were delivered after the introductions, each presentation involved substantial Q&A and discussion. This format fostered relevant conversation and was the basis for many of the workshop conclusions. The workshop agenda is available in Appendix A**.**

1.4 Workshop Presentations – Day 1

This section will summarize each workshop presentation and provide the suggested action items for the FAA. Most presentations were made available for this report and are included in the appendices.

1.4.1 Welcome Session

Dr. Robert Johnson, Deputy Director, Civil Aerospace Medical Institute

Figure 3. *CAMI Deputy Director (right) welcoming workshop delegates*

Dr. Robert Johnson, CAMI's deputy director, opened the meeting and welcomed the delegates to CAMI and the Mike Monroney Aeronautical Center. Dr. Johnson stated that CAMI was delighted to host the first AVS Maintenance Human Factor Leader's Workshop. CAMI feels particularly attached to this topic because of their continued participation in numerous MX HF studies. CAMI researchers have been integrally involved in the human factors survey of international and FAA maintenance inspectors, maintenance fatigue risk management research, and the evolving work with maintenance and ramp Line Operation Safety Audits (LOSA).

1.4.2 Workshop Introductions

The workshop began with an extensive introduction and discussion session. Each speaker came with a prepared and prioritized list of their perceived maintenance human factors challenges. The list and discussion is described in Section 2.0.

1.4.3 MX HF Requirements in the Canadian Aviation Regulations.

(See presentation slides and transcript in Appendix B.)

Mr. Martin Maurino, Civil Aviation Program Manager, Standards Branch, Transport Canada.

Figure 4. Mr. Martin Maurino briefing HF requirements for Transport Canada

Mr. Maurino offered an overview of the structure of the Canadian Aviation Regulations with specific attention to Part V, Subpart 73 – Approved Maintenance Organizations (CAR 573.06). Under Part V, Subpart 73, technical, regulatory and human factors training guidelines are described. It specifies that Human factors training must be delivered to all staff with technical responsibilities. The HF training must include initial training and update training, with special provisions for training on new procedures as they arise. The initial Canadian human factor training is mandatory and must be 2 days long. The training must be classroom-based and cannot include any computer-based training. The training must cover the Dirty Dozen - the 12 factors known to influence human error in maintenance operations. In addition, Transport Canada requires Safety Management System training to be linked with the human factors training. Currently, they are working to implement a rule for fatigue risk management systems that will be integrated with the rule for SMS and human factors training.

1.4.3.1 Actions from Mr. Maurino's Presentation.

Transport Canada has had their human factors rules in place for nearly ten years and they have not had a negative financial impact on airlines or other maintenance organizations. Attention to human factors and the Dirty Dozen have become culturally ingrained at most maintenance organizations in Canada. As a result, this human factors culture will have an inevitable impact on the ease of implementation of SMS and Fatigue Risk Management Systems. The experience, in Canada, appears to be directly transferable to the U.S. Federal Aviation Administration. The rule is not complicated but very explicit about what should be included in human factors training and how it must be delivered. The acceptance and overall quality of computer-based training has evolved since the Canadian rule was implemented. Thus, the FAA should not limit the application of computer-based delivery of human factors information.

1.4.4 International Perspective on MX HF with Special Emphasis on Event Reporting Systems

(See presentation slides and transcript in Appendix C.)

Dr. William Rankin, Technical Fellow and Lead of MX Human Factors Group, Boeing Airplane Aviation Services

Figure 5. Dr. Bill Rankin discussing the EASA rules for HF programs and the MEDA reporting form

Dr. Bill Rankin is involved with an extensive number of domestic and international carriers as part of the Boeing customer support for the Maintenance Error Decision Aid (MEDA)

Dr. Rankin first reviewed the European Aviation Safety Agency (EASA) rules for human factors programs. There are 10 major human factors training requirements, many of which are listed as suggested HF training topics in the FAA's advisory materials. EASA requires initial and then recurrent training on a biannual basis. Since there are about 1,200 U.S. repair stations with EASA Part 145 certificates a very high percentage of U.S. maintenance workers are already receiving human factors training. Generally, the EASA rules are in harmonization with the Transport Canada requirements.

Dr. Rankin closed with a review of Boeing's MEDA form. The MEDA is considered to be the "Gold Standard" for event reporting systems. Nearly 1,000 airlines have received training from Boeing. Most U.S. carriers in the Aviation Safety Action Program use MEDA as the basis for all event investigation. MEDA has been successful for many reasons. The primary reasons are: simplicity of use, data remains in the hands of the airline or MRO, and Boeing has offered continuing product support throughout the life cycle.

1.4.4.1 Actions from Dr. Rankin's Presentation

EASA is an international leader in maintenance human factors regulations. In the U.S., the EASA rules are followed by 1,200 U.S. maintenance organizations and are accepted without issue. The FAA should have the same rules, in full harmonization with Europe and Canada. FAA should prioritize harmonization with EASA rules immediately in the U.S.

1.4.5 Fatigue Risk Management for Aviation Maintenance: A Status Report

(See presentation slides and transcript in Appendix D.)

Dr. Katrina Avers, Industrial/Organizational Research Psychologist and Principal Investigator for FAA MX FRMS R&D, Civil Aerospace Medical Institute

Figure 6. Dr. Katrina Avers leading the discussion on fatigue in aviation maintenance

Dr. Avers chairs the FAA's multi-disciplinary maintenance fatigue workgroup. The workgroup includes representatives from industry, academia, and government and is identifying and developing practical science-based methods for fatigue risk management.

Dr. Avers first discussed the NTSB's recommendation to investigate fatigue in aviation maintenance operations and the FAA's subsequent responses over the past twenty years. Most recently, the FAA Flight Standards Maintenance Division commissioned a multi-disciplinary workgroup to examine potential fatigue risk management solutions in maintenance operations. The workgroup has addressed the issue with both short-term and long-term solutions. The short-term solutions are intended to have immediate effect and improve awareness of fatigue related hazards and personal fatigue countermeasures. These solutions include fatigue awareness materials such as posters, a 2010 calendar, newsletters, mechanic and supervisor training on fatigue countermeasures, a fatigue symptom checklist, and fatigue assessment forms among others. The long-term solutions are intended to provide the FAA, the company, and individuals with clearly defined fatigue risk management responsibilities. The solutions include an operational handbook on how to develop an FRMS at all levels within the organization. The handbook will outline the guidelines based on international best practices and intends to provide users with all of the tools necessary to implement an FRMS. The workgroup also intends to make recommendations to improve hours of service limitations based on scientific modeling tools and the practicalities of maintenance operations.

All of the tools created by the workgroup are available on the FAA's human factors website and accessible through mxfatigue.com. A fatigue countermeasure training course will be available October 1, 2010 and an automated fatigue assessment form will be available June 1, 2011.

Dr. Avers reported that the working group conducted an informal survey of the members asking whether there is a necessity for a maintenance fatigue regulation. Twenty-one of the 25 members responded to the survey. The results indicated that 100% of the respondents felt that a regulation was the only way to ensure industry action on fatigue issues.

1.4.5.1 Actions from Dr. Avers Presentation

While the FAA has made substantial progress in developing short-term solutions to address fatigue in aviation maintenance operations, it is simply not enough. The industry needs better hours of service rules and the FAA should proceed with guidelines that will improve safety across maintenance operations. The attention that is currently being given to pilot fatigue rules should also be given to maintenance operations. There is no reason to delay such rulemaking for maintenance personnel.

1.4.6 Current Aviation Safety Inspector Training and Discussion of Recurrent Training Ideas.

(See presentation slides and transcript in Appendix E.)

Mr. Rick Anglemyer, Manager for FAA Inspector HF Training Project, Southern California Safety Institute (SCSI)

Figure 7. Mr. Rick Anglemyer describing current ASI HF training

For the past three years SCSI has delivered a 3-day human factors training course to about 1,200 Flight Standards Airworthiness Inspectors. In that role he and his colleagues empower the FAA workforce to understand and apply the fundamentals of human factors with the companies that they oversee. Student feedback on the 3-day course continues to be highly positive. Mr. Anglemyer outlined the course content and also stimulated discussion about the possible content of a second generation/recurrent course. Many of the workshop delegates had attended the SCSI course and were enthusiastic about the current course and ideas for recurrent training. The delegates suggested a number of ideas for recurrent training, including: teach inspectors how to market MX HF programs to the industry, create ways for inspectors to assist industry with the return-on-

investment (ROI) in HF programs, provide supplementary training on hazard analysis and applied risk assessment, and teach inspectors to communicate and facilitate a positive safety culture.

1.4.6.1 Actions from Mr. Anglemyer's Presentation

Flight Standards should begin specification for a recurrent training for Aviation Safety Inspectors (ASI). This would require a new maintenance human factors course. Many delegates suggest that the new course should have particular focus on teaching the ASI to promote cultural change, with respect to human factors, both for the industry and for FAA colleagues.

1.4.7 Maintenance Repair Overhaul (MRO) Presentations

The final presenters for day 1 represented both the MRO industry and Original Equipment Manufacturers (OEM). Gulfstream Aerospace is an OEM but also operates many repair stations around the world. AAR Corporation has multiple repair stations worldwide.

1.4.7.1 Human Factors from the AAR Corporation Perspective

(See presentation slides and transcript in Appendix F.)

Mr. Bill Huntley, Corporate Director for Human Factors & Safety Management, AAR Corporation

Figure 8. Mr. Bill Huntley outlining AAR Corporation's approach to HF

Mr. Huntley began by expanding on his top 5 human factors concerns. He talked about the fact that production requirements are often the driving force making it difficult to make human factors considerations an important priority. He believes that there should be increased effort in collecting and using data to make a strong business case for HF initiatives. He believes that HF training techniques must continue to evolve. On a related issue, he said that it has been very difficult to hire qualified personnel as human factors leaders.

He talked about the nature of the MRO workforce and the challenges that it presents. He said that the MRO labor pool is a "revolving door," making it difficult to develop and maintain a corporate safety culture. He commented that having many international locations is another challenge to maintaining a standardized high quality and safety culture. He was positive about the potential of

quality human factors programs to reduce error, to lower costs, and to ensure continuing safety. He also looks to the benefits of voluntary reporting systems and various SMS initiatives to work hand-in-hand with human factors initiatives.

1.4.7.2 Human Factor Challenges at an Original Equipment Manufacturer (OEM) with Multiple Repair Stations

(See transcript in Appendix G. Presentation slides not provided.)

Mr. Fred Etheridge, Manager of Compliance and Technical Training, Gulfstream Aerospace

Figure 9. Mr. Fred Etheridge discussing HF challenges and successes at Gulfstream

Mr. Etheridge described the human factors programs at Gulfstream Aerospace. The company complies with the EASA Part 145 requirements for Repair Stations. Therefore about 98% of the employees have had initial HF training and many groups are in the first stage of the 2-year recurrent training. Their training Department throughout the company is called “Gulfstream University.”

Gulfstream is a desirable place for employment and experiences a very low turnover rate. Their current workforce is made up of both a senior aged workforce and a new generation of young workers. Gulfstream recognizes that the generational gap in their workforce presents some human factors and communication challenges.

Gulfstream has an active Safety Management System (SMS) and plans to build their fatigue risk management into the SMS.

1.4.7.3 Actions from MRO Presentations from AAR and Gulfstream Aerospace

Both companies report active HF programs because they operate under the Part 145 Repair Station Rules regarding HF programs. This is an indication that regulations do encourage/force compliance. That said, there is a lot of variance among repair stations and any FAA regulatory activity should be aware that one size does not fit all.

Based on comments from the AAR and Gulfstream presenters, the SMS should be developed in close cooperation with all HF initiatives.

1.5 Day 2 Presentations

Day 2 started with MX HF accident related data presented by the National Transportation Safety Board (NTSB), The FAA, and Transport Canada (presenting International Air Transport Association data). This section summarizes each speaker's remarks and lists the collective action items from the three presenters.

1.5.1 Maintenance-related Accidents

(See presentation slides and transcript in Appendix H.)

Dr. Katherine Wilson, Human Performance Investigator, U.S. National Transportation Safety Board

Figure 10. Dr. Katherine Wilson describing NTSB investigations of maintenance-related accidents

Dr. Wilson presented MX-related data from five NTSB accidents. For each accident she covered the facts of the accidents and the maintenance and human factors related issues that may have contributed to the accident. The accidents included: Air Wisconsin Flight 3919 in Philadelphia (a gear-up landing); Air Midwest Flight 5481 in Charlotte (a flight rigging failure); Air Sunshine Flight 527 in the Bahamas (an engine failure and ditching); Chalk's Ocean Airways Flight 101 (wing attachment/spar failure on aging A/C); and Delta Airlines Flt 1288 in Tallahassee (an uncontained turbine failure). The maintenance-related shortcomings in these accidents were related to the following issues: failure to follow procedures; unqualified technician without task specific training; improper oversight of work; and inadequate inspection. Dr. Wilson also talked about worker fatigue and about the long-standing NTSB recommendations to the FAA regarding fatigue and maintenance personnel. She suggested that the FAA capitalize on some of the guidance and regulatory materials developed by the trucking industry. Specifically, she referred to Schneider Trucking's attention to sleep apnea programs and the resulting cost savings.

1.5.2 Maintenance-related Factors in Alaska Airlines Flight 261

(See presentation slides and transcript in Appendix I.)

Ms. Victoria Anderson, Senior Accident Investigator, FAA AVP-100

Figure 11. Ms. Victoria Anderson describing the FAA's investigation of Alaska Airlines Flight 261

Ms. Anderson is a senior investigator that was involved with the FAA's investigative team for the Alaska Airlines Flight 261, on January 31, 2000 off the coast of Southern California. Ms. Anderson offered a detailed description of the flight and the subsequent investigation. This flight experienced a loss of pitch control resulting from failure of the horizontal stabilizer trim system jackscrew assembly. The failure was caused by insufficient lubrication of the jackscrew assembly. The FAA and NTSB identified a number of factors that contributed to the accident. The causal factors ranged from the difficultly of performing the lubrication task to the complexity of measuring the acceptable wear limits. There was also discussion about the corporate culture and procedures that would permit a marginally worn component to continue to fly without adequate lubrication.

1.5.3 Recent Accidents Involving Maintenance

(See presentation slides and transcript in Appendix J.)

Mr. Martin Maurino, Civil Aviation Program Manager, Standards Branch, Transport Canada

Figure 12. Mr. Martin Maurino describing international accident data from IATA

Prior to joining Transport Canada Martin Maurino was responsible for compiling international accident data for the International Air Transport Association (IATA). This presentation was based on his work with IATA. He reported only on recent accidents, between 2005 and 2009. Example accidents included the following:

- The Tuninter Flight 1153, an ATR-72, which crashed due to fuel starvation, caused by an incorrect fuel gauge from an ATR-42 installed.
- The Helios Airways Flight 522, B-737-300, pressurization failure and failure of flight crew to respond to pressurization alarms. Caused by MX leaving pressurization mode selector in manual position rather than automatic. The flight crew did not notice during pre-flight inspection.
- SAS Flights 1209/2748/2867 gear failures on DH Dash 8-Q400 aircraft. All gear failures were related to technical documentation and procedures associated with landing gear components.
- United Airlines Flight 267, an A-320, the auto brake system was cross wired after landing gear replacement. Technical documentation was confusing and therefore not followed.
- Air India Flight 717, a new B777-200ER, had a nose gear collapse at the gate. MX personnel placed gear select switch in up position while gear was not pined, the correct procedure was not followed.

Mr. Maurino reported that IATA data, from 2008, showed that 15% of the world airliner accidents were caused by a maintenance error. Twenty eight percent of accidents involving aircraft malfunctions involved maintenance. In 57% of the maintenance accidents a deficient maintenance organization was cited as a contributing factor.

1.5.4 Actions from the Three Accident Investigation Presentations

The presenters felt that aviation maintenance experts must develop their own approaches to reduce risk in the areas identified by the accidents. However, the accident reports can inform some organizational and regulatory approaches that would reduce such risk in the future.

The factors that seemed to appear across accidents included, but were not limited to:

- use of technical documentation,
- corporate culture and related organizational factors,
- situational awareness regarding required inspection items,
- engineer/mechanic personal responsibility,
- proper post maintenance inspections, and
- design for maintainability.

It is no surprise that most of the contributing factors identified in these accidents were also on the delegates' list of challenges for maintenance human factors. These challenges are described in more detail in Section 2.0.

1.5.5 The Technical Community Requirements Group (TCRG) Process

(See presentation slides and transcript in Appendix K.)

Dr. Bill Johnson, Chief Scientific & Technical Advisor, FAA, AIR-100

Figure 13. Dr. Bill Johnson demonstrating how the TCRG process works

Dr. Johnson described the TCRG process, the AVS procedural process for defining research, developing requirements and assigning priority for research funding. Johnson characterized the TCRG as a very organized process for defining and prioritizing Research and Development (R&D). The process requires substantial development and preparation but not every project gets funded due to insufficient resources. That said, the Aviation Safety Act ensures that resources be allocated to both flight and maintenance operations. For the most part, every organization receives some level of funding.

Dr. Johnson reported that the process typically plans projects three years in advance. During the summer of 2010, the TCRG is planning the TCRG requirements for (FY) 2013. While there is a provision for requirements that may “pop up”, the emphasis is on good long-term planning. Once a project is approved, it can be moved forward in the schedule if necessary.

Dr. Johnson provided the delegates with a percent chart to show how the resources are projected for allocation for (FY) 2012. He showed some example R&D projects from numerous AVS entities as well as details about current projects and deliverables from recent AFS maintenance human factors funded projects. Some examples of recent MX HF projects included:

- fatigue risk management,
- maintenance and ramp line operations safety assurance,
- extensive training for FAA Aviation Safety Inspectors,
- recurrent training for Inspection Authorization Certificates,
- HF Ops Manuals for Maintenance, Ramps, Airports,
- the Maintenance Human Factors Presentation System,
- support of Aviation Safety Action Program, and
- looking to the future of aviation maintenance/engineering

Dr. Johnson also covered some examples of new or continued projects proposed for (FY) 2013. Examples of (FY) 2013 projects included:

- fatigue risk management
- line operations safety audit,
- future of maintenance/engineering (including Next Gen),
- addressing technical documentation
- knowledge capture of senior personnel
- cost-effectiveness of MX HF programs

The session concluded with details of the web-based TCRG process. Dr. Johnson created an interactive example and briefly answered the following questions from the list of TCRG requirements:

- How to title the R&D requirement to attract proper attention,
- How to briefly describe the requirement,
- When to identify the project as a NextGen requirement,
- What are the steps necessary to do the R&D
- How to build the background for the project or a related activity,
- What if the project is related to an existing or upcoming regulation, and
- How to define future concrete deliverables for each year of the project.

1.5.5.1 Actions from Dr. Johnson's Presentation

The TCRG process is generated and justified by the technical community. That said; field ideas and accompanying management support is very important in influencing the R&D Management Team and AVS as they select the projects for funding. Any MX HF requirements should be submitted to the AFS 300 TCRG representative and/or the CSTA for MX human factors.

1.5.6 Proactive Safety Management: Maintenance and Ramp Line Operations Safety Audit (LOSA)

(See presentation slides and transcript in Appendix L.)

Dr. Kevin Gildea, Personnel Research Psychologist and Principal Investigator for FAA MX LOSA R&D, Civil Aerospace Medical Institute

Figure 14. Dr. Kevin Gildea discussing proactive safety management with LOSA in maintenance operations

Dr. Gildea presented the scientific and operational rationale for LOSA. LOSA provides a unique opportunity to identify threats and errors in the MX and ramp environments before they lead to incidents and accidents. This is accomplished by observing normal day-to-day operations in a non-intrusive, non-punitive, anonymous manner. With the rarity of aviation accidents, the aviation community can be lulled into a sense of security. Many threats and errors can remain unidentified or unaddressed for years or decades before they cause damage, injury, or loss of life. When using rare incidents and accidents as the only metrics, relatively risky and inefficient operations can look statistically similar to relatively safe and efficient operations. Thus, threats and errors must be addressed in a proactive manner in normal operations.

This form of proactive intervention is new to the MX and ramp communities but has already provided benefits. In the first two years of LOSA observations, airlines have already realized safety benefits and financial savings in the millions of dollars.

The MX and ramp LOSA forms and procedures were recently approved by the ATA Human Factors Committee after two years of development, beta testing, and refinement. CAMI is creating electronic database tools to assist in the collection, analysis, and sharing of LOSA findings. The forms, procedures, and a standalone version of the software will be available to the public in October 2010. CAMI will also provide computer based training modules and other LOSA support materials.

Development and beta testing will continue into (FY) 2011. In September 2010, the MX LOSA process will be tested with Part 135 base MX. Additional Part 121 MX and ramp testing will occur throughout the winter of 2010-11. Further database development will extend the data collection, analysis, and dissemination capabilities. The ability to compare performance worldwide with virtually unlimited quantities of data will be available. This will provide greater opportunities to identify threats, errors, and associated remedies before injuries, damage, or loss of life occurs.

The industry is very interested in the LOSA process. Interested parties include maintenance, repair, and overhaul (MRO) companies, original equipment manufacturers (OEM), and international carriers and service providers. Future efforts will seek to extend the benefits of LOSA to these companies.

1.5.6.1 Actions from Dr. Gildea's Presentation

The delegates agreed that LOSA research is critical as a proactive safety measure. It is necessary to continue funding LOSA and to extend Maintenance and Ramp LOSA to MRO, OEM, and larger Part 91 operators. As LOSA is further developed it will be important to create and provide a Memorandum of Agreement (MOA) for LOSA teams and begin calculating an ROI for LOSA observations. Once finalized, it is critical to communicate the ROI methodology with air carriers and service providers.

1.5.7 Maintenance Human Factors Rulemaking

(No presentation slides or transcript available.)

Mr. John Jay Hiles, Aviation Safety Inspector, National Staff Specialist, Human Factors, FAA, AFS-330

Figure 15. Mr. Jay Hiles reviewing general rulemaking procedures

Mr. Hiles represented the general rulemaking procedures in accordance with Title 14 CFR Part 11. He described the process as somewhat protected and did not distribute his slides. Mr. Hiles demonstrated how the Office of Rulemaking uses a Rulemaking Project Report (RPR) to track the process. For example, when an Office of Primary Responsibility (OPR) first identifies the need for a rule, the OPR will file with the rule making counsel, composed of managers and directors and chaired by the Director of Rulemaking. The process also requires guidance from an assembled team of subject matter experts, an analysis from the office of rulemaking, aviation policy economists, and general counsel. Although the process is thorough, tedious, and requires a lot of patience, it is effective.

Mr. Hiles speculated on what Human factors rules would look like if they became part of Part 121.375. He thought that any rulemaking on the part 121 training programs would require approval rather than acceptance. He believed that corresponding Advisory materials would require training curricula comparable to the requirements outlined by EASA and Transport Canada. Eventually these rules would promulgate to Part 135, Part 145, Part 163, and others.

1.5.7.1 Actions from Mr. Hiles' Presentation

Discussion after Mr. Hiles' presentation focused on the importance of a requirement for HF training in maintenance operations. A number of delegates voiced concern that rulemaking with respect to maintenance human factors and maintenance fatigue risk management are taking unnecessarily long. Delegates recommended that these maintenance human factors rulemaking efforts should receive an elevated prioritization.

1.5.8 Demonstrating Safety or Financial Return-on-Investment from HF Programs

(See presentation slides and transcript in Appendix M.)

Dr. Bill Johnson, Chief Scientific & Technical Advisor, FAA, AIR-100

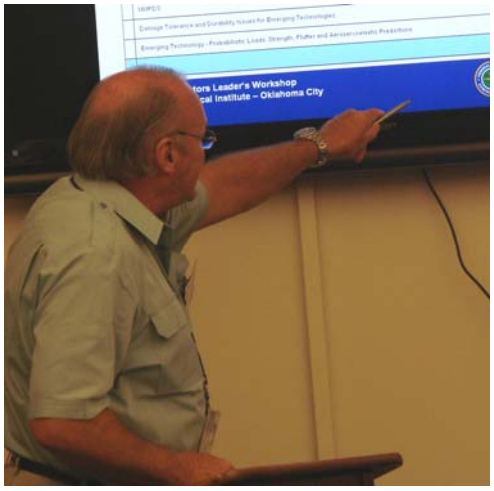


Figure 16. Dr. Bill Johnson showing delegates how to calculate return-on-investment

The topic of cost justifying and marketing the commercial and safety value of human factors programs was identified repeatedly throughout the workshop as a high priority issue and is discussed further in Section 2.0.

Dr. Johnson began the presentation with information from Chapter 6 of The Operator's Manual for Human Factors in Maintenance, published by the FAA in 2007. The chapter shows how to calculate a ROI for specific human factors programs interventions. The chapter, written by Johnson, emphasized that HF programs must be justified by multiple small successes rather than by trying to imply that the HF program prevented a large catastrophic event.

After Johnson demonstrated how financial calculations for a human factors intervention basically worked, he explained that it is much more difficult to have an ROI calculation for safety. "Safety" is intangible and not conducive to a simple calculation but requires a number of operational measures. The discussion identified potential safety measures such as number of reworks, gate-returns, warranty claims, or lost-time job injuries. While cost can be applied to such measures the ROI becomes one of money rather than of safety. Inspector Keith Frable suggested an alternative method of computing ROI. Essentially, he suggested calculating the cost of inaction or "not doing something" as a way to assess the ROI.

As a final example of the complexity associated with ROI on safety programs, Johnson led a discussion to calculate the safety return on the workshop financial investment. Positive results identified by the delegates included:

- Recommendations for new programs and priorities
- Development of a shared list of critical challenges
- Establishment/reinforcement of a network of FAA MX HF leader's

While delegates emphasized the benefit and importance of the networks developed at the workshop, most struggled to put a safety ROI on such critical communications.

1.5.8.1 Actions from Dr. Johnson's Presentation

Discussions indicated that the industry and FAA must pay increasing attention to the financial and safety ROI in human factors initiatives. The delegates believe this topic is important and should be prioritized for continuing applied research and development.

Dr. Johnson challenged the delegates to apply the simple model from the Operator's Guide to the interventions used in the organization they oversee. Johnson added that findings from ASAP and other voluntary reports, or event investigations, are excellent ways to identify targets of opportunity for ROI calculations.

Section 2.0 Workshop Recommendations

2.1 Pre-Workshop Activity and Concerns

Before the workshop, organizers asked each attendee to prepare one slide as part of their formal introduction to the group. Each attendee was asked to list their name, organizational affiliation, and "top 5" concerns regarding maintenance human factors. This section begins by summarizing that information.

For starters, the group was quite experienced with an average aviation industry experience of 25 years. The range was from 3 years to 46 years with one attendee having both pilot and A&P mechanic credentials for 44 and 40 years, respectively.

A doctoral student reviewed all of the "top 5" concerns and analyzed the frequency of each concern. Many concerns were repeated across delegates. The top eight concerns coming into the workshop and the number of times they were identified are shown in Table 1.

Table 1. Priority Rank of Pre-Workshop MX HF Concerns

Rank	Pre-Workshop Concerns	Frequency
1	Fatigue/Alertness	15
2	Technical Knowledge and Skill Levels	9
3	Return-on-Investment (ROI) Issues	9
4	Technical Publication Complacency	7
5	Production Pressure	6
6	Shiftwork Issues	6
7	Safety Culture in Maintenance	5
8	General Work Environment	4

The introduction session was in depth and expended a considerable portion of the first morning. The level of discussion indicated a high-level of commitment to developing solutions for MX HF issues and proved to be an excellent way to set the tone for the entire workshop. The group dynamic permitted time for all to speak and delegates shared their time equitably.

The list of pre-workshop and post-workshop concerns (shown in Table 2) evidenced substantial overlap. This section will only discuss the pre-workshop concerns that were not identified in the top 8 post-workshop concerns.

2.1.1 Technical Knowledge and Skill

Approximately one third of workshop delegates identified technical knowledge and skill as a pre-workshop concern. The workshop discussion revealed a concern with the underlying capabilities of new hires, many of whom are recent graduates of CFR Part 147 mechanic training programs. Many believed that the schools and the FAA certification process do not ensure that new employees are fit for immediate employment in today's aviation maintenance workplace. Prior to the events of 9/11 and radical changes to the aviation maintenance industry, there was time to

train/mentor new mechanics. In today's industry, the training programs have been reduced and the structured time for on-the-job training has also been reduced. This challenge is particularly exacerbated in the MRO industry because there is no requirement for a mechanic to have mechanic credentials.

Although the concerns regarding technical knowledge and skills were multi-faceted, the workshop delegates focused specifically on the training content of most aircraft mechanic schools. The delegates noted that use of technical documentation and modern technology procedures are not being taught in most aircraft mechanic schools.

2.1.1.1 Solutions for Technical Knowledge and Skill Deficiencies

As is often the proposed solution, more and better training is recommended. Although training may be over-prescribed, it does seem warranted for this particular issue. Workshop participants discussed upcoming revisions to CFR 147, while others believed the proposed revisions are insufficient.

An alternative to training regulation might include improved tracking of task errors and task-time overruns. The improved documentation of error costs will likely result in an improved awareness of the cost savings associated with additional training. This suggestion is inherently linked to the ROI calculations that are discussed in the "top 8" post workshop concerns (see section 2.2.5).

An alternative to improved training is to improve/simplify procedures and, perhaps, increase inspection.

2.1.2 Workplace Pressure

Workplace pressure comes in many forms for aviation maintenance personnel. In the airline operator environment (e.g., gate, flight line), the goal is on-time performance. In the maintenance repair and overhaul organization, there is pressure to complete maintenance on a pre-planned schedule. In most cases, specific tasks have an expected performance time. Regardless of the type of operation, the cost and margin for the maintenance job is based on time and maintenance personnel are pushed for on-time task performance. As a result, maintenance personnel experience explicit, as well as implicit, pressure.

Unfortunately, workplace pressure is a breeding ground for procedural non-compliance. Peer-accepted non-compliance transitions into an organizational norm ("everyone does it that way"). While such procedural non-compliance is not always a safety breach it is a known hazard. It is also against the regulations and can lead to FAA action against maintenance personnel or their organization.

Overall, delegates felt that pressure is a negative aspect of many maintenance organizations and should be address with structured mitigation practices. These practices can and should be developed by the industry with FAA support.

2.1.2.1 Solutions for Workplace Pressure

It is virtually impossible to eliminate workplace pressure to perform the job quickly since that is the nature of the business. Airplanes are expensive and time on the ground, for maintenance, does not

generate revenue. While much maintenance is performed at night when aircraft are already on the ground, there are not enough hours in the night or people to do the job to lessen the pressure. Workplace pressure is a characteristic of aviation maintenance.

Delegates discussed safety culture and its role in mitigating the effects of pressure. Some specific solutions that could begin to address the issue of workplace pressure include:

- start an applied R&D program with the FAA to mitigate the effects of workplace pressure,
- structure event investigations to identify if workplace pressure was a contributing factor,
- assess the impact of pressure on error,
- identify ways to mitigate the impact of pressure based on data,
- give maintenance personnel a reasonable approach to address real and/or perceived pressure,
- give middle managers tools or avenues to address pressure with senior management and the workers they supervise, and
- recognize that addressing pressure is a difficult matter associated with overall corporate safety culture

2.1.3 General Work Environment

This concern is very broad but was mentioned by 4 delegates at the outset of the meeting. This can include aspects such as corporate culture, general house-keeping, corporate and interpersonal communications, personal occupational safety, lighting, and training. This term is very broad and is difficult to address without additional detailed explanation and discussion. The workshop did not dedicate additional time to this issue in its general form.

2.2 Post-Workshop Prioritization of Concerns

Figure 17. Dr. Bill Johnson leading the open forum discussion for action items

This section of the report will discuss the eight most significant challenges that workshop delegates identified at the conclusion of the workshop. The workshop closed with an open forum discussion that was directed toward generating a list of prioritized concerns and action items. Delegates generated a list of topics and recorded all suggestions on white boards and charts around the room. Approximately 25 topics were identified and briefly discussed. There was some redundancy in the list of 25 so the list was collapsed to create a final list. Using the final list, each attendee

ranked the ten most important topics with a closed ballot. Table 2 shows the top eight challenges that emerged from that list. We received topic rankings from 26 of the 30 delegates. The topics were put into a spreadsheet with subsequent rankings from each attendee. A point value was assigned to each rank (e.g., topics ranked number 1 were given 10 points, topics ranked as number 2 were given 9 points, etc.). The topic with the highest overall points was then assigned a rank order priority of 1. This calculation method was applied to all of the concerns to provide a rank-ordered prioritization.

Table 2. Priority Rank of Post-Workshop MX HF Concerns

Rank	Post-Workshop Concerns	Score
1	Use of Technical Publications	207
2	Fatigue/Alertness	189
3	Safety Culture in Maintenance	153
4	Event Reporting (ASAP, MEDA, other VRP)	122
5	Return-on-Investment (ROI) in MX HF	117
6	Establish MX HF as a Priority	82
7	Professionalism and Generational Issues	65
8	Attention to Required Inspection Items	46

The following subsections outline the top eight challenges and offer proposed actions that are based on discussion from the workshop. To the extent possible the actions will be listed in a bulleted list for easier comprehension and action. Slides summarizing the workshop and the entire transcript of the discussion are contained in Appendix N.

2.2.1 Use of Technical Publications

“Failure to follow procedures” continues to be the number one cause of maintenance related events. The accident presentations by the FAA, NTSB, and Transport Canada/IATA showed “failure to follow procedures” as a contributing factor in most of the accidents. Therefore it is no surprise that the use of technical publications is the top rated concern amongst AVS MX HF Leaders.

Unfortunately the root cause analysis of an accident often stops after the simple finding of “failure to follow procedures.” This failure goes far beyond a “lazy mechanic” who chooses to be non-compliant. In fact, a number of other contributors have often been identified as the reason behind “failure to follow procedures.” For example, it may be due to an organizational issue or corporate norm. Some procedures are known from memory while others are simply too difficult to follow with instructions in multiple manuals and multiple media, both hard-copy and digital. Sometimes mechanics get lost in the warnings, linked-references, and other minutia and can miss the safety-critical important details.

In the contract MRO industry, maintenance personnel must use customer manuals for repairs and maintenance. Unfortunately, there are often significant differences in the procedures to accomplish the same task on the same model aircraft where one customer has a half page of instructions and another has seven pages of instructions.

In the workshop discussions, ”failure to follow procedures” and the use of technical documentation were linked to at least five broad causes: 1) a cultural norm that allows or encourages non-

compliance, 2) problematic documentation of technical procedures, 3) conflicting guidelines for the same task, 4) difficulty executing procedures, and 5) miscellaneous personal or work environment factors.

One thing is certain; the list of causes underlying “failure to follow procedures” could go on and on! Since the regulated aviation industry continues to rank technical documentation as a leading safety risk, we must begin to find solutions. The industry can do better! It must address this problem.

2.2.1.1 Actions to Address Use of Technical Publications Challenges

Many industries have begun to make their publications synchronized and available on visual displays with video attachments that can be accessed with a cell phone or personal digital assistant (PDA). The aviation industry should pursue similar avenues to reduce some of the safety risk associated with technical documentation.

Perhaps time and technology will help address the challenges. However a more proactive approach than waiting for time and technology is preferred. Below are some possible activities to help better define the problem and potential solution strategies:

- Conduct a FAA R&D project to identify the multiple issues underlying “failure to follow procedures” and develop mitigating strategies (a proposal was submitted to the AVS Technical Community Requirement Group during (FY) 2010).
- Develop event and accident investigation tools that will go beyond a finding of “Failure to follow procedures.” For example, what was the corporate norm, what was the lighting, when was vision last tested, what was the availability of the documentation, what was the level of pressure to complete the task, what was the oversight by experience and trained personnel, was the mechanic rested, what was the time of day, and more. Often the root cause may extend beyond the documentation.

2.2.2 Fatigue/Alertness

The maintenance workforce is tired. Few debate that fact. The risk associated with a fatigued workforce is clearly documented but has not yet been addressed by the international aviation maintenance community.

A significant 2000 FAA study showed that the average mechanic sleeps about 5 hours. Since 2000, it is generally known that the mechanic workforce has decreased in size and hourly wages have decreased by as much as 35%. The fatigue issue is exacerbated by the closing of many airline hubs. Many maintenance workers must commute, by air or automobile, great distances because their domicile closed and they cannot afford to relocate. The result is an accelerated work week where workers can complete a 40 hour work week in about 2 ½ days. They sleep in the poor conditions of shared crash pads for the few days when they are at their away-from-home work location. The issue of fatigue seems to be rooted in operations that can benefit both the workforce and the employers in some way. Although there are some personal or corporate benefits with today’s schedules, the safety risk can not be ignored.

The FAA Flight Standards Service, with the Civil Aerospace Medical Institute has begun to address the challenge by improving fatigue awareness through educational materials. Although this is a necessary first step in fatigue risk management, it is not enough. The workshop delegates were in agreement that regulations are the only way to ultimately address this issue.

2.2.2.1 Actions to Address Fatigue/Alertness Challenges

There are many ways to address the fatigue issue. The FAA, through R&D, is currently pursuing the path of safety promotion with a hybrid approach to fatigue risk management with hours of service limitations. The current R&D project has outlined the elements needed in a rule and has begun to develop the necessary support materials. The report on current R&D progress led to a number of workshop recommendations that include:

- FAA should immediately initiate rules on fatigue risk management for maintenance organizations. This recommendation is non-negotiable and is supported by industry, labor, scientists, and FAA inspectors.
- FAA should continue to work with industry to support fatigue awareness in lieu of no regulation.
- FAA should continue to objectively document fatigue-related events, the corresponding costs, and potential ROI.

2.2.3 Safety Culture in Maintenance

It can be easily argued that the entire final list of prioritized MX HF challenges can be driven by an organization's safety culture. Safety culture was ultimately rated as the number three concern of workshop delegates.

Simply defined, safety culture is a shared belief in the value of safety wherein each individual can articulate and practice their specific roles assuring safety. While safety culture can be a bit abstract, there are a number of concrete indices of a healthy safety culture. For example, an organization with a healthy safety culture will often have an active event reporting system and a "just culture" policy.

There is no doubt that an organization's culture is difficult to change. Maintenance personnel typically have difficulty working with abstract concepts like safety culture. However, safety culture can be made more concrete with organizational programs and procedures. Once the programs and procedures are in place and an organization begins to reward its employees for compliance with the safety culture programs and procedures, a healthy safety culture will follow.

2.2.3.1 Actions to Address Safety Culture in Maintenance

This entire report provides action recommendations that will improve or promote a healthy safety culture. The workshop delegates identified a number of specific recommendations that will help an organization move towards a stronger safety culture. Some of the most basic actions include:

- do not expect a regulation about safety culture,
- communicate a safety culture from the top down,
- use MX HF programs to help promote and ensure a healthy safety culture,
- use ROI calculations to justify promotional programs,
- consider hiring consultants to help measure safety culture and change,
- be patient – culture change is slow,
- nourish the current good cultural characteristics, and
- attend to opportunities for improvement.

2.2.4 Event Reporting

Event reporting was ranked as the number four concern for MX HF. Event reporting is critical because it provides the necessary data to support evolving Safety Management Systems (SMS) – without data, educated safety action is impossible. Event reporting systems can be either reactive, proactive, or both.

Dr. Bill Rankin described the Boeing MEDA system and shared some of the challenges and successes he experienced. The successful application of MEDA is characterized by, but not limited to, proper training for investigators and all employees, corporate commitment to a just culture, and application and communication of the lessons learned from the MEDA data.

Dr. Kevin Gildea described a two-year-old FAA-ATA cooperative project on maintenance and ramp line operations safety audits (refer to section 1.5.6 above). This system, modeled after a similar flight deck initiative, enables peer-to-peer audits of normal operations. The process identifies the strengths and weakness of on-going maintenance and ramp operations. The shortcomings are identified and threats are managed accordingly. Workshop delegates rated maintenance and ramp LOSA as a very strong contributor and component of SMS.

The FAA's voluntary reporting systems are absolutely critical to SMS. The FAA's Aviation Safety Action Program (ASAP) was discussed extensively. Like MEDA and LOSA the program's success must be based on education, trust, fairness, communication, and application of the lessons learned from the reports. Most felt that ASAP is one of the best examples of voluntary reporting. The ASAP reporting system empowers workers, the company, and the government to learn from events.

Each of the aforementioned reporting tools is accompanied by implementation challenges. Some of the most predominant issues across reporting systems seem to be education, trust, and corporate or government politics. For example, some see voluntary reporting as a "get out of jail free card" while others fear punishment from observation. Regardless of the challenges, the workshop delegates agreed FAA and Industry leadership cannot back down on the principles of just-culture or on the high value of voluntary reporting.

2.2.4.1 Actions to Address Event Reporting Challenges

Given the multi-faceted challenges of event reporting, a number of actions were recommended. Some of the key actions needed to improve event reporting include:

- provide extensive education to everyone involved in event reporting (including investigators, workers, corporate and government senior management, congress, the press/public),
- guard the fundamental principles of data protection and "just culture",
- ensure that companies, governments, and individuals learn from the data,
- monitor the corrective actions progress from the reported data, and
- use data and corrective actions as a means to calculate the safety and financial ROI for event reporting systems.

2.2.5 Return-on-Investment in MX HF

Number five on the post-workshop list of critical challenges was "Return-on-Investment." In his presentation, Dr. Johnson showed how to make ROI calculations. The majority of the presentation

was about financial return although safety return is also believed to be highly critical. As discussed in section 1.5.8, the calculation of safety return is not straight forward and can be more difficult to estimate. In a very safe system it is difficult to measure the incremental change that one program or intervention may have on the total system safety. Regardless of difficulty, the workshop delegates agreed the safety ROI should be pursued.

For the past three years, since 2007, AFS 300 has submitted a research requirement related to ROI. It has never made it out of the AVS TCRG committee for consideration by the Research and Development Management Team. Senior management within the FAA has begun to ask for ROI data for some human factors R&D. The R&D community must strive to implement ROI practices.

Return-on-investment calculation procedures and the demonstrated return can influence organizational actions on other MX HF challenges. For example, an ROI calculation might impact an organization's prioritization and investment in a human factors program, safety culture, fatigue risk management system, or technical publications.

2.2.5.1 Actions to Address Return-on-Investment in MX HF

The workshop delegates suggested a number of different actions that could be used to improve the use of ROI for MX HF. Specific activities that could impact increased use of ROI models include:

- fund the proposed TCRG requirement on ROI R&D that has been submitted into the process,
- promote the ROI model presented in the 2000 *Operator's Manual for Human Factors in Maintenance*,
- recommend that TCRG requirements and proposals include a plan for calculating ROI for safety and finances, and
- encourage industry to tell ROI success stories and not treat such information as proprietary and/or competitive source.

2.2.6 Establish MX HF as a Priority

The sixth MX HF challenge was to establish MX HF as a priority for both industry and government. The European Aviation Safety Authority, with assistance from the Joint Aviation Authorities, prioritized human factors by making maintenance human factors a requirement for training amongst all current aviation maintenance workers, managers, and support personnel.

Recognizably important, raising the priority of maintenance human factors is a fundamental issue like the number three ranking, safety culture. In other words, the prioritization of human factors in general will be achieved when the other identified MX HF challenges are elevated in priority.

2.2.6.1 Actions to Establish MX HF as a Priority

The FAA has supported R&D funding for MX HF since 1988. In part, the support is in response to the Aviation Safety Act's specific language on attention to human factors in maintenance and flight deck issues. The workshop delegates were in agreement that this important funding should be maintained at a reasonable level. Some specific action items to elevate the priority of maintenance human factors include:

- enact FAA regulation for maintenance human factors training, and

- create methods and support industry in the calculation of safety and financial ROI in maintenance human factors.

2.2.7 Professionalism and Generational Issues

The seventh identified challenge is a combination of two topics that are loosely related, professionalism and generational issues. The similarity is that both issues are tied to individual behavior.

In his first year, Administrator Babbitt placed a high focus on individual responsibility and professionalism. He provided examples of individual acts of unprofessionalism that lead to catastrophic events. In instances were individuals came to work unfit for duty it was considered a case of failed personal responsibility. Professionalism and personal responsibility issues are a bit more abstract than HF issues such as training for communication or use of technical documentation. Regardless, personal responsibility is critical to the safety of aviation operations and must be sought by every aviation professional.

The airline industry woes of this past decade have decimated airline retirement funds at a time when the public stock market has also collapsed many retirement savings. As a result, the industry has as many as four generations in the workforce. These generations have differences in value systems, work ethics, personal ethics, ways of communicating, ways of accessing information, and more. Despite these generational differences, the workforce must work together to perform maintenance. Generational diversity can be either a hazard to safety if mismanaged, or a significant industry strength if managed properly.

2.2.7.1 Actions to Address Professionalism and Generational Issues

The issues of professionalism and generational differences could benefit from the academic rigors and expertise offered by a robust applied research and development program. While in depth study would benefit industry and the public, it is not the kind of activity that is aligned with the capabilities of the aviation industry and corresponding funding priorities. That said; the government must take leadership on these projects. A number of actions can be pursued to address the issues of professionalism and generational differences and include:

- research and develop various types of training to address professionalism and generational differences (e.g., cross-training, mentorship, communication),
- create promotional video on AMT professionalism,
- create multi-media videos that appeal to different age groups with instructions about dealing with generational issues, and
- increase use of new technologies (e.g., PDA, cell phone)**.**

2.2.8 Attention to Required Inspection Items

A significant number of the accidents discussed in the workshop as well as many FAA actions against organizations and individuals are related to improper attention to Required Inspection Items (RII). This situation seems to be a combination of failure to follow procedures combined with complacency toward required inspection items. This challenge, again, is a combination of such challenges as safety culture, technical documentation issues, professionalism and responsibility, and raising the priority of maintenance human factors.

2.2.8.1 Actions to Address Attention to Required Inspection Items

Given the criticality of required inspection items, the workshop delegates generated a number of immediate solutions. Interventions could include:

- start a campaign that raises RII in the eyes of mechanics and inspectors,
- involve FAA safety team in the creation and dissemination of RII education materials,
- produce an instructional/motivational video and MHFPS segment that addresses the RII topic,
- encourage the use of an air carrier/operator specific training guides, and
- encourage operators to development an RII On-the-Job Training (OJT) program for the newly RII authorized employees

2.3 Other Actions Recommended by the AVS MX HF Leaders

Workshop delegates provided a number of recommendations that were not directly linked to the top eight challenges. The additional suggestions include:

- Create extensive documentation and associated whitepaper of the 1st AVS MX HF leaders Workshop.

This report is an immediate response to the recommendation.

- Add additional content to the Maintenance Human Factors Presentation System DVD.

The MHFPS system has been distributed to about 20,000 users worldwide. About 5,000 of the copies were sent based on individual E-Mail requests from around the world. The system, created in 2008, has been very popular and is the basis for many human factors training programs. It covers about 5 fundamental human factors topics, has over 150 PowerPoint slides, 40 Flash animations, and 11 video snippets. In August 2010 another video, on fatigue, will be produced for a September 2010 delivery. It will be integrated with the MHFPS and provided as a stand alone supplement to fatigue countermeasure training. Currently there is no planned funding for (FY) 2011 additions to the MHFPS. Additional segments could be completed if funding is available.

- Update Advisory Circular (AC) 120.72 Maintenance Resource Management Guidelines.

This AC was prepared in 1999-2000. It is overdue for a major revision. AFS has not allocated funding for this task in (FY) 2011. This could be completed with resource allocation. The workshop delegates strongly recommend that this action be completed.

FAA Aviation Safety Inspectors find themselves in a position to audit existing MX HF programs. There is a requirement for materials to support such audits. AFS has not allocated funding for this task in (FY) 2011. This could be completed with resource allocation. The workshop delegates strongly recommend that this action be completed.

Section 3.0 Workshop Evaluation and Comments

An invitation and hyperlink to an online course evaluation was sent to all 30 delegates following the workshop. The invitation to provide course feedback assured anonymity. Within a two-week time period, 27 of the delegates responded (90%) with feedback. The evaluation form (Appendix O) consisted of 17 items and was designed to assess attendee perceptions of workshop content, participation benefits, and the overall quality of the workshop. Delegates were also asked to provide comments or suggestions for improvement. The following sections will outline the results of the evaluation form. The complete item report is available in Appendix P.

3.1 Evaluations of Workshop Content

Respondents were asked to indicate their level of agreement (strongly disagree, disagree, agree, or strongly agree) with eight statements regarding workshop content. The response from delegates was overwhelmingly positive with every respondent (100%) agreeing that the workshop was well organized, constructive, and covered useful material. The majority of respondents felt that the workshop information was practical for his/her needs and interests (96.3%), but all of the respondents (100%) thought the workshop contained the appropriate level of detail, was appropriately paced, encouraged active involvement, and provided useful visual aids and handouts. Overall, the responses indicated that the workshop content was delivered in a manner that met the objectives of workshop organizers and delegates.

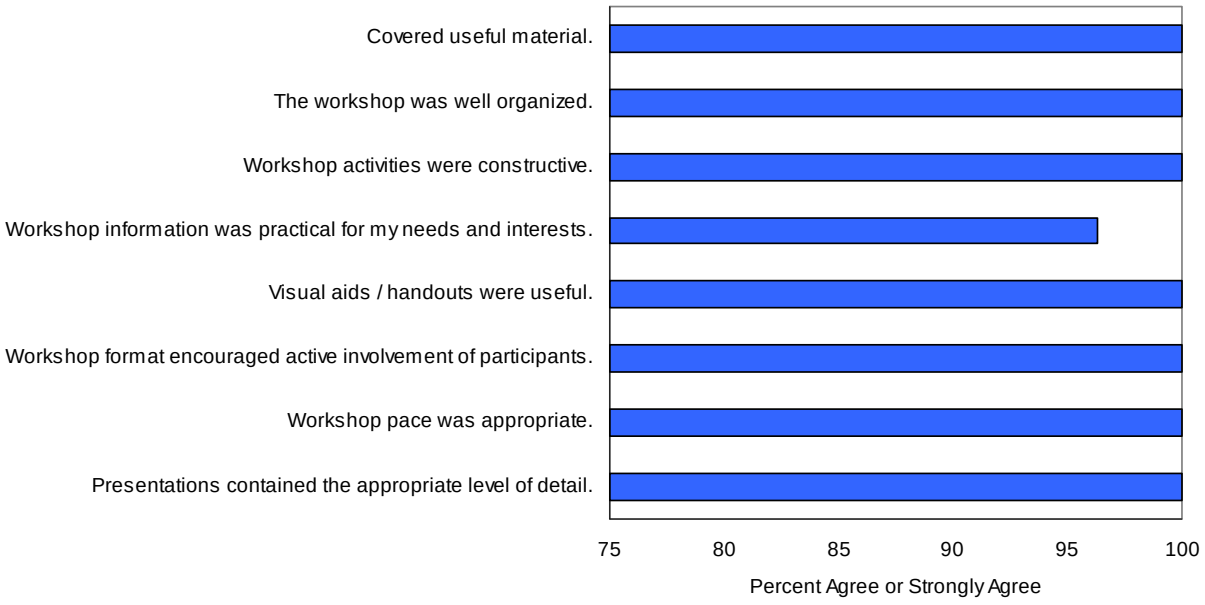


Figure 18. Delegate perceptions of workshop content

3.2 Evaluations of Participation Benefits

To quantify the benefits of the workshop, delegates were asked to indicate their level of agreement (strongly disagree, disagree, agree, or strongly agree) with a series of eight statements regarding

the benefits of the workshop. The responses indicate that the workshop's benefits are far reaching. The majority of delegates agreed (96.3%) that the workshop materials were personally beneficial (e.g., helped focus personal thoughts on MX HF, provided new insights into MX HF, and provided new information to aid in MX HF presentations). All respondents (100%) agreed that they learned information that could help them do their jobs better, and that the workshop recommendations could benefit FAA senior management and U.S. domestic aviation maintenance operations. The majority (96.3%) believed the workshop recommendations could benefit MX HF research and development and FAA MX HF operations. Overall, the responses indicated that the workshop was personally beneficial and could have far reaching implications for both the FAA and domestic maintenance operations.

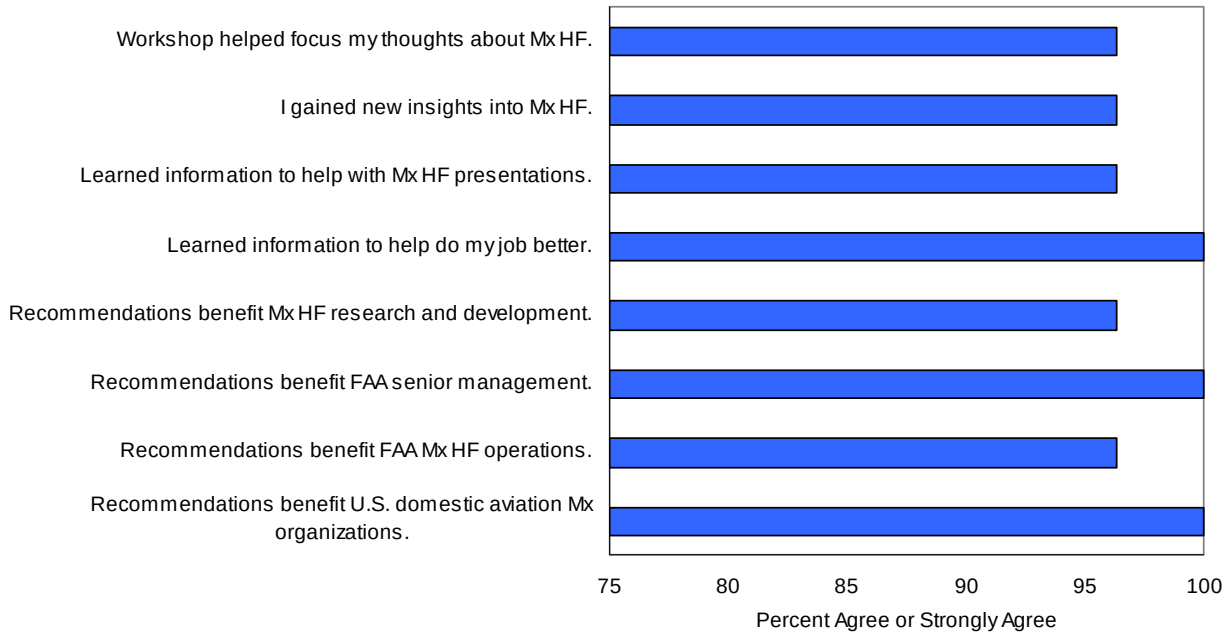


Figure 19. Delegate perceptions of workshop benefits

3.3 Evaluations of Overall Quality

Each respondent was asked one broad evaluation of the workshop overall. Respondents were asked to evaluate the course as either poor, fair, good, or excellent. Even though a few respondents disagreed with individual items regarding workshop content and participation benefits, all of the respondents thought the workshop training was either good (14.8%) or excellent (85.2%).

3.4 Suggestions for Improvement

Workshop delegates were asked two open-ended questions.

The first question "How could the workshop be improved?" was answered by 15 respondents. A review of the suggestions for improvement revealed two common themes - extension and recurrence. Six of the respondents suggested extending the meeting to allow for more in-depth discussion while four of the respondents recommended making the meeting a recurrent or annual

event to continue the discussion and momentum. The remaining five suggestions for improvement were beneficial but would be classified as miscellaneous.

The second question was very broad and simply asked, “Any other comments or suggestions?” Twelve respondents provided responses and all of the responses were complimentary or constructive. The common theme overall revealed a positive appreciation for the workshop and expectations for continued discussion of MX HF solutions in the future (Appendix P).

Appendix A: Workshop Agenda

MX Human Factors Leaders Workshop Agenda

Day 1 Wednesday, August 4, 2010

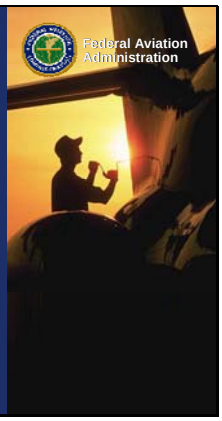
0800 – 0815	Welcome from Dr. Robert Johnson	Deputy Director of CAMI
0815 - 0830	Introduction and Logistics Workshop Format	Dr. Bill Johnson (AVS)
0830 – 0930	Extended Introduction, Name, Current responsibility, HF Background, Major concerns, Expectations	ALL
0930 – 1000	Break	
1000 - 1030	Human Factors at Transport Canada	Mr. Martin Maurino (TC) & Discussion
1030 - 1100	Lessons from Boeing MEDA Experience & International View of HF	Dr. Bill Rankin Boeing Company
1100 - 1200	Defining HF Mx Evolving Challenges	Small groups with assignments
1200 – 1300	Lunch and Small Group Work	
1300 – 1400	Small Group Challenges/Solutions	Group Speaker GA, Airline, MRO
1400 – 1445	Fatigue and Discussion	Dr. Katrina Avers CAMI Scientist
1445 – 1515	Break	
1515 – 1545	Current ASI Mx HF Training and discussion of recurrent plans	Mr. Rick Anglemyer & Discussion
1545 – 1630	An MRO HF Perspective	Mr. William Huntley (AAR) Mr. Fred Etheridge (Gulfstream)

Day 2 Thursday, August 5, 2010

0800 – 0815	Day 1 Recap and Plan	Dr. Bill Johnson
0815 – 0930	Identifying HF Examples from Accidents	Ms. Victoria Anderson FAA Accident Investigation
	Identifying HF Examples from Accidents	Ms. Katherine Wilson NTSB
	Identifying HF Examples from Accidents	Mr. Martin Maurino Transport Canada
0930 -1000	Break	
1000 – 1015	The Technical Community Requirements Group Process (TCRG)	Dr. Bill Johnson
1015 – 1045	TCRG Topic Generation Session	Group Discussion
1045 – 1115	Mx and Ramp LOSA	Dr. Kevin Gildea CAMI Scientist
1115 - 1145	Mx HF Rulemaking Discussion	Mr. Jay Hiles (AFS 330)
1145 – 1245	Lunch	
1245 – 1315	Demonstrating safety and/or $$ Payback	Dr. Bill Johnson & Discussion
1315 - 1415	Group Discussion - HF beyond Training (With Break)	Small Groups with Assignments
1415 – 1500	Small Group Reports - HF beyond Training	Group Speakers
1500 – 1630	Address issues postponed during discussions	

AVS Maintenance Human Factors Leader's Workshop

My Top 5 Concerns about Human Factors in Maintenance



Presented by: Victoria Anderson

Office Affiliation: AVP-100

Primary industry segment experience: 20 Years with a major airline, 13 years in accident investigation

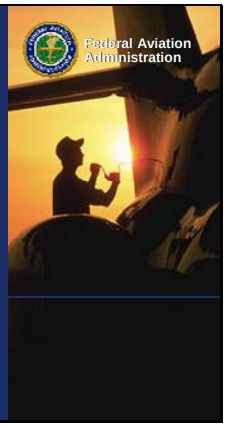
Years in Aviation: To many to count…

My Top 5 HF in MX Concerns are:

1. Health, as it relates to a person's ability to do his/her job
2. Fatigue
3. Lack of continuing proficiency checks
4. Layout of work areas
5. Lighting in work areas

AVS Maintenance Human Factors Leader's Workshop

My Top 5 Concerns about Human Factors in Maintenance



Presented by: Rick Anglemyer

Office Affiliation: SCSI (contractor)

Primary industry segment experience: USAF, airlines, HF training

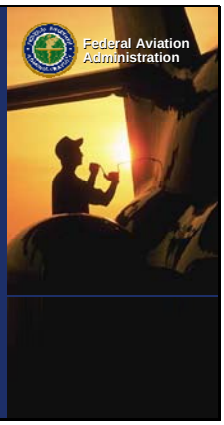
Years in Aviation: 40

My Top 5 HF in MX Concerns are:

1. Senior management buy-in of HF training
2. Implementing a Just Culture
3. Operators accepting fatigue counter-measures, i.e., naps
4. ROI of HF training
5. No regs

AVS Maintenance Human Factors Leader's Workshop

My Top 5 Concerns about Human Factors in Maintenance



Presented by: Katrina Avers

Office Affiliation: CAMI – HF Lab

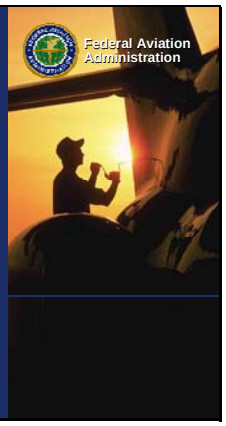
Primary industry segment experience: Gov't

Years in Aviation: 3

My Top 5 HF in MX Concerns are:

1. Fatigue Risk Management
2. Identification of preconditions for unsafe acts
3. Organizational/supervisory influences for unsafe acts
4. Maintainer proficiency and knowledge exchange over next 10 years
5. Safety culture in GA Mx operations

AVS Maintenance Human Factors Leader's Workshop



My Top 5 Concerns about Human Factors in Maintenance

Presented by: Joy Banks

Office Affiliation: Human Factors Research Lab

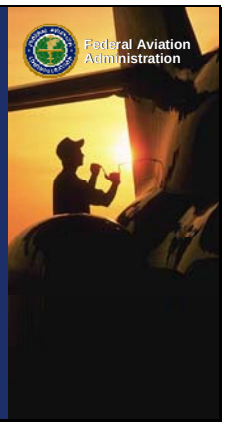
Primary industry segment experience: FAA

Years in Aviation: 3 Years

My Top 5 HF in MX Concerns are:

1. **Fatigue**
   - 3 consecutive shifts of 16 hours
   - Long commutes – in/out of state and international travel

AVS Maintenance Human Factors Leader's Workshop



My Top 5 Concerns about Human Factors in Maintenance

Presented by: Mark Brock

Office Affiliation: FAA Northwest Mountain Regional Office

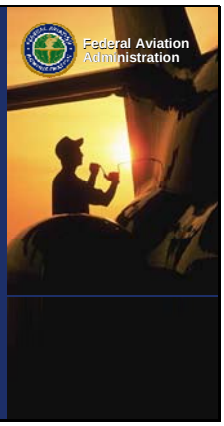
Primary industry segment experience: Airlines and GOV

Years in Aviation: 29

My Top 5 HF in MX Concerns are:

1. **Is there a standard or working model for an aircraft mechanic?**
2. **If there is a standard working envelope for an aircraft mechanic, does it have measureable limitations?**
3. **If there is identified limitations, can potential human factor errors be identified?**
4. **If there are measurable potential human factor errors, can a risk value association be made to help establish methods of prevention?**
5. **Are there any automation tools that can be applied to help prevent maintenance human factor errors?**

AVS Maintenance Human Factors Leader's Workshop



My Top 5 Concerns about Human Factors in Maintenance

Presented by: Brian Capone

Office Affiliation: ASW204 SW FAASTeam

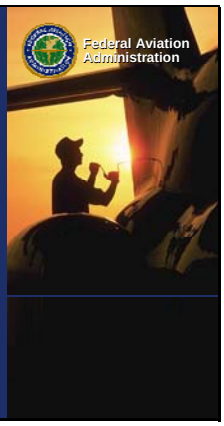
Primary industry segment experience: Government

Years in Aviation: 30

My Top 5 HF in MX Concerns are:

1. **HF Factors with computer automation**
2. **Simple Products to get HF message across**
3. **Why mechanics don't Follow Procedures**
4. **Maintenance Fatigue: Duty Times**
5. **Effects of Shift Work**

AVS Maintenance Human Factors Leader's Workshop



My Top 5 Concerns about Human Factors in Maintenance

Presented by: Greg Carroll - ASI

Office Affiliation: FAA - Delta CMO (Atlanta)

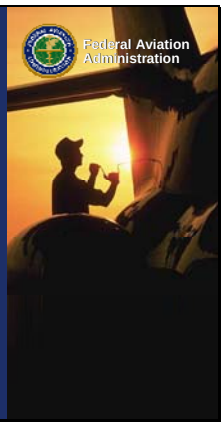
Primary industry segment experience: Airline

Years in Aviation: 22

My Top 5 HF in MX Concerns are:

1. Motivating Airline Managers Away From Penalty Driven Cultures
2. Human Factors – Eclipsed By SMS?
3. 'Selling' Human Factors Programs In The Absence Of A Rule
4. Human Factors Programs With Lasting Behavioral Change Effects
5. Controlling Intentional Risk Taking

AVS Maintenance Human Factors Leader's Workshop



My Top 5 Concerns about Human Factors in Maintenance

Presented by: Jennifer Ciaccio

Office Affiliation: Management and Program Analyst

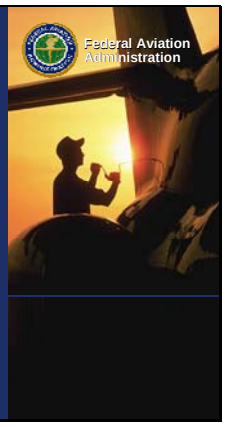
Primary industry segment experience:

Years in Aviation: 6 years

My Top 5 HF in MX Concerns are:

1. Gaining support and real buy-in from management at both large and small organizations, including those with just one maintenance worker. Saying you support it is one thing, but actually doing it is another.
2. Being able to justify the cost of MHF training and adherence to general principles (adequate rest, awareness of personal issues that affect one's ability to work safely, the "dirty dozen", etc.) to management and employees alike.
3. Public awareness of human factors issues. Make them real to the general public so they continue to push industry to improve. People don't want sleepy truckers, and they shouldn't accept maintainers that are not adequately trained, rested, aware, certificated, etc.
4. Continue to get the message out to all FAA inspectors, including GA.

AVS Maintenance Human Factors Leader's Workshop



My Top 5 Concerns about Human Factors in Maintenance

Presented by: Fred Etheridge

Office Affiliation: Manager, Compliance and Technical Training at Gulfstream Aerospace

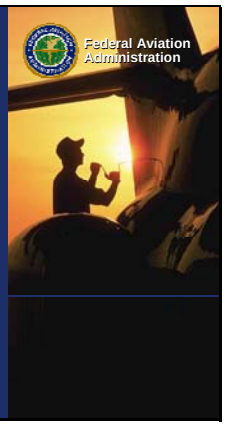
Primary industry segment experience: MRO/OEM

Years in Aviation: 22

My Top 5 HF in MX Concerns are:

1. Fatigue Risk Management
2. New employees in just culture

AVS Maintenance Human Factors Leader's Workshop



My Top 5 Concerns about Human Factors in Maintenance

Presented by: Keith A. Frable

Office Affiliation: Delta Air Lines CMO

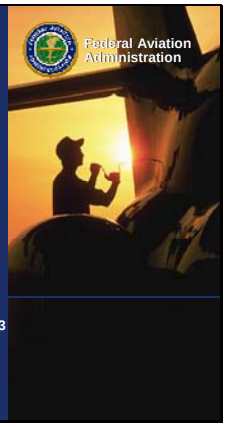
Primary industry segment experience: Principal Maintenance Inspector/ FAA

Years in Aviation: 22

My Top 5 HF in MX Concerns are:

1. **Complacency** (i.e. not following approved procedures)
2. **Distractions**
3. **Fatigue**
4. **Pressure** (high on-time rate)
5. **Lack of Knowledge** (many fleet types and procedures)

AVS Maintenance Human Factors Leader's Workshop



My Top 5 Concerns about Human Factors in Maintenance

Presented by: Victoria Frazier

Office Affiliation: CSTA Program Manager, AIR-103

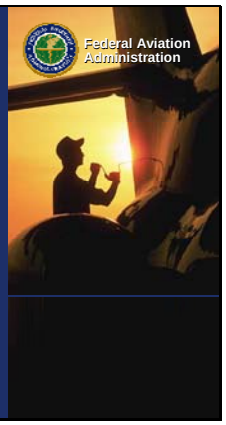
Primary industry segment experience: Government

Years in Aviation: 10 yrs

My Top 5 HF in MX Concerns are:

1. **Mechanic thinking a problem is fixed, when it is not**
2. **Inspections not catching problems**
3. **Maintenance not occurring on schedule**

AVS Maintenance Human Factors Leader's Workshop



My Top 5 Concerns about Human Factors in Maintenance

Presented by: Kevin Gildea

Office Affiliation: AAM-510

Primary industry segment experience: DoD contractor

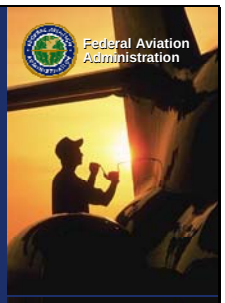
Years in Aviation: 10

My Top 5 HF in MX Concerns are:

1. **Will MX personnel internalize their organizations' safety cultures?**
2. **To what degree will MX personnel adapt to continued rapid changes?**
3. **Will MX personnel be able to identify the challenges in their environment before an incident or accident?**
4. **Can the research community place the proper resources in the right places to really make a difference?**
5. **How successfully will we engineer systems and develop procedures that allow the greatest chance for safe operations?**

AVS Maintenance Human Factors Leader's Workshop

Federal Aviation Administration



My Top 5 Concerns about Human Factors in Maintenance

Presented by: Jim Hein

Office Affiliation: AWP-204, Honolulu FSDO

Primary industry segment experience:
GA Maintenance and Airline Maintenance Reliability

Years in Aviation: First flying lesson 1964

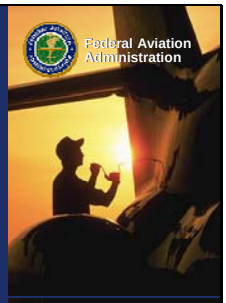
My Top 5 HF in MX Concerns are:

1. **PERSONAL HEALTH**
   - Fatigue, stress, memory, mental, physical, spiritual, family, ethics
2. **PHYSICL ENVIRONMENT**
   - Lighting, Temperature, Tool Management, Working surface, sound, ergonomics, clothing, PPE
3. **CORPORATE ENVIRONMENT**
   - Communication/styles, management/styles, expectations, feedback, reporting system, honesty, legal, group think, error management
4. **JOB KNOWLEDGE**
   - Privileges, Limitations, skills, abilities, competency based performance standards
5. **CONTINUING EDUCATION**
   - Blended training, history, safety practices, skills, androgogy vs pedagogy, maintenance management training

Top 5 HF in MX Concerns
AVS MX HF Leaders Workshop - 4-5 August 2010
Federal Aviation Administration
26

AVS Maintenance Human Factors Leader's Workshop

Federal Aviation Administration



My Top 5 Concerns about Human Factors in Maintenance

Presented by: Jay Hiles

Office Affiliation: AFS – 300 Washington DC. HQ

Primary Industry Segment Experience: Air Carrier Maintenance / GA Flight and Maintenance

Years in Aviation: 32 years

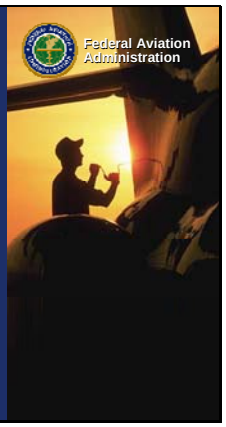
My Top 5 HF in MX Concerns are:

1. Harmonizing regulatory and guidance material that require HF intervention (Communications)
2. The future of HF Research and Development
3. Ensuring rulemaking efforts that have HF implementations remain strong throughout the rulemaking process – especially during the comment period
4. The challenges associated with the current HF website
5. Who will replace me at HQ!

Top 5 HF in MX Concerns
AVS MX HF Leaders Workshop - 4-5 August 2010
Federal Aviation Administration
28

AVS Maintenance Human Factors Leader's Workshop

Federal Aviation Administration



My Top 5 Concerns about Human Factors in Maintenance

Presented by: Bill Huntley

Office Affiliation: AAR CORP Director Human Factors & Safety Management Systems

Primary industry segment experience: DoD, Part 121, 145, – Quality, Safety, Training and Maint.

Years in Aviation: 26 **A&P, ASQ CQA**

My Top 5 HF in MX Concerns are:

1. MX HF has not been "Sold" to Top Mgmt
2. Training is used to "Fill the HF Square"
3. Operational needs push the HF theory and practice aside
4. The business case for HF and ROI is not very strong – Leaders don't see the value
5. Most training still relies on outdated (however important) information – new material should focus on every level in an organization – not just Technicians.

Top 5 HF in MX Concerns
AVS MX HF Leaders Workshop - 4-5 August 2010
Federal Aviation Administration
30

AVS Maintenance Human Factors Leader's Workshop

Federal Aviation Administration

My Top 5 Concerns about Human Factors in Maintenance

Presented by: Steve Keesey

Office Affiliation: FAAST Team, AW FPM - OK

Primary industry segment experience: GA, Manufacturing, Air Carrier Maintenance

Years in Aviation: 30 years

- Complacency
  - Inadequate Preflight Inspections
  - Limited use of Technical Data
  - Lack of Assertiveness
  - Over Tasked

AVS Maintenance Human Factors Leader's Workshop

Federal Aviation Administration

My Top 5 Concerns about Human Factors in Maintenance

Presented by: Terry Kleiser

Office Affiliation: IND FSDO

Primary industry segment experience: 121 Air Carrier

Years in Aviation: 31

My Top 5 HF in MX Concerns are:

1. Lack of Knowledge i.e. GMM Policy/ Procedures, Required Inspection Items & Major/Minor repair classification
2. Fatigue
3. Norms
4. Lack of Resources i.e. parts, tools
5. Complacency

AVS Maintenance Human Factors Leader's Workshop

Federal Aviation Administration

My Top 5 Concerns about Human Factors in Maintenance

Presented by: Martin Maurino

Office Affiliation: Transport Canada

Primary industry segment experience: Airlines, Gov

Years in Aviation: 8

My Top 5 HF in MX Concerns are:

1. Fatigue
2. Documentation - Quality
3. Training (HF, SMS)
4. Workarounds (deviations, shortcuts)

AVS Maintenance Human Factors Leader's Workshop

Federal Aviation Administration

My Top 5 Concerns about Human Factors in Maintenance

Presented by: Guy Minor

Office Affiliation: FAA, Western Region - LAX

Primary industry segment experience: Gov,

Years in Aviation: 38 years

My Top 5 HF in MX Concerns are:

1. FAASTeam Human Factors National project
2. Human Factors Book Club
3. Non-Technical/Leadership Training for Maintainers
4. Communications Network/Knowledge Sharing site for HF/HE Group
5. Approval Method for Human Factor Training Product

AVS Maintenance Human Factors Leader's Workshop

Federal Aviation Administration

My Top 5 Concerns about Human Factors in Maintenance

Presented by: Dwayne Pittsenbarger

Office Affiliation: So. Reg. FAASTeam, SC FSDO

Primary industry segment experience: General Aviation

Years in Aviation: 30

My Top 5 HF in MX Concerns are:

1. Complacency (Dirty Dozen)
2. Norms (Dirty Dozen)
3. Instilling professionalism and ethics at earliest stages of career training
4. Personal Responsibility
5. Human Factors awareness

AVS Maintenance Human Factors Leader's Workshop

Federal Aviation Administration

My Top 5 Concerns about Human Factors in Maintenance

Presented by: William L. (Bill) Rankin

Office Affiliation: The Boeing Company

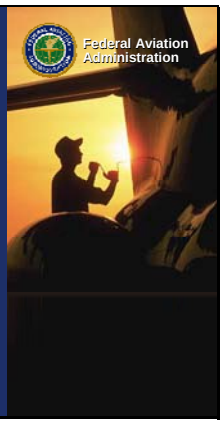
Primary industry segment experience: Manufacturing

Years in Aviation: 24

My Top 5 HF in MX Concerns are:

1. Lack of FAA regulatory requirements for Human Factors applications in maintenance.
2. Moving beyond Mx Human Factors Training regarding the application of HF in maintenance.
3. Developing a good Fatigue Risk Management process for maintenance.
4. Applying risk assessment in a Maintenance Safety Management System.
5. Carrying out good maintenance-caused event investigations.

AVS Maintenance Human Factors Leader's Workshop



My Top 5 Concerns about Human Factors in Maintenance

Presented by: Bobby Reed

Office Affiliation: ACE FAASTeam

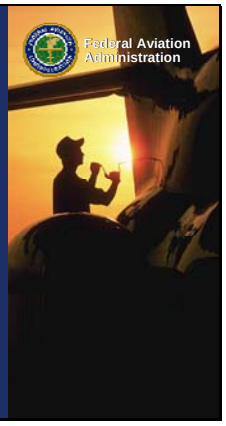
Primary industry segment experience: Large Transport Military and some GA

Years in Aviation: 28 years

My Top 5 HF in MX Concerns are:

1. **Challenge To Change to Safety Culture**
2. **Non-existent or Missing HF Data**
3. **Lack of interest by company managment**
4. **Lack of Resources**
5. **Low on the Priority List compared to Ops**

AVS Maintenance Human Factors Leader's Workshop



My Top 5 Concerns about Human Factors in Maintenance

Presented by: Mary Schooley

Office Affiliation: Transport Airplane Directorate Safety Management Branch

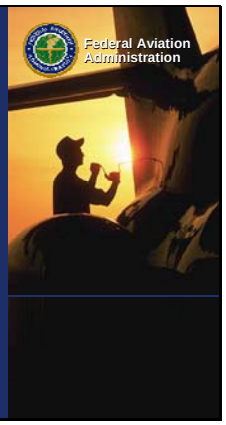
Primary industry segment experience: Safety Recommendations Program Manager (current), Human Factors Engineer FAA Tech Center, California Air Guard C-130 Maintenance

Years in Aviation: 25

My Top 5 HF in MX Concerns are:

1. **Accessibility and error-proof MX tasks designed into aircraft. Goal of reducing reliance on training**
2. **Criteria and monitoring strategies for fatigue in MX. Goal of alerting / preventing potential fatigue related errors**
3. **Operational definitions, guidance and LOSA style audits for safety and reporting MX cultures**
4. **Tools and guidance to better manage the risk of HF MX errors for manufacturers, overhaul organizations, operators and FAA overseers**

AVS Maintenance Human Factors Leader's Workshop



My Top 5 Concerns about Human Factors in Maintenance

Presented by: John Sims

Office Affiliation: Alaska Regional 230 Branch

Primary industry segment experience: Airlines, GA, MRO, Gov – All three disciplines

Years in Aviation: 30 + years

My Top 5 HF in MX Concerns are:

1. **Mx personnel design, build and maintain. Pilots only operate: Why only now……..**
2. **SMS: MX needs to be integrated visibly into these systems**
3. **How do Mx factors play into current accident prevention mgmt**
4. **HF in: Automation, corporate culture, TEM, fatigue, workload, stress, workload, etc…**
5. **Overview of HF and any recent/current advances**

AVS Maintenance Human Factors Leader's Workshop

Federal Aviation Administration

My Top 3 Concerns about Human Factors in Maintenance

Presented by: Vickie Stahlberg

Office Affiliation: HNL CMO

Primary industry segment experience: Air Force (mechanic), Rockwell NAAO (mechanic), GE (Tech Rep), Hartzell (Tech Rep)

Years in Aviation: 32 (includes 15 yrs with FAA)

My Top 3 HF in MX Concerns are:

Work Schedule

- Shift work (i.e., working different shifts each week)
- Excessive hours
  - Double shifts (i.e., 2 - 8 to 10-hour shifts in a row)
  - Continuous weeks (i.e., 14+ day in a row, etc.)

Work Environment

- Working in bad weather (i.e., rain, night, extreme hot/cold)

AVS Maintenance Human Factors Leader's Workshop

Federal Aviation Administration

My Top 3 Concerns about Human Factors in Maintenance

Presented by: Vickie Stahlberg

Office Affiliation: HNL CMO

Primary industry segment experience: Air Force (mechanic), Rockwell NAAO (mechanic), GE (Tech Rep), Hartzell (Tech Rep)

Years in Aviation: 32 (includes 15 yrs with FAA)

My Top 3 HF in MX Concerns are:

Work Task Diversity

- Working a variety of different products in one shift (i.e., B737 classic, B737 new gen, B747, B757, B767, B777, Airbus 320, Airbus 330, etc.)
- No specialization requirements

AVS Maintenance Human Factors Leader's Workshop

Federal Aviation Administration

My Top 5 Concerns about Human Factors in Maintenance

Presented by: Michele Wallentine

Office Affiliation: RKMCMO

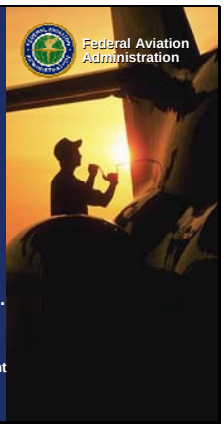
Primary industry segment experience: Government

Years in Aviation: 29

My Top 5 HF in MX Concerns are:

1. Fatigue
2. Lack of Resources
3. Pressure
4. Communication
5. Lack of Assertiveness

AVS Maintenance Human Factors Leader's Workshop



My Top 5 Concerns about Human Factors in Maintenance

Presented by: Katherine Wilson, Ph.D.

Office Affiliation: National Transportation Safety Board

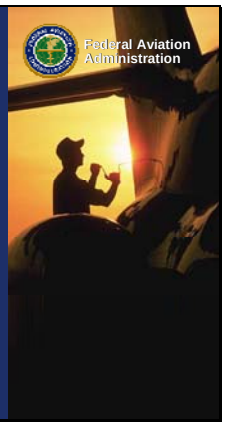
Primary industry segment experience: Government

Years in Aviation: 11 years

My Top 5 HF in MX Concerns are:

1. **Fatigue**
2. **Training/supervision**
3. **Performance-based testing**
4. **Guidance/instructions**
5. **Documentation procedures**

AVS Maintenance Human Factors Leader's Workshop



My Top 5 Concerns about Human Factors in Maintenance

Presented by: Nadine Yeager

Office Affiliation: Central Region FAASTeam, Memphis, TN FSDO

Primary industry segment experience: General Aviation Operations, Air Traffic Controller, Flight Instructor

Years in Aviation: 30+

My Top 5 HF in MX Concerns are:

1. **Normalization of Deviance**
2. **Lack of Awareness**
3. **Pressure**
4. **Complacency**
5. **EGO**

Speaker	Dialogue
Dr. Bill Johnson	Hi I'm Bill Johnson. We've dedicated enough time for the introductions for you to say the kind of things you need to say on your level of interest in being here. Let's go ahead and get started now.
Victoria Anderson	I am Victoria Anderson. For email purposes or just a normal conversation I'm Vickie Anderson. I work in the FAA's office of Accident Investigation in Washington, it used to be AAI, now we're AVT. We handle major accidents and incidents world-wide. And I've been an investigator for 16 years. I'll be talking about one of my accidents that was an maintenance related accident. Well, I'm not one of the really smart PhD's and smart in human factors in here, I'm an accident investigator and when everything fails is when I get involved in the investigation. So the accident that I'm going to talk about, one that wasn't mine that we saw years ago, was a [unintelligible] airplane that landed in Dorita. An engine literally fell down because the fuse sensor had been left off and they were sitting on a ramp back in Minneapolis-/St. Paul. That's when I got interested in how did that happen. And it was fascinating how the maintenance was done, how the lighting was, who was the supervisor, who was on all of that train of things that happened was so interesting to me. So I can say, I'm not the smart one in here but I do see the end results of what happened. Well, that's all I have to say.
Rick Anglemyer	My name is Rick Anglemyer, one of the few non-FAA people here. I'm actually a contractor. I work for Southern California Safety Institute, my job there is the Director of Human Factors Training Programs and I was the architect, designer and instructor for the Human Factors in Aviation Maintenance that all the ASI's are getting. There are a lot of familiar faces here, people that have been in a class before and when we get a little farther down the road, we've trained almost 1200 ASI's out of 1800 So we're well on our way of getting everybody trained with the same course. My primary function is looking at it from the training side, you know how do I get this information across, what's relevant to the ASI's and later on today we'll be talking about what's for the future. We know what should we in some of the out years to continue this type of training with the ASI's. My basic background in this, I'm actually on the ops side. 20 years in the USAF and as a pilot for Eastern for just a couple of years before they rolled over and died. Since the early 90's, I've been involved exclusively in what we'll call human factors training: CRM, Maintenance Resource Management (MRM), accident investigation concentrating on the human condition, its the human side. I actually developed the very first program for the US Air Force, and when they instituted their MRM it was based on an accident in Charleston, SC. I also developed this for the FAA. And early on we actually developed some of the very first CRM training for SAC. If anybody remembers old SAC
Joy Banks	Oh yeah. I was at Offutt AFB, NE.
Rick Anglemyer	Oh, is that right?
Joy Banks	Headquarters, yeah.
Rick Anglemyer	So you were in the old SAC for awhile?
Joy Banks	Yeah.
Rick Anglemyer	So my background covers a lot of areas, and like I said I've really been in aviation for about 40 years continually since I started pilot training at Willy. Some of my concerns, if you'll look at those up there, most of them have to do with the operators. Because the feedback I get from the ASI's is how they work with their operators. We talk about Just Culture

Speaker	Dialogue
	and maybe Bill and I can talk later about this culture and how to get the operators to buy into it. Okay, I said nothing requires them to buy it and we're still actually living in a culture of blame in some of these areas. So senior management buy-in, I think that's the secret and once we can do that then it will be much easier and the ASI's that I work with, they're the salesmen. They're out there pushing this with the operators. It's the operators we want to get to. The ASI's are knowledgeable on human factors; some of the operators maybe not so much. Some of the counter measures we have, I noticed fatigue was in a lot of the issues, the challenges that people brought up, the counter measures we have like what I call NASA Naps, power naps. Most of the operators just laugh at that, like if somebody is napping they're going to get fired. We need to get over that. We really need to get over that. Return on investment and the last thing I'll always bring up is when you ask them well "Why don't you have a human factors program?" they're going to say, "Costs money, then its not required". So these are to me the challenge that we need to look forward in the future. So I'm glad to be here to hear what everybody has to say, I'll offer my two cents in here like I always do. I know the guys who've had me in class are not afraid to talk about some of these issues. Right guys?
Dr. Bill Johnson	Yes, Rick we know that you and your colleagues never run out of enthusiasm its like every time you teach that class people say its like the first time you taught it.
Rick Anglemyer	You have to do that.
Dr. Bill Johnson	That you are really pumped up every time.
Rick Anglemyer	Well the part of that is I really like the ASI's, and I remember when we first started working on this you said, "Now Rick you know you're a pilot, these ASI's are going to eat you alive if you tell them pilot stories". Well it's a mutual kind of understanding here they like to hear some pilot stories and of course I like to hear all the maintenance stories. Most of them are bright-eyed, ears wide open, so-
unknown	We're just big teddy bears.
Rick Anglemyer	That's it, that's all. And I'm the one, you see we don't give them their certificates until the very last day of the [unintelligible].
All	[Laughter]
Rick Anglemyer	You got to pass the test then you'll get your certificate, right?
unknown	That's right.
Dr. Bill Johnson	I think there's a pretty fair change that you know more; you and your colleagues know more about what it denotes about human factors than anyone, cause you're the one that has spoken to 1200 of our inspectors.
Rick Anglemyer	That's right.
Dr. Bill Johnson	It's really, so we're delighted that you're here.
Joy Banks	Dr. Katrina Avers is in the building, she is presenting at a cabin safety training for flight attendants. She'll be here probably after the break, but I just wanted to put her slide up and show you her top 5 concerns. As for me, I guess I'm the rookie in the room today, even though I'm retired Air Force after 20 years, but I've only been with the FAA for 3 years working in human factors research right here in CAMI. I don't have as much experience in human factors, comparatively speaking, to everyone else in this room, but one of the things that we're working on is fatigue. Just a few months ago I gave fatigue countermeasures training to maintenance technicians in Texas. I learned that some technicians in the training were working three consecutive 16-hour shifts and then commuting home. Some were even flying in from around the country to work those

Speaker	Dialogue
	3 days consecutively and then flying home. That was just really, really scary to hear. They are at high risk for fatigue related accidents.
Mark Brock	Thank you. What I'd like to say is for those people here that are professionals, like Dr. Johnson and Rick. I've had a chance to take your classes and you guys have sparked the human factors imagination within my experience. So while you guys are focused on the higher levels of academics, I'm out in the working world and of course I have a history as an aircraft mechanic since around 1979. At this time my experience in the FAA puts me in a maintenance environment which I hope is where we are going with the goals of this workgroup. While cockpit recourse is important, my interest is not as a pilot, but as a technician in support of such operational objections. My current situation is as the principal avionics inspector at an essential maintenance provider employing about 1500 mechanics for work on aircraft operated by major air carriers such as Delta, Southwest, Hawaiian, UPS, and previously with FedExpress, I'll give a recent example where a quality escape was reported using the voluntary disclosure program and one of the avionics technicians hooked up the buss side wire to a circuit to the load side of the breaker. In another words they electrically remove the circuit breaker from the circuit. So we think, "Well gosh, how can something like that happen?" So we look at issues like fatigue, and think, was that a factor in the error. So what I hope is, wouldn't it be great is if we could put a model out there for the working environment I've described. So this is my question: Is there a standard working model for an aircraft mechanic? If we represent the airplane as a box where all maintenance should occur inside the box and color the box green but then the mechanic works outside the box but inside a triangle that encapsulated the box and we color the triangle yellow, we have a risk model for working outside a normal operating envelope. If we can identify when a mechanics starts to work in a risk area outside the normal operating envelope, then we can act to mitigate any perceived risk. To limit risk further, we can take the normal operating envelope and make it smaller, limiting any risk by advocating focused tasks while still working within the normal operating envelope and ensuring that the mechanic uses only accepted methods and techniques. Nevertheless to work outside the box can promote improved methods and techniques and increase productivity. So I thought if we could somehow model that and establish measurable limitations, like I said we take a green box with yellow flags on it, we start to identify maintenance human factor risks. And if we can measure those, like fatigue for example, we could have the mechanic go take a nap. I think that's a great idea, and I don't believe there is anything wrong with doing that in the work environment if it reduces risk or a maintenance error. For example, pilots have crew rest areas to combat fatigue so a nap has already been identified as means to effectively mitigate the risk of fatigue? Using that as a simple example, and depending on our background and interest, can a model of measurable probability be developed so an appropriate action can be taken to mitigate the perceived risk? So I was hoping a formula could be developed by people like Dr. Johnson and others who can use this idea to develop a structured model. Thank you.
Brian Capone	I'm Brian Capone, I'm with the FAAST team, over 30 years in aviation, mostly general aviation and a lot of government working not only FAA, some other agencies to include Customs Service, drug interdiction and a

Speaker	Dialogue
	lot of weird stuff, along with some state aviation work. One of my concerns isn't substantiated by 'official' data studies, but you know that tug in the side. Its just information gleamed when I talk to a lot of mechanics. Out of Baton Rouge we deal with a lot of the helicopter operators in the Gulf with a lot of helicopter experience and we're just rolling into all the automation into helicopters, glass cockpits and all that stuff, and I get involved with issues concerning computers and the maintenance manuals themselves. I think it's just the thirteenth of the dirty dozen I call it automation frustration. I don't know of any data, but I think there's a lot of issues out there with the automation side of the house dealing with computer maintenance manuals, and using them. Some people, and maybe its the generation thing, you know maybe when the next generation mechanics are out there if we have them it will go away, but I see people that can read something but can't read it on the computer. So that's one of things that has been bothering me. Another thing is I'm just an old swamp Louisiana boy, and we keep it pretty simple; we work hard, we like to play hard and if anything that comes out of human factors dealing with the mechanics you have to be simple, and it has to be the realistic side and not the theory side, cause they just turn it off. So I think as we develop things that we need to kind of keep that in mind to the mechanic level. One of my favorite topics and I know it is a FAAST team push, this big failure follow procedures but you know, my question is, Well why don't we follow procedures? And so I think we need to develop that a little bit more.
Dr. Bill Johnson	You don't know the answer to that question do you?
Brian Capone	Some things, I think. And then the last two up there have been mentioned already and they are just regular routine stuff. There's no regulation on work amount for mechanics in a small GA world and the Part 135, just go and go and go and it creates issues.
Greg Carroll	Good morning everybody my name is Greg Carroll from Atlanta. I'm an FAA inspector on the Atlantic Southeast Airline certificate; been with the FAA for 4 1/2 years. What got my appetite going for human factors and industry, I use to be a regulatory compliance manager for Delta Airlines, and in that role, along with running interference in front of the FAA, I did accident investigation so that's where I really kind of got my first exposure, and gained a passion for human factors, air management and cultural change. So it's kind of funny that I've lived life on both sides of the fence. It's been interesting really getting used to trying to work with the operators and encouraging them do the things obviously in the right direction. Anyway to that end I came up with what I thought what I see particularly with respect to my operator, a rapidly growing regional operator with quite a few airplanes now and they are going to have a huge fleet here in the next few years. So there coming away from this shade tree regional mentality into an actually major mentality, and we're trying to push them along. These are my top five concerns - motivating the airline managers way from the penalty driven culture is what we are seeing is this arbitrary dollar figure and when people go out and damage airplanes I start thinking that it reaches some level there it just well, we don't have a choice, we have to get rid of them, they have to go we can't withstand this risk. For example, we had one technician that drove an airplane into two others destroyed one and severely damaged the other two. Between deductibles and damages and down time they were the airline was out well over $10 million dollars and despite my best efforts within the boundaries of priority of course, despite my best you just invested 10 million dollars in a poster child for what not to do and you're

Speaker	Dialogue
	getting ready to put that investment on the street. #2, I won't say much about it, I'm involved with the [SASO] program the FAA people know what that is and I'm a little bit concerned the push particularly at the operator level toward SMS is eclipsing human factors. That maybe just a perception on my part. I don't want to see that happen. #3 selling human factors programs, Rick already covered this - its absolutely true, its just tricky. It's sometimes easy to get an operator to agree to train everybody in 4 hours of basic human factors awareness training and then it's forgotten and away they go, which leads me to #4; what does a human factors program look like, that's going to have lasting effects in the way people, the individual approaches his or her job. I would love to see something come out here about them. Cause we inspectors have to sell the program because they don't have a rule to enforce; if we're trying to sell them a program, we need to know that's its going to have lasting effects, we need strategies to be able to influence the operator and early direction. And they really don't have that right now. The 5th one, this is my big one, this is the one that just gets me and it goes back to what Mark just said, controlling intentional risk taking. I found you have people who have been with the company, 3, 4 or 5 months but they want to show that they know how to do it. They'll get an assignment that they are not qualified to do and they know they are not qualified to do it but they do it anyway. Because they want the boss to be happy, so we have complacency in the ignorance of inexperience over here and then we have complacency in the 35 year guy who, "You're not going to tell me how to do something". I was standing right next to the guy doing servicing a nose strut the other day, he knew I was standing right there and intentionally did it wrong. Didn't have the manual this guy, you're not going to tell him anything. Now how do we deal with that? How do we change his mindset away from that to do it the right way. Okay I'll get off the box.
Dr. Bill Johnson	I can't resist one question on your very 1st bullet would you mind if I suggest the modification to say motivating airline and FAA office managers away from a penalty here in the culture. But that's jeopardizing ASAP right now.
Jennifer Ciaccio	Okay. My name is Jennifer Ciaccio and I am a management program analyst in the aircraft maintenance division at FAA headquarters in Washington DC, and I've been in aviation for 6 years almost, before that I was at telecom so I really don't have an aviation background. My biggest concern is that getting real buy-in from management. I think you probably have it in a lot of the larger organizations, but I think the smaller organizations you really don't have a part 135 operators, especially ten or less and you know they may only have one worker, so how are they really going to implement a human factors program and do that. Then being cost justification for training, adherence to the principles to match that employees likes so employees may not want to really rest, they want that double shift, they want that triple shift because they have to make money. They have a long commute because they can't afford housing closer. I mean I know for myself I have a 2 hour commute each way. I get up at 4:30 in the morning and its a long day and I have a 9 hour shift and not a 12 hour shift so I'm tired. And I'm not working on a airplane that's going to effect anybody. No one's going to die because I'm tired. But they can die. I just think we need more public awareness for human factors issues. I mean we have mentioned truckers, because people know about fatigue

Speaker	Dialogue
	and sleeping truckers. Make the airlines more aware. Just getting the message out to inspectors, including the GA inspectors because they can drive it home with their operators and look at the small organizations.
Dr. Bill Johnson	Jennifer was one of the key people that worked with us to get that maintenance human factors presentation system together. She did line by line, edits of everything including graphics and minimum of ten times, so you know quite a bit about human factors from that experience. I wanted to mention that as well.
Fred Etheridge	Good morning, I'm Fred Etheridge with Gulfstream Aerospace based out of Savannah Georgia. I'm the compliance and technical training manager for the corporation of Gulfstream. I'm responsible for human factors elements and all of the training that we have, whether it be sealant, metal to metal bonding those types of things, as well as the human factors training implementation program, as well as SMS. I've been there for 7 years, 22 years in aviation. If you don't know that much about Gulfstream we are an MRO as well as the OEM of our product. We have 12 repair stations, a couple of which are international. So we started our human factors program back in 2007, we're a company of about 9,000 people who've gone through all of our 145 operations and implemented a lot of those changes as well as the training because we all know the training is a big part of that. We're getting ready to implement that into our MRO. So thank you for having me here. Some of my top five, and you won't see them up there, I'm so sorry Joy, and you can beat me around I've been gone for about 4 weeks. Of course fatigue risk management, if there's something within Gulfstream that we started to have within a year and a half. We have like Go teams to go all over the world to go work on a customers aircraft on call; you're working for 2 weeks straight, on call, you have to be available within 2 hours. So we need other fatigue risk things. Of course we already have those concerns and we're trying to work those at Gulfstream but that's all our big ones right now is trying to tackle that. That one portion of it, and we're trying to tackle that because some of our competitors and other industry friends are starting to do the same kind of work. So we can see if that's branching out in a lot of other places. We also did, we started SMS about 2 years ago, we have about 1/2 of our operational, which is about 5,000 people, that have gone through a portion of that and again we're getting ready to start the FAR 21 side of that for us as well. One of our biggest challenges is bringing in about 40 new people a week into Gulfstream and introducing them to those outside people externals into our just culture. We've taken dollar amounts away from aircraft damage and things like that. So we're starting to see that we continually start to battle with that kind of stuff. Everything else that I've seen so far I have those same concerns. As well as [unintelligible]. Thank you.
Keith Frable	Good morning my name is Keith Frable I'm currently the principle maintenance inspector for Delta Airlines. We have 805 airplanes and about 10,000 mechanics so about 10,000 mechanics including a lot of sub contractors [Unintelligible]. They've imitated human factors in their work and see the benefit of having a robust human factors program. As for myself, I have a Masters in airline Embry Riddle, I teach human factors Embry Riddle, a little bit of background there. I first got interested in human factors in England. They were well ahead of us when I was over in England in maintenance human factors so that's where I got my first interest in UK flight maintenance committee, working with them and over there. Complacency; from what I see and I've got a lot of data back

Speaker	Dialogue
	up what the first one here is 55% of the inspector results from last quarter were due to mechanics or mechanics not following proper procedures. So the procedures are in place we have good quality procedures, they're adequate, had they followed them they would not of had the problem they had, so for real concern inspectors are finding that error in a lot of what their doing so its been validated. Oh distractions, at any given time there could be 14 different fleet types that a mechanic could be working in. In and out of [Unintelligible] so the different. Airplanes coming in different [unintelligible], its just a very complex organization mostly because of the merger. Also if the merger will have full programs so you can be working on a legacy delta plane today 757 and then two minutes later a legacy Northwest airplane comes in which would have a total different procedure contained within the same manual. So some of the process of procedures are dual processed. You'll have a dual process for say lets say [ETOX]. Different program. You can have a program for a legacy Northwest Airplane and a total different one for Delta within the same manual so we're working that and we have some harmonize programs also that cause a lot of distraction but we can't confuse. You know what plane am I working on right now, what procedure am I following, and what am I suppose to do. Even the log books are different in the airplane so a lot of oversight that we perform that we find these distractions. Fatigue, I guess it's on everybody's minds, however one reason I brought it up is if you got a medical field, your an intern don't worry about fatigue, so I'm wondering why we put so much concern on fatigue and we can't control fatigue like the medical industry has been doing for years its just something that I want to bring up.
unknown	And they're killing a lot more than we are too.
Keith Frable	On pressure a lot of [unintelligible] on the Datalink. Delta's really pushing to get the door closed, get the planes out, I think a lot for log time for performance so its really affecting versus flight attendants you'll have about 9% - 10% of flight attendants legacy Northwest on Delta airplanes and legacy Delta and bunch of versa working off the airplanes. Big concern know where the safety equipment is yeah they've been trained however when you go to ask them well god I've never been on this plane and I've never been on this airplane so we get a lot of that and pressures behind that and pressure to get the airplane out. That goes at the lack of knowledge, too many different fleet types that are within Delta and you could 14 different fleet types, different variance of those fleets and that's my lack of knowledge.
Victoria Frazier	Good morning I'm Victoria Frazier I'm a program manager for the chief scientific and technical advisors in AVS so I do all of the management and administration for all 20 of them. I'm to see more about the technical aspect of the work that they do so this is the first workshop that I've seen and assisted in action. I've been in the FAA for 10 years, I started out as a consultant and I've put up some concerns really not from a technical background or aspect, but just what would I be concerned about as a passenger. Even if the mechanics does the procedure is there a quality check, how do you know if the problem has been fixed? You know even if they inspect it, there might still be a problem, or once they have the maintenance schedule how do you know that its being performed on time? Those are the kind of concerns that I thought about.
Dr. Bill Johnson	And if some of you comment that my behavior is better than usual, there's a reason. I do want to mention as you just did that there are 20 chief scientific and technical advisors and there are, Victoria, about 5, 8

Speaker	Dialogue
	workshops or [unintelligible] or not even that many.
Victoria Frazier	Yeah about 5 are done a year. It's up to the assistant to determine if they can and should put one on. So its good when they do we're trying to capture more of that and put it into our training program at headquarters.
Dr. Bill Johnson	I'm also very sincerely appreciative of the fact that you make a lot of the decisions on where that workshop budget goes and when you and I first talked about this workshop - I'm convinced this a high value one please, please, please. So I really appreciate that you took the time to be here and really see what kind of things go on in a meeting such as this. Thanks.
Kevin Gildea	Hi I'm Kevin Gildea, I work here at CAMI Human Factors Psychologist about 10 years in aviation only one year at the FAA. Prior to this I worked as a contractor for the Air Force working both the training and human factors programs. Here at CAMI I work with the line operation safety audits and we're extending this up [Unintelligible] RAMP communities. I think everything that I got up here has been discussed in previously, but one of our main concerns with LOSA, since it's a voluntary program, is how many people buy into that since it will never be mandatory. We'll also have you get the buy in from the maintainers to how do you concept behind LOSA is how to push that down to the maintainers so that they have a understanding that they do it the way it should be done.
Jim Hein	I am humbled to be here with the brain-trust in this room and thank you for inviting me. What I think I bring to this group is that I've had some hands on experience with general aviation. After working for 6 years as a director of maintenance in Alaska and experiencing some of the things that probably an aviation mechanics shouldn't experience; things I was doing because I was a young mechanic and I thought that those were things that I had to do in order to become journeyman/master mechanic, I went back to college and earned my degree in aviation maintenance management. Later, I went to work for a major airline and found out there are differences in the kind of maintenance that's done between airline maintenance and general aviation/small corporate maintenance …. there's really a pretty big cavern between them and general aviation maintenance really takes a lot more unnecessary risks than airline maintenance does. And so the five things that I've chosen to put on my maintenance concerns all boil down to the number three item on my list … the corporate environment; because, what's true, is a small airline or small air taxi that has maybe 10 or 15 airplanes and only one or two mechanics implies that the maintenance people out there are wearing multiple hats. Since there are only so many hours in a day, fatigue falls into that personal health and the physical environments arena and sometimes doesn't fit well with safe maintenance practices. The job expectations of small corporations/small companies when they hire a mechanic that has an A and P certificate in his pocket is that - that person pretty much knows everything there is to know about aviation maintenance and they don't have to train him anymore. They just put

Speaker	Dialogue
	him to work .. and in fact .. since he can probably work on the fuel truck and the forklift, the hangar door to make sure it goes up and down, and the facility maintenance, and the fuel farm, well … as a cost saving measure they'll have him do that too. And by the way, if he has time, he can work on the airplanes. So continuing education about human factors that affect corporate culture is really important for the aviation mechanic and somehow we need to decide what kind of human factors education that general aviation mechanic needs in order to create a positive safety culture. Then we need to design effective ways to deliver that education and to somehow get the general aviation mechanic interested enough so that they will take the training that's available. So .. my concerns are fairly deep down in the hands of the human factors that mold a company's corporate culture … and I'm here … glad to work with you great minds to see if we can find something to make that work.
Jay Hiles	Hello good morning my name is Jay Hiles. I'm in Headquarters in Washington DC I'm specifically with AFS-300 and with the air carrier maintenance branch which is AFS-330. One of my responsibilities is human factors within maintenance. It's not my only responsibility but a big part of what I do and what I have done over the last probably 5 years or so working with Bill and others. I've been with aviation 32 years now. I probably took a different approach than most of you in my five concerns. I probably could have listed 20 top concerns, I didn't really know where to go with it because I've been involved with it for so long. So I took a different approach from where I work and that's my first point was harmonizing regulatory and guidance material. They require human factors intervention. You know we got a lot of material out there that we're trying to get human factors trying to have a word into whether it be regulatory or guidance material, advisory circular, whatever it may be and we want to make sure that we put some language over here that doesn't compliment a language over there so it is a big task. So those are some of my concerns in that area and then when you do that you get the word out. Its hard to get the word out as well. I'll tell you I'm concerned with the future of human factors research and development. Its an interesting process I guess I'll leave it at that and somewhat frustrated process for us as well. And I'll be honest with you Bill was probably the biggest cheerleader for maintenance with the [RMD] efforts. But between him and I, we're the only two voices. And that's a big concern for me because the R&D money seems to go very easily to a lot of other areas but specifically to all the [unintelligible] all the pilot stuff, if it has the word pilot in it, we're going to give you a million dollars. So we need more folks out there helping us preach the word that we need more R&D help. And there's a lot of stuff that Bill and I talked about that we need to look at yet. And it has to be the blind stuff, not just someone out there doing research so those are some concerns as well. It's a fairly cumbersome process so it requires a lot of patience. I'll talk to you some more tomorrow about the rule making process and how we get human factors into the rule making, what we're doing at Headquarters to try and get that information. I'm sure everyone here knows we have a human factors website for maintenance. There are some challenges with it and

Speaker	Dialogue
	[unintelligible] habit I think it still needs a lot of work so there needs to be some more efforts and with just two guys one part time and one full time its hard to accomplish all these great ideas.
Bill Huntley	Alright good morning everybody my name is Bill Huntley I'm with AARCORP I'm currently the director of human factors and safety management systems. And due to [downsizing], I'm also the corporate safety environmental health safety wreckage. So that's kind of taken a lot of precedence and a lot of time actually away from human factors development of safety management systems. Because I'm the only guy basically. Primary industry experience I've got 26 years in this business. But oh primarily the Department of Defense worth 1.1.145 now currently we've just acquired a new 135 operator which is going to be an interesting little piece of history with us. Primarily quality safety and also maintenance training, that's my background as well. My top five concerns. I don't think maintenance, I mean human factors programs really just doesn't sell the programming to top management maybe a little of the management. That's both internally with our company as well as I've seen outside as well. They don't see the importance of [unintelligible] I see training being used to fill the square. We have a requirement out there to have a human factors training program and that's how its always listed as just training. So a lot of times that's what's being accomplished is this training. Our operationally and a lot of this I'm speaking from internal as well. Operationally needs seem to push the human factors practice and theory aside we have to deliver an aircraft or we have to deliver components or parts or whatever that takes precedence and it seems like its not really practice [unintelligible] so and I heard it mentioned before is how to take that knowledge and have people make the correct behavioral decisions and move forward. I've noticed on some of the slides up there, as well, business case for human factors on the return investments not very strong. How do you sell it to the leaders to get them to buy in or even the middle level management, what's the value to them. What are they getting out of it? So its just like anything else if I do this what am I getting? Then a lot of the training it relies on a lot of outdated information however important there's a lot of historical data and I'm not taking away from any of the disasters that have taken place but I think there needs to be a re-generation of some new material out there focusing on every level of an organization. A lot of training I've seen now and even the stuff that I've put together focuses directly on the technician but I think we've missed the boat somewhere with the middle level managers and even leaders, what's in it for them again? So those are some of my main concerns.
Steve Kessey	My name is Steve Kessey I'm a FAAST team program manager for [unintelligible] in the State of Oklahoma in Southwest region. My top five concerns are complacency during scheduled inspections.. Pilots inadequate pre-flight inspections but I think it starts at the flight school level is where they get their first couple of trained pre-flight sessions and then after that their on the ground. Limited use of technical data [unintelligible] you say it all the time but for the most part it's by real memory. Not that I'm speaking from experience mind you. Lack of assertiveness, sometimes [unintelligible] owner/operator doesn't take initiative to give the [unintelligible] and/or the technician [unintelligible]. There's multiple service bulletins over the years that [unintelligible] inspection and I would approach the aircraft owner and discuss the rather importance of complying with the service bulletin he knows not mandatory by the FAA standard, its mandatory by the manufacturer and

Speaker	Dialogue
	the first thing out of the mouth is how much does it cost? That's always the first issue, what's the cost? Then the next issue is well how long do you think it will last? And I normally always told them when I was a [unintelligible] night time IFR on the way to your base in the Bahamas' so with your family onboard and that normally changes their mind go ahead [unintelligible] make the corrections and just over tasked. As Jim you know indicated earlier about some of the dollar signs you get as a specially as a GA guy I'm pretty much in general aviation I've got air carrier background I worked manufacturing but my heart and soul always was general aviation that's where I make my real living. And as a GA guy you maybe the only person on an airport with 60 airplanes placed there that's maintaining all these airplanes trying to keep these customers happy cause you're trying to pay your bills, put your kids through school, food on the table and seventy and eighty hours a week is not uncommon. Matter of fact I didn't know what to do with myself 9 years ago when I came to work at the FAA they were telling me after 40 hours go home. Not in the hangar anymore Steve. So it was a great change but it also I haven't forgotten where I came from and there's a lot of problems, there's a lot of concerns out for human factors plays into it. Mechanics not following procedures, interesting question to ask, Ken Larcher is sitting over there in the back I want to introduce him in a minute Ken works here at CAMI but I'm working with Ken right now on a project Ken is working tireless with the FAAST program right now and doing some research, to come up with a questionnaire to find out are mechanics really not following procedures? Is it a lack of knowledge? Is it more the lack of understanding? Is it just, I don't care attitude? If they're not following procedures why are they not followed? But the big question is where's the data showing they're really not following procedure? I have a different take on procedures. I've had an airplane come in for instance and tell me that part of the manual I need to remove the cylinder to perform a certain task on this airplane which was just follow the maintenance manual. But I can assure you I can do that job in a [unintelligible] time never pull a [unintelligible] off that airplane so technically did I not follow procedures. So I have a big gap there and what I ask is what are you referring to when you're saying I'm following procedures? Cause a mechanic is going to do what he needs to get the job done to be done productive and efficient and you're trying to make a living out there. Organizational changes versus industry changes. It's easier for an organization years ago over at AAR here in OKC, when my manager came up and said Steve I want you to do this for this reason. Yes sir. I continue to march with my orders. If he wants to pull me out of that toll or put me over in flash [unintelligible] PACA training I'm going to sit here and go through that training. As an individual in the GA world and when I say GA corporate down for primary light winds down. I've got a lot of corporate background but their even more structured than when I say GA I really mean light winds down. That's where the light flatter structure and in that environment I'm much likely to stop what I'm doing to get in front of a computer and watch human factors training on the computer or take my time on the weekend to go sit through training somewhere the industry is providing. So I ask the same questions of myself as a past program manager, what can I do to give the technicians into this training why I wouldn't go when I was in industry. Is the last place I want to be and when I didn't have to be at the airport, I was in training somewhere

Speaker	Dialogue
	talking about airplanes. I had other interest I want to fly my model airplanes. So that's a big question that I ask to how we going to get the mechanics into these places? But you know I worked in the bachelor program at Oklahoma, what has worked for me is I go to the operators, they sponsor the programs, they hold it during a normal work day, during the normal work hours, they provide a lunch. When their employees return to the repair station they get a certificate that allows them to apply towards the repair station training manual requirements.
Ken Larcher	My five concerns. One thing that happened just recently that I thought was very interesting is they had to re-register all their aircraft every 3 years. But we don't have any mechanism to re-train the mechanic ever. Maybe one of things that we're looking at should be to have an on-line training so the FAAST team can do it through their website is a way for the mechanic to be delivered this information and make it mandatory in a special way that they have to look at it. And if you can tell the man well your AMP isn't going to be valid unless you do this training and you have some sort of certificate to follow that. Their not going to do anything, there not going the change the way that their doing it. I've looked at 500 out of 1,000 accidents right now and a lot of this stuff is one of two things who knows the difference between apathy and ignorance? Well I don't know and I don't care. That's it. I mean there after the fact. We're trying to look at what is before and what I'm trying to do is get a hold is some of the enforcement data to see where these individuals who have had it and then of course when they should have told us they told it. Why. Well they may load us up with things that are not necessarily true but at least there's a snippet of information that I can get here as a researcher to try and come up with a interview that I can go out and try to find out why people don't follow procedures. And what procedures or how difficult.
Guy Minor	Hello, My name is Guy Minor. I work for the FAA Safety Team. I have been part of the FAA for fifteen years. I started flying when I was sixteen. That was 38 years ago. I have just a little over 10 years experience as a general aviation mechanic. My desk is in Oakland California. I would like to see mechanics trained in nontechnical skills like leadership, assertiveness, and other management topics. The reason is that managers are most in control of the error promoting influences in the maintenance organization. We tend to promote aviation maintainers to management positions with very little management experience or training. We promote them because they are smart, and responsible. They are the very best mechanics. Then we are mystified when their performance is less than stellar, and the crew they lead is prone to unsafe acts. Sadly, so often the first promotion of a maintenance technician to management finds him at the level of his incompetence. The untrained manager is less than assertive. This makes him somewhat averse to confrontations, and willing to take inappropriate risks. It can manifest in what seems to be a very positive way, as a “can do” attitude. However, the down side is that this attitude can lead to unrealistic expectations. Untrained managers tend to discipline their people when they fail to meet those unrealistic expectations. The untrained manager is not the type who would particularly listen to suggestions, and certainly would not encourage free reporting of errors, or reporting of clunky, difficult to follow, procedures. This type individual puts too much pressure on his people, has too much confidence in his own skill, and is smart enough to see the advantage in violating. For the

Speaker	Dialogue
	most part, poor management does not foster procedure compliance, and it certainly does not create safety. If the point of human factor projects are to ultimately reduce the frequency of error, and to capture error prior to loss of life, then perhaps it is time to provide maintainers with the tools they need to create safety.
Terry Kleiser Martin Maurino D. Pittenbarger Bill Rankin	Not recorded.
Bobby Reed	Hi I'm Bobby Reed, I'm with the Central Region FAAST Team, I'm the regional manager there and I actually have a very interesting opportunity to help guide how we implement the FAAST team working with the division management team in Central regions. So I get to help develop how we're going to do things and I wanted to share before I got into my maintenance concerns, a major coup that I had yesterday in a DMT meeting as we're planning out 2011 performance plan. The central region FAAST team will be directly engaged with accident/incident causal factor analysis specifically focused on human factors data collection. Any accident any incident, any pilot deviation, VPD, mechanic or otherwise the Central Region will be a focal point for doing that. And we'll be using your tools here Mr. Rankin as well. The PETA and the META excellent tools; if you don't have those you should. It's a great starting point for air decision collection. So that was a real coup. Safety culture, I know that's my primary concern, and what I think changed the safety culture, my concern is that we are not looking bare and teeth I mean we're dancing around it, the FAA and the organizations. If we don't change safety culture, if we don't begin attacking that we can talk about the heat, talk about shifts, we can talk about all the different things. the dirty dozen, you know all the different factors. We're not going to change anything unless we begin to work on safety culture. And I'm afraid the agency isn't looking down that direction as well as we should, and I hope to hear different. Non existing or missing human factors data, I hope to help provide some of that. You know one of the things that we talked about in our performance planning was we were going to do causal factor analysis; now this a regional performance goal. We're going to do causal factor analysis based on the current data we have, the AQTA is that the right term the right acronym AQTA?
unknown	ATQA
Bobby Reed	ATQA right.
unknown	Traffic Quality Assurance
Bobby Reed	The data not's there. How do you do route causal analysis if the data's not there. Well, the data is there, see it says right here descended through altitude that's the causal factor. That's not the causal factor. That's the what it was - was a type. But this is the root of the problem people don't understand what it is we're trying to get to, so I hope to help provide some of that and the other thing speaks for itself. Several years ago I had the pleasure of meeting Jay and Bill as a part of a human factors presentation in Wichita, and that was an exciting time for me. I went to AFS-900 over 9 - 10 years ago, developing oversight systems, and what I learned about system safety told me that everything was part of the system. And human factors to me, goes across all of it. And I had an opportunity to present specifically on a human factors event that I was involved in at that meeting and that started me down this road to

Speaker	Dialogue
	focusing on human factors. As a result of that presentation Rockwell Collins invited me to do a presentation to all their international directors of quality assurance; it hit home. I did an interesting presentation and then I also gave them some avionics related stuff which I know Brian talks about brain box overload. I was on a new aircraft, an Embraer, brand new airplane, pilots were loving it, talking about how cool it is. I was sitting on the jumpseat and I'm looking at the instrumentations all pretty cool glass box stuff and I said, "what's that green dot on the left-hand side of the screen?" It seems to be going up and down but its not stall, and I said wow what is that, I've never seen that before. They both look at each other and he says we don't know either. That's a scary thing. They don't know what the green dot is and they had just gotten the airplane and they shouldn't have known. The guy in the left seat was a check airman; he didn't know what it was. So at any rate Rockwell Collins got a kick out of that, cause they were it was a competitors' box and they thought that was kind of interesting. But the presentation I did down there was based on something I was involved in and if I ask you a question in the accident side of the house how many people know about a major legacy airline that crashed an MD-80 out of Oklahoma City in a incident similar to the [unintelligible] incident. I was on the jumpseat in that aircraft and it didn't crash. But should have crashed. And for the excited situation to have to had an opportunity to experience all the human factors associated with it. The story, the presentation focuses on a maintenance issue related to a baggage compartment placard that was missing, and so the presentation talks about how does a baggage tag, how does a compartment tag and a maintenance issue cause an MD-80 to crash? This the chain of events, and as you go through the entire chain of events the maintenance issues that are involved, the operations issues involved all the different people, the human factors are incredible. And I had the opportunity to live through that and I didn't know it was an accident until about a year after it happened when the rest of the story came out. And so at the time, only five people knew that there was actually an accident that didn't happen. And that's what human factors in my opinion, is about, and that's what data collection is about, and our challenges because what we're trying to collect is data that isn't there yet because it didn't happen. Because there are more accidents that don't happen than do. And that's where our challenge is to get that data through ASAP through voluntary programs, with a safety culture change through lack of blame culture change, and when we do that, I think we're going to take that little tiny line that's at 1% and we're going to get it down - down to very, very small numbers, so I'm glad and proud to be a part of this. And I'm real excited to be here with you. I look forward to that outcome that we're going to develop and that's all I've got.
Dr. Bill Johnson	Bobby let's get back to that meeting where we met in Wichita. There were four presenters. You, Jay Giles, Bill Johnson, and Bill Rankin. So we were the four back then gosh, that's been 6 or 7 year ago and who else knows? [unintelligible] six, so it was about 5 - 5 1/2 years ago, something like that. It was a great start it was. More of those is what we need. Thank you sir.
Mary Schooley	Hello I'm Mary Schooley, I work with the Aircraft Certification Service, in the Transport Airplane Directorate. I am the program manager for our Safety Recommendations programs both FAA and NTSB Safety Recommendations. I've been in aviation for about 25 years now as an aircraft maintainer, then department manager and then on to the FAA as an Operations Research Analyst helping to determine the health of air

Speaker	Dialogue
	carriers with Flight Standards. Also stopped along the way to finish my masters in human factors, and start my PH.D. . At this point I'm "all but dissertation" (ABD) too. So that's where I am professionally. My concerns, and maybe I've just been hanging out with the wrong crowd and I don't know that these things are going on. One thing I'd like to look into is accessibility and error proofing maintenance tasks so that we can not rely so heavily on training. More critically evaluating the design of aircraft to see how we can build in and certify better with the goal of error proofing maintenance tasks and criteria for evaluating the risk. Also, fatigue is a concern of mine that has been widely acknowledged in this room. LOSA style audits for maintenance…
Kevin Gileda	Mary, what do mean when you say LOSA style audits.
Mary Schooley	That's one of the safety audits they currently use with flight crew threat and error management – at least that's what I'm familiar with.
Dr. Bill Johnson	And Kevin, as you know we'll present that tomorrow. I think you're on, Kevin.
Kevin Gileda	Yes.
Mary Schooley	I'm looking forward to that
Kevin Gileda	Yeah. There have been some really good priorities for the last two years. There are some tools that are going to be rolled out and we'll talk a bit about that tomorrow.
Mary Schooley	That's great.
Dr. Bill Johnson	When Kevin gets done this, the pilots are going to be saying why didn't we do it that way? The answer is well we sort of learn from all your mistakes and you fixed all those things, Kevin.
Dr. Bill Johnson	They're especially glad you're here. You and Victoria really represent aircraft cert unless I left someone out. Typically she finds this money, tends to its administrated through aircraft certification and tends to [unintelligible] a little bit more aircraft certification than to Flight Standards, that's just the way it shakes out. So what we're really delighted that you are here and look forward to increasing participation between Flight Standards and Aircraft Cert in these kinds of endeavors. So we're really delighted you are here.
Mary Schooley	I think the cross over between ops and maintenance many times is human factors, and you know when accident investigation (AVP) sends out a safety recommendation that has to do with operational error, invariably, we find human factors issues throughout.
Dr. Bill Johnson	Alright I'm done go ahead and go to the next person.
John Sims	Thank you, Doc I'm here from Fairbanks, Alaska. Unlike Jim I went up there intending to stay five years, to work on airplanes. I went up there in 1984; I'm still there. I joined the agency in 1997. Before then I worked mostly air carrier, GA, and 135, and I'm the guy, I'm the director of maintenance who was out there - I took care of the airplanes, I took care of the paperwork, I took care of the business side, I took care of pilots. You work 14, 15, 18 hours, 6 or 7 days a week, go home and get a call cause an airplane will not start. You are on the clock 24/7 as a mechanic. Airplanes need to fly, they generate the revenue. On my five concerns, what I put up there was why only now are we considering the maintenance aspect of human factors, when the technician/mechanic takes care of the aircraft, we design them, we build them, we put them together we put them out there. But nobody pays any attention to what the mechanic does. Human factors just don't really exist. We talk about it but we don't follow through with it. Especially the 135/GA world, we talk about it but we don't do anything about it. I can see where we need

Speaker	Dialogue
	to be aware of their human factor needs in aviation.
John Sims	And that's what this is about, recognizing the technician, stopping him from working so many hours especially in the 135/GA world. I mean I cpuld say Alaska is a different world, but its not anymore. We have made leaps and bounds, changes into pushing safety to the forefront and recognizing human factor issues. And that's why I'm here. I don't have a big background in human factors, but I really think the mechanics, the little guy out there working to put these airplanes together, still needs to have some backing. And some help with human factors today. That's why I'm here.
Vickie Stahlberg	I'm Vickie Stahlberg, I'm in Honolulu PML. Been there since August. Before that, pretty much in Houston my whole career. Started out in my career with the FAA. Started out in the GA world and went over to the Houston CMO, and was [unintelligible] program manager for power plants, which is my background in the Air Force. I did that for a few years and went over to CMI and so where Continental is described. And some flight seven fleet management and now I'm PMI overseeing a small cargo carrier that caters to the Pacific Islands out there. They're a little challenging because they are in Honolulu and their main base is in Guam, their headquarters is in California, and there seems to be a norm out there in Honolulu when you're doing a lot of traveling and trying to coordinate all those communications and doing your record keeping, you got maintenance different places and how the air carrier themselves are coordinating all of these efforts and keeping on top of it. Communications is one of my concerns. I don't have it as one of my top human factors concerns, but oversight that's a big issue especially for me since I've been in air carrier. I've got three, so there's another page kind of [chilled] it down to the work schedule and work environment and the 3rd one would be the work past, of the mechanics. Work schedule allows everyone to work several shifts in a row working - I know when I was working Rockwell it was mandatory to spend; you got Sunday off, you did that for months, some of them I've heard are even sized mandatory 12's and it works on you. One of my pet peeves I haven't seen in aviation sector as much, but know its out there and that was very interesting to hear that you've done a study on, Bill was on the shiftwork. Shiftwork is one of mine, I would love to see become illegal even. I think its very damaging to an individual and an organization in what little I do know about it and talking with individuals that work in plants. That type of environment is very dangerous in my opinion. Work environments, the same thing in which the mechanics constantly in an environment the actions don't, where the sticks don't seem to line up, you know you've got when its a beautiful day out, 80 degrees and the schedules are, you got timing but between your checks it's when everything piles up, you know, you got the rain or the cold and everything's going wrong and then coupled with my third human factor, is your past diversity. That's an environment especially with the majors' or even kind of transit type of environment where you've got the mechanics shuffling from, as I use an example, you got your free set of classics, your Nextgen, we tell people to speak to the classics in the airbus 320 and everything in between. I think for the younger ones even more tasking especially if they got someone overseeing them. And following through, typically its not that you're out there you're trying to move aircraft, and so you've got procedures, type of situation, how well they're written, how good they are. How you're working around procedures. You're constantly shuffling assuming you've got that going on, you've got your work environment

Speaker	Dialogue
	going on, coupled with fatigue [unintelligible] your life starts, start lining up, and these are the three that I see more commonly, and that's why I'm focusing them on my maintenance concerns. And it goes downs to the mechanics, and so and the environment and the recognition. I think which I've heard management buy-in, from what I have observed is a lot of times management is from the flight, the pilot type arena and they only know what they know, thinking from mechanically we only know what kind of [unintelligible] observations event unless you've lived in those shoes you really don't recognize what's going in that world. So when you've got management that's in an operations type environment they really, in my opinion, don't really recognize what's going on, and that filters down to that culture and the emphasis of what's going on, and I think the mechanic does lose a lot of this ability in the day to day operations. And even taking it a step further and looking at the analysis when I know what the oversight that I look even from day to day occurrences, from what I"m seeing from diversions or anything like that which would appear to be simple day to day operation. I tend to view more as a possible incident or accident. What was going on? What caused that diversion? The locality, well it didn't cost the company this much money, as if it crashes into something and or hurts or you have loss of life, but you still, you've got some of those lining up for a conversion [unintelligible] through root causes.
Michelle Wallentine	I'm Michelle Wallentine I'm out of the Rocky Mountain CMO which is in Denver Colorado. I'm the principal avionics inspector on Frontier Airlines. Certificate right now. My background is primarily working for the government; I've worked Civil Service for the Air Force. Was in the Air Force reserves. And I've worked for the FAA now for about 9 years. Yeah 29 years in aviation, I was as shocked as the rest of you, so-
Michelle Wallentine	My top five are, and actually my major three are fatigue, lack of resources, and pressure. I have real concerns about fatigue obviously everyone is aware of the shiftwork, people trying to do more with less, as far as lack of resources, and then the pressure from company heads and officials to get the job done. Mechanics typically always try to do the right thing and they are always leaning forward and over extending themselves, and I see that so much where I sit on the ERC for the maintenance ASAP program. When you look at the data that we've gathered just from that program, or even looking at the self disclosures in the company, you look at the timeframe's that there have been issues, its always at night. Adverse weather, the environment, lack of resources with the downsizing; so many carriers just don't have the personnel, the staffing, even within management there just have not refilled those people that are either 1) experienced with how the carrier operates, and 2), just don't understand that they really do need more people so we're seeing a lot of that. And then the pressure to get the job done. Communication is an issue and the lack of assertiveness, where people aren't actually screaming uncle, when they need to be doing that. I'm real excited about the LOSA presentation I'm interested in that a lot. I think that will be interesting to hear.
Katherine Wilson	Speaker requested introduction to be excluded.
Nadine Yeager	I'm Nadine Yeager, no relation to uncle Chuck. [Laughter] That's the first question everybody asks, so I just tell them Uncle Chuck and they don't know what to say so they don't ask anymore. My background is all operations. My only real maintenance experience is helping the mechanics work on my little baby airplane when it needs things done to do it. But I do as a FAAST team program manager, and not having an

Speaker	Dialogue
	airworthiness safety program manager nearby. I end up doing a lot of the airworthiness presentations in association with some other people. I have some very strong business people who do a lot of that head work with me, so that helps a lot. But what I see ties a lot with what the pilots experience too, and norms is a big deal, I think for everybody. You do it this way which isn't exactly right once, it works out there's a tendency to do it just it a little bit more off to the side the next time. And pretty soon we make the norm thing down to the point where something falls apart. And that effects everybody. Lack of awareness from the pilots side of the house, why do I have to send this money to him to spend on my airplane? And on the mechanics side, obviously of how to do to the job if its a unique job or whatever. But one of actually to pressure from pilot owners on the mechanic to get the job done quickly, cheaply and extensively cut corners, all these sorts of things. And now we've got a mechanic who is trying to make a living, and he's trying to keep his customer happy so the customer doesn't go some place else. Because he can get it done cheaper or whatever, and those two things tie together in the GA world to create issues on both sides of the fence. Complacency, as far as not really caring, and if the plane flies fine, why should I do this to it? And the mechanic is okay we'll get the job done, but we'll cut a corner here, we'll cut a corner there and those are out there. We've had some experiences, accident related, in our area where when we looked into the maintenance that was not on the airplane and once signed off is amazing, but those things don't come to the surface without some reason to really dig and find out what's going on. It's all - a lot of people's attitude, they choose to do that. So that's something I think we'd like to address. Ego, I threw in there as I was going through some stuff and I came across the challenger video. And it's a video of one of their Morton Thiokol and NASA are discussing whether or not to launch, and I'm sure all of you have seen that video. And Morton Thiokol is saying no. And in the end they caved. And it's almost like we can't be the ones that stop this very important launch by saying no, don't go. So they went and we all know what happened. And I'm sure there's a lot of that out there in the aviation world. If you look at a lot of the maintenance related accidents you see situations where maintenance never was completed because they needed the plane right now, so they shoved it out the door thinking it was good to go and it's crashed. There's a litany of those out there. So nobody wants to be the one to say no. And we've got to get that back into people's vocabulary, if you're not 100% sure that its good to go, it can't go. And whoever wants the plane is going to have to deal with it. So I'm very interested in human factors on the pilot side of the fence and this side too. Its' all the same thing, we're all human beings. We all respond in similar manners and the majority, I think the population of the world doesn't stop to think about why did they do the things they do and they'll deny that they would ever do some of the things that we talk about until you throw an example up because its worded a little differently, then they scratch their head and they go, oh yeah I've done that. We need to get people thinking ahead of the game so that these things don't happen. So hopefully we can do that.

Appendix B: MX HF Requirements in the Canadian Aviation Regulations (Mr. Martin Maurino)

MXHF Requirements in CARs

AVS MxHF Leadership Workshop

Martin Maurino M.Eng, Civil Aviation Program Manager
Standards Branch, Transport Canada

Overview

- Canadian regulations overview
- Regulations specific to AMOs
- General training requirements
- HF training requirements
- Content of MXHF training
- AMO requirements vs. Operator's MX Control System
- Training of AMO MX Safety Personnel
- HF & SMS

How are CARs Organized?

- Part I: General Provisions
- Part II: Aircraft Identification & Registration and Operation of Leased Aircraft by Non-registered Owner
- Part III: Aerodromes, Airports and Heliports
- Part IV: Personnel Licensing & Training
- Part V: Airworthiness
- Part VI: General Operating & Flight Rules
- Part VII: Commercial Air Services
- Part VIII: Air Navigation Services

Regulations Under Part V

- Subpart 33 - Aircraft Engines
- Subpart 35 - Aircraft Propellers
- Subpart 37 - Aircraft Appliances & Other Aeronautical Products
- Subpart 41 - Airships
- Subpart 49 - Amateur-built Aircraft
- Subpart 51 - Aircraft Equipment
- Subpart 71 - Aircraft Maintenance Requirements
- Subpart 73 - Approved Maintenance Organizations

Part V - Standard 573 - AMOs

- 573.01 - Application for Approval
- 573.02 - AMO Certificates
- 573.03 - Reserved
- 573.04 - Person Responsible for MX
- 573.05 - Qualifications for Signing MX Release
- 573.06 - Training Program
- 573.07 - Personnel Records
- 573.08 - Facilities & Equipment
- 573.09 - QA Program
- 573.10 - MX Policy Manual
- 573.11 - MX Arrangements
- 573.12 - Reserved (amended 2009/12/01; previous version)
- 573.13 - Foreign Approvals
- 573.14 - AMO Identification
- 573.15 - Technical Records

Part V - Subpart 73 (CAR 573.06)

AMO Training Program

- AMO certificate holder shall implement training program to ensure that persons authorized to perform or supervise performance of any function under this Subpart are trained in respect of regulations, standards and AMO procedures applicable to that function
- Program shall include:
  - Initial training
  - Updating
  - Other training necessary
    - to ensure continued qualification that is appropriate to function

Standard 573.06
AMO Training Program

- Pursuant to subsection 573.06(1) of CARs, AMO certificate holder shall ensure that all staff with technical responsibilities are provided appropriate training in:
  - Technical,
  - Regulatory, and
  - Human Factors
- …issues related to work for which they are responsible

Training Program Includes…

- Initial training
  - To ensure persons taking on new responsibilities are aware of their technical, administrative & regulatory responsibilities
- Update training
  - To ensure that personnel remain competent & are made aware of change to their area of responsibility
- Additional training
  - Necessary by finding made under QA program or required due to changes in regulations, applicable standards, or company SOPs
- Procedures to ensure staff are kept aware of MX safety-related issues in general
  - by means of bulletin boards, info notices, Co. publications, verbal briefings, or by similar means

Human Factors Training Standards

- CAR 573.06 in respect to HF training drafted in response to ICAO requirements
- HF training shall include instruction in:
  - Human performance
  - Factors influencing human error
  - Error management, including error prevention and error containment

Factors Influencing Human Error

- Fatigue
- Stress
- Assertiveness
- Awareness
- Resources
- Knowledge
- Team work
- Norms (commonly accepted standards and procedures)
- Complacency
- Pressure
- Distraction
- Communication

Regulatory Interpretation

- TC requires 2 days of initial HF training
- Classroom training is mandatory for initial training and optional for update training

Requirements for Air Operator's MX Control System

- Under CARs Part VII - Commercial Air Services
- Standard 726 - Air Operator Maintenance
  - Reflects same HF training requirements as for AMOs

Standard 573.06(8)
Training of AMO MX Safety Personnel

- Person responsible for MX and all personnel assigned duties under SMS established pursuant to section 573.30 (SMS) of CARs shall successfully complete safety related initial training course that includes following subjects…

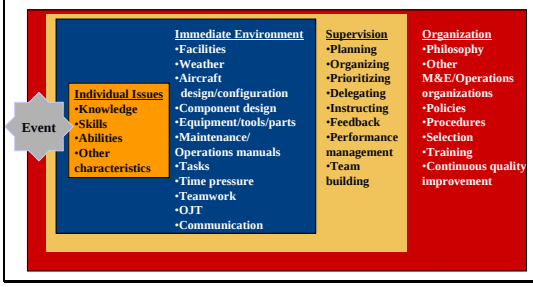
Standard 573.06(8)
Training of AMO MX Safety Personnel (Cont'd)

- MX and flight safety philosophy
- Human Factors
- Accident prevention
- Responsibilities of MX safety personnel
- Risk management
- Accident/incident reporting
- Incident investigation

Human Factors & SMS

- Since 2000, TC has integrated consideration of HF into SMS requirements
- Focus on human and organizational factors coupled with strong accountability framework

Contributing Factors to Human & Organizational Errors



Summary

- Canadian regulations defines specific HF training for AMOs & air operators' MX personnel
- Includes initial, updated & other necessary training + promotion
- CARs also address specific training for AMO's MX safety personnel, including:
  - HF
  - SMS
- FRMS requirements will be coming into effect for MX
- More info on CARs: www.tc.gc.ca/civilaviation/regserv/affairs/cars/menu.htm

Speaker	Dialogue
Martin Maurino	This is just a quick overview of how are regulations are lined out: we have the general provisions, aircraft authentication, aerodromes licensing, airworthiness, part 573 we're going to look into today. General operating flight rules are commercial air cert system that's where are [unintelligible] 121, 135 in there and [AS]. So that's what we're going to look into. Now under part 5 I didn't put all of them in here but we have sub part 73 so that's the AMO, part 73's are AMO regulations.
Unknown	Is AMO an MRO?
Martin Maurino	Yeah its approved maintenance organizations
Unknown	Yes.
Unknown	So 573 is like Part 145?
Martin Maurino	It's 145 exactly. Because the way I understand here in the United States it's a bit different our regulations mirror EASA in terms of when you're if you're an operator with your own AMO the certificates are issued separately. It's not within the air operator we have a maintenance control system that's in between and I'll come to that later. So when we talk 573 its really 145.
Unknown	No such thing as 121 maintenance in Canada and Europe right?
Martin Maurino	Yes, what we have is you'll have the airline that will have an AOC and their maintenance will have a certificate and then you have a maintenance control system in between. That's where the regulations apply and that's sort of the interface between the two. So again this is an example but just to show you kind of when you're going down all the 573 standards you have one that's point zero six and that's the training program for their MROs. So that says in here that I've cut a bit of the text from the regulations that basically says that the AMO certificate holder has to have a training program that ensures that the people that are authorized to perform or supervise the performance of different functions within the certificate are trained with the regards to the specific regulations standards and the procedures of the AMO. And I heard this discussion this morning in terms of training our regulations include initial training, recurring training and any additional training so that's actually specified in the right and we'll come to the human factors when its also specific in there. So if we continue down that same rate we have to according to regulations that the AMO has to ensure that the staff that are technical staff so we put [admin] out here. How training that relates to technical issues, regulatory issues, and human factors issues. Okay so then already here you see it within that regulation we are mandating human factors training for technical personnel within the 145. Now within that training you need initial training so for staff coming into the organization, recurrent training to make sure that people maintain their proficiencies and are competent. We also have additional training so aside from the initial and the scheduled recurrent training we also ask that other as a result of any changes in procedures or in regs or also as part of a QA program which is required for them under the SMS that when there are findings that relate to any issue that has actually made the subject of additional training that's not necessarily scheduled into the recurrent loop. And the last point is really safety promotion so its aside from the mandated training that there are according to the size and complexity of the organization bulletin boards, info notices emails so to maintain awareness of safety related issues within the organization.
Martin Maurino	Now within the CARS why have we implemented these human factors standards one big reason was to be ICAO compliant. So that was a major push for us in terms of having them into drafted into our regs.

Speaker	Dialogue
	Within our standards we specify very clearly that human factors training has to contain these elements. Human performance, factors influencing human error, and I'll come back to those in a sec. And error management including error prevention and containment. So these are written as is in the our regulations that they have to be covered.
Martin Maurino	Now that second bullet there does the factors influencing human error again in our regs it specifies that training has to include fatigue, stress, assertiveness awareness, resources, knowledge, team work, norms we talked about this morning, complacency, pressure, distraction, and communication. So you can you guys realize that these are the dirty dozen. And they are required in training.
Martin Maurino	Now we looked at sort of all these different issues and topics and we figured in order to do a descent job, companies need to cover all this material in two days. We don't want people to sort of get around human factors training think, “well, you know, we give them a CD and they did it somewhere” so we require that the initial training be two days for human factors. It has to be classroom training; initial training has to be classroom training we figure for human factors that's really the best way for delivering the content. When it comes to recurring to additional that can be computer based, distance learning to have more flexibility for the others.
Dr. Bill Johnson	Are we allowed to ask questions along the way?
Martin Maurino	Sure.
Dr. Bill Johnson	Is there any discussion at Transport Canada right now about reconsidering that requirement that initial training be all hands on, classroom as a opposed to delivering some of it CBT?
Martin Maurino	Right now? No.
Dr. Bill Johnson	No?
Martin Maurino	No. I spoke internally about this right before I came and they're very adamant in having it. You know when we're looking at things like having team exercise and things like that or the interaction they rather it be a classroom training. And then the recurrent and the, you know, computer based or CD to take home something like that.
Dr. Bill Johnson	But, respectfully, is that not one of the big differences between the way Canada and Europe makes the rule compared to the US makes the rule. Seldom would we say it has to be delivered a certain way. We'd say you might need to deliver it, but we tend to be less prescriptive.
Unknown	Just say adequate training period.
Unknown	Yeah.
Unknown	Well that piggy backs onto my question. Is it the Transport Canada make that a required group program so that IE Transport Canada inspector would have to approve that program prior to its training program? So you can't make any changes to it without the approval of Transport Canada inspector?
Martin Maurino	Yes.
Unknown	Okay. Alright.
Unknown	Does that involve management's level? The training?
Martin Maurino	No, well, this is for like, I mentioned before, all the technical personnel. And what we'll come to later is for the person that is responsible for safety within that MRO. And people involved in SMS there's actually an additional requirement for training for them. But this is sort of all technical staff.
Unknown	Where is the technical staff end? You know the supervisor, managers I mean where do you draw the line?

Speaker	Dialogue
Martin Maurino	Well this would apply to all of the technical staff. Like I said then there's additional training for people in management functions. That will come to.
Unknown	So past vividly does everybody in maintenance and engineering have to take this training?
Martin Maurino	Yes. Well the only people that are left out here are non-like administrative stuff. They're not
Unknown	But not everybody?
Martin Maurino	I'm sorry.
Unknown	Not everybody is so secretaries don't have to take it.
Martin Maurino	No. No - no technical well we mean technical yeah I mean one's that are not performing administrative duties.
Unknown	But maintenance program people, engineers that are looking at service bulletins?
Martin Maurino	I believe so yes.
Unknown	Okay.
Martin Maurino	I can double check with you.
Unknown	What's interesting to me also in the United States is an [OAM] and MRO for a regulator to tell us that you're requiring two days in initial training when I look at that, and that's fine, that's not what we do, but we have a pretty specific regime. I'm really interested on how you figure effectiveness on that two days.
Martin Maurino	Yes. That link but that was the decision that was taken out
Unknown	[unintelligible] group program.
Martin Maurino	Yeah.
Unknown	That inspector will be able to determine it
Unknown	unintelligible
Martin Maurino	Because really what we want to get away from is people with just kind of putting in a little module somewhere and saying well you know when we cover it human factors and we covered all of those bullet points when in fact it will take longer.
Unknown	Yeah.
Martin Maurino	So I mean I wasn't there when they assessed this, but they looked at the program they said, “well this really takes two days to cover.”
Unknown	Martin is there a prescribed set of objectives that have to be met by the end of the two days?
Martin Maurino	I have to look into that. In terms of maintenance.
Unknown	You said you mentioned they have to cover the dirty dozen?
Martin Maurino	Yes. Yeah, like what we've covered before, like for example, these are actually written into the regulation so they have to have addressed all these issues.
Unknown	[unintelligible] that's the objective compound. In two days.
Unknown	Yeah.
Unknown	If you're asking if there was an assessment I know they do require an assessment at the end of an exam or measurement activity of some sorts.
Unknown	[unintelligible] with the dirty dozen issues how are those presented is there way they are suppose to be presented, is it that these are the major issues to look out for, or do they teach them strategies to overcome them, or is that
Martin Maurino	It’s just a cover to cover the issues not to say that like a lot of the what I've seen in dirty dozen for example would be case studies. So if you're look in accidents like if we're looking at norms like the famous American Airlines DC10 is one of the cases they use there when they mounted the

Speaker	Dialogue
	engine with the forklifts. So it's like that. We covered it through those kind of scenarios.
Dr. Bill Johnson	Well, if also when Gordon Dupont put it together his plan was you present the fatigue, what are the contributing factors? Does he even use the word contributing factors? That's a Boeing word, but then, what are the safety nets that you put in place in an organizations that's not counteractive measures for each of those dirty dozen. I don't know if the Transport Canada says it that way or not but Gordon Dupont certainly did and he was with Transport Canada when you did that.
Unknown	Yeah.
Martin Maurino	The other point that I was coming to before is the requirements for airlines' maintenance control systems. And basically it's a copy paste of what you'll see in terms of that MRO's. They have the same everything that I just went through with what is also required for 726.
Martin Maurino	Now the difference which I was touching on before is that for the 145's themselves for the 573 there's additional requirements for training AMO maintenance safety personnel. So aside from what everybody gets in terms of technical staff, this is the standard it comes out like this so the person that's responsible for maintenance and all those people that are assigned duties under SMS and our MRO's have an SMS requirement in place right now for larger carriers. So all our 121 carriers have now under gone the SMS process and their SMS has been approved by Transport Canada, and now the smaller groups like the 135 they're going to be coming on line and they're associated. Maintenance as well. And for the 145's there's also there are requirements already in place so those individual's have to do an initial training course that covers maintenance and flight safety philosophy, human factors accident prevention for their responsibility of maintenance safety personnel, risk management, accident/incident reporting and incident investigation. So again for that factors specific requirement of human factors training scenario. In this regulation. And you can see there it also covers all the different aspects you would also have within an SMS in terms of risk management and reporting and things like that.
Martin Maurino	Now I heard this discussion a bit this morning in terms of, "well, now that SMS is coming onboard what does that mean for human factors?" The approach we've had at Transport Canada for about a decade now is to integrate human factors in our SMS requirements. So, what we really want to do is sort of look at three things human factors, organizational factors and the accountability framework. So basically the way we look at it how they fit together as well. We'll have the individuals, so you'll have, you know, people committing errors, but obviously they're doing it within the larger the picture that is the organization and how its managed so human factors training's addresses really human performance in errors. Around that you'll have a systemic approach to safety so you'll have the SMS and on top of that you have all the accountable executive the [TO the TO] with the upper management accountability. So that's how we loop everything together and then within that within SMS then we also require, for example, carriers to do human factors training.
Martin Maurino	And this is a slide from Boeing so it just sort of depicts how we look at things in terms of human factors, organizational factors, and then SMS so we have an event where you'll have individual issues such as knowledge, skills, abilities of course then you have within the environment where that where this takes place so the facilities to whether we're talking about it terms of doing maintenance outside when

Speaker	Dialogue
	its cold, when its raining. Then you'll have the supervision so planning, organizing, prioritizing and then the over arching picture of the organization so that the philosophy, the policies, the procedures, the training who we choose, how we train them so - so with human factors and SMS we want to be able to capture everything all together.
Martin Maurino	So, just as I wrap up we have specific human factors training requirements for our MRO's and for air operators. There not a one time thing it was very important for us to be specific in terms of having initial training, recurring training, and sort of re-qualification training, as well as safety promotion, and we also have regulations that address maintenance safety personnel at the MRO's specifically, so above just the general staff, and as you saw, these include both human factors and SMS topics. And in terms of fatigue, we talked a lot about fatigue this morning, we are going ahead with our SMS requirements for our certificate holders and AME's and flight crew will be the first to be effected. Its actually been drafted its just sort of going through the motions now to be actually put into [unintelligible] to be officially published, but our drafting is pretty much complete and because our concerns for maintenance personnel there - there among the first groups. We decided to file differences in terms of flight attendants and then ATC will come later down the road but these are the two first groups that we want to touch one with requirement.
Dr. Bill Johnson	Martin, are you, what level of industry push back has Transport Canada received as their putting this FRMS for maintenance in place?
Martin Maurino	The biggest push we've had is from small operators, generally, because the requirements would include what is aerial work? Commuter? And regionally so - you know much smaller one person sort of operations. And there we get a lot of push back because of SMS, they're the next group that's coming onboard with SMS, so they sort of feel like they are being bombarded, and then there's issues for us, you know, like in the Great North and maybe in Alaska its like that small term of seasonal work, up North, you know, so these guys might not work for months and then they'll have to work several days and that's the nature of their business, you know, and outfits that are doing operations, like, you know for our hydro-electricity and fighting forest fires and stuff like that so how we manage them versus a commercial airliner.
Dr. Bill Johnson	And then Katrina are you going to say much about the links that are on our website to all of the Transport Canada? Okay.
Martin Maurino	And I can put it in there somewhere
Unknown	Yeah.
Martin Maurino	So the CARS that I mentioned you have the presentation the one in the binders is actually this one, so it’s the correct one. So, if you want to see all those regs chop them up for the slides but if you go to the link there then you can navigate through all the parts you go to part 5, part 573 and all our regs are online and for SMS everything is also available online.
Unknown	It might be good if you had a case in the group to know that an AMO and Canada does not have to have a [unintelligible] part 145 certification to work on US operator or AME [unintelligible]. We accept them by reg.
Unknown	What kind of time limits are they talking about in that fatigue regulation? Working days. Time limits on the day are they specifying them?
Martin Maurino	No. I think when we're looking at departments just for these sort of building the framework like SMS but they have a fatigue policy, they have to have a reporting system in which they can capture fatigue and do trend analysis and things like that.

Speaker	Dialogue
Unknown	unintelligible
Martin Maurino	We have them in terms of the regs like we have them for pilots but there not part of, for either group, there not part of the FRMS.
Martin Maurino	That FRMS reel looks like a SMS its just pretty much fatigue only. And then the things like you see [unintelligible] and things like that and scheduling. But we don't we get I think our whole and I think the direction we are going especially for the smaller operators is I think like the Australian's, to try to give them a choice of having flexibility in terms of you take fatigue, for example, flight and duty time limitations, as prescribed, or do you want to have an FRMS and be flexible? So that's also in discussion. Because in Australia that's how their looking at it right now.
Unknown	So you try to make it scalable so he can take [unintelligible] example ASI's in this. Eight questions answered as the same, well, we'll derive the same answer, where as you have you taken the SMS or that FRMS is scaling it down to that particular question. You know eight of those questions just don't need to be there for the small guy and combining it into a single question.
Martin Maurino	Because we have to look at things like the budget for large carriers versus the small operators so they don't have to buy all this software and stuff.
Unknown	The small guys want to do the SMS as well but they don't have, I think, you mentioned then they operate for May to October only the rest of the time they're sitting because they just don't fly at that time now. But they do on
Dr. Bill Johnson	We can just barely hear you back here.
Unknown	Okay. They operate only 6-8 months of the year but that 6 8 months of the year they're running. Well up North with the daylight, only then they can operate. They're running 24 hours a day 7 days a week, non-stop. Have you come up with a way to scale it to adapt it to the smaller operator and environmental issues?
Martin Maurino	Yeah.
Unknown	You want them to sub contract it out? If you sub contract out your SMS program to you know somebody else [unintelligible].
Martin Maurino	Well, what we've had for SMS for the, think that within our 121 we have also smaller carriers or these kind of airlines but their regionally commuter.
Martin Maurino	There actually considered a 121 there not a 135 right?
Unknown	Right.
Martin Maurino	And then we also have even smaller than that but that still needs the sort of 121 criteria. What we have done for SMS is to do an exemption, right, so, they as long as they're implementing they're exempted from the rule and then they would have about 4 years to do it. In phases and then we validate each phase of their SMS and then we do a validation when its all over. So its going to be the same approach for the smaller carriers but we had done some documentation for small operators, but it’s still a hard sell for them. They still don’t know what it’s going to look like, and they don’t have the manpower to do it. They’re supposed to start coming online, I think, next year, so it’s going to be a challenge.
Unknown	Is this going to have requirements for duty day, rest periods and that type of thing for the maintainers?
Martin Maurino	Within FRMS?
Unknown	Yeah.
Martin Maurino	No I don't think so. That's covered separately.

Speaker	Dialogue
Unknown	My understanding is that you don't have in Canada, you don't have guidance on duty days, crew rest for maintenance yet.
Unknown	Your FRMS does have scheduling tools?
Martin Maurino	Yes
Unknown	So essentially it enables you to develop science-based schedules to optimize effectiveness?
Unknown	Yeah but they are not prescribed.
Unknown	So it has flexibility so 16 hour day time shift is different from a, might have the same effectiveness as a 12 hour night shift if we're looking at performance, fatigue and lots of stuff. And so modeled her
Unknown	Would it be a requirement? Is that they have to use that matrix?
Unknown	In your FRMS, you are required to use scheduling tools?
Martin Maurino	Yes I believe so.
Unknown	I think that I haven't seen the exact words but that was my impression of that - that's one of the requirements in a FRMS to have the scheduling and I know that what we're working on in our workgroup does one of the aspects of FRMS that we consider as critical.
Unknown	Does it show you the best way to schedule 16 hour shift, or does it tell you, you can't?
Unknown	It would tell you if you were going to do a 16 hour shift what time of the day to do it from or a 16 hour shift might not even be a reasonable shift, actually. Or it would tell you when you could take naps or take a break to improve performance, so that you could get a 16 hour day. For example, you might be able to work 16 hours if you take a break at the 10 hour point at 2 o'clock in the afternoon. At that time you can really maximize your sleep opportunity and you can have that effectiveness and later on into the night when you wouldn't otherwise.
Dr. Bill Johnson	But it probably would not let you take a 16 hour shift anytime if you also did a 16 hour shift the day before.
Unknown	Right.
Dr. Bill Johnson	Because there's a requirement for how much you rest, you get from one shift to the other based the length of that shift. So, when you say, “what's the number” is it 8 hours or 12 hours or 16?
Unknown	Yeah.
Dr. Bill Johnson	You can give them what we're saying in our groups, tell you what, its 16 its 12 hours, if you don't like it, get a shift scheduling tool, work out how you're going to manage working more than 12 hours and go ahead and do it. So it’s sort of like either use the tool or use this 12 hour number or 8 hour number over there whatever the number might be. It’s surely going to be a trade off but a wise company would say, “no, lets schedule it the way I need for my type of operation, rather than just buying into your 8 hour, 12 hour rule whatever it might be.
Unknown	Its going to come out as a requirement to do one or the other?
Unknown	No. We don't have anything in the requirements work on our side, and we have recommendations that we're putting together from our workgroup that will recommend to flight standards, but from what I understand is that FRMS requires the use of scheduling tools since they do not have a descriptive rule that says you have to work 16 hours or you can't work more than 16 hours. Whereas, we're taking a little bit of a different spin off of that and saying, “okay here's the baseline” and this is all in the works of course – “here's the baseline [unintelligible] we recommend not too exceed 16 hours.” If you want to have a different operation than that, use a scheduling tool and demonstrate that you are at least at the same level of effectiveness as the prescriptive rules and if

Speaker	Dialogue
	you can demonstrate equivalent effectiveness for the same as the prescriptive rules than you can have that type of operation.
Unknown	Where does the [unintelligible] approval come at 16
Unknown	No I'm just throwing out a number.
Dr. Bill Johnson	As a committee when we put that number up, we didn't use 16
Unknown	No
Dr. Bill Johnson	No. Otherwise you might as well have 24. Or go in one 16 hours everyday.
Unknown	It was 12 and that was it and I don't know if it was based on study and we're talking [unintelligible] if I remember correctly, you said you're not held responsible past 12 hours of work. So that was your cut off because of said fatigue and blah blah blah. [unintelligible] that was an overload kind of number if you go past 12. [unintelligible]
Unknown	Simon Folkard is - oh go ahead.
Unknown	Who and how is the equivalency decided?
Unknown	With the fatigue models.
Unknown	And [age]?
Unknown	Which they're based off the research data from X number of individuals to create averages and all that.
group	Talking at once.
Unknown	They give you a score basically. Its just modeling.
Unknown	Sorry what was your last question?
Unknown	I'm not sure anymore. [unintelligible] take the next step.
Unknown	[unintelligible] Folkard is a researcher that has done quite a bit of research on fatigue, very well known in the field and his recommendations for our shift maximum can work 12 hours and then you have, you know, every once in a while you have to have overtime to the 16 hour limit but have that limited within a week I mean there's several themes that are listed off in Folkard's organizations but a 12 hour maximum is what he recommends.
Unknown	But you can always look at, you know, take it to the next step maybe at 20 you could do two shifts of 8, so a lot easier than being older so you really want to stretch it, do you want to even define it to an age kind of range. You know okay if you're at maximum 10 and 12 and if you really tear into
Unknown	Well from what we know about sleep after they do 18-21 pretty much everybody needs the same amount of sleep so then we're getting into more work load fatigue, or physical ability rather than actual based on number of hours worked. So that's kind of a different flip of the coin.
Unknown	But I think that's one thing about the FRMS that potentially, I mean, if you have a whole work force that's in a certain age group that you could, you know, put that it in there as a variable but that's not how it's set up right now. But I think that's something that the science will definitely be able to do.
Unknown	On your CAR requirements for training,- I enjoyed this discussion because especially when you're talking about tools that might be presented in that training so the question would be does Transport Canada actually ever validate the regulation by saying its effective, in other words, has it reduced a number of maintenance errors? Through the training? Or maintenance errors are really only reduced by application of these models? This is fatigue model is a good example. In other words, have you guys approved of your rule to be effective in reducing maintenance errors through the training alone?
Unknown	I'm thinking the answer is no.

Speaker	Dialogue
Martin Maurino	Yes and you are correct.
Unknown	Rules relying on implementation tools
Martin Maurino	And we're developing now as a spin-off from SMS and then that would then maybe answer your question in the long term as we're now developing databases where we're looking at carriers specific or certificate specific when you look at, for example, findings and things like that - that we can actually keep in a data base and then we're trying to move a lot of surveillance activities to being risk based. So aside from the sort of calendar schedules that we have of when we're suppose to go in and do inspections to give more leniency when an operator, for example, we know is complying and so we deem that they're a lower risk we can extend the cycle and then for other carriers we'll have to do a lot more surveillance and more intense training.
Unknown	That's why I like the 16 hour fatigue model it didn't say no, it just said there are risks associated with it.
Martin Maurino	Yeah.
Unknown	A way to mitigate the risk?
Martin Maurino	So in terms of for FRMS the certificate holders would have to prove it to us through data, right? And because, basically, I don't know if you are familiar with things like this faith software and it actually shows you basically and you can get different scorings that says, “its fine” or, “no, it’s a disaster, you can't do that.” And also looking at stuff like how much sleep you've had, and days off and things like that. So, I'm more familiar with the pilot side then from the flight OP side, the up side for the sale of FRMS to airlines is to have more flexibility aside from flight and duty time limitations.
Unknown	So an employer who does 6/10 of his who is that who gets 6/10's?
Unknown	Rockwell.
Unknown	Rockwell. So the employer would have to justify 6/10's?
Unknown	Yeah.
Unknown	That's great.
Unknown	The rule says 1-7 right?
Unknown	Well remember that's not based on data that's just on a fixed model.
Unknown	We don't regulate off time either.
Unknown	That's true too and that's the part of the problem from our [unintelligible].
Unknown	If you regulate duty time, how do you regulate off time?
Unknown	Yeah but plus if you establish a justification for 6/10's when you may actually bend a part off time.
Unknown	Part of the FRMS, I think you guys have this in yours, is the requirements to be fit for duty
Unknown	Yes, there’s a lot of education.
Unknown	[unintelligible] full responsibility to self manage their time and I think that's we're the training component comes in and as we can all talk about fatigue and we've been in human factors for a long time but you talk to somebody else and being able to work through the night or, you know, work for 24 hours straight, it’s almost a badge of honor. Until you start talking to people about the effects of fatigue can have on their performance, the effects it can have on them personally, in terms of health and also in terms of safety for the organization, and so I think where the training component comes in and helps really fit into that requirement for you to be fit for duty and making sure that you have knowledge to be fit for duty.
Unknown	OM regulates pilots off time.
Unknown	What can he do in his off time but what can he not do in is off time so

Speaker	Dialogue
	many hours before he comes on duty?
group	Talking at once.
Dr. Bill Johnson	I think I got a pull an administrative trick here we definitely are talking fatigue. Katrina's got a whole presentation on fatigue and we're really, really getting behind badly. So sorry to do this. It's cool stuff. Was that your last slide Martin?
Martin Maurino	Yes
Dr. Bill Johnson	Okay. Thank you.

Appendix C: International Perspective on MX HF with Special Emphasis on Event Reporting Systems (Dr. William Rankin)

BOEING

Commercial Aviation Services
Maintenance Engineering

International Perspective on Maintenance Human Factors Programs with Special Emphasis on Maintenance Error Decision Aid (MEDA) Implementation Issues

William L. (Bill) Rankin, Ph.D.
Technical Fellow
Maintenance Human Factors

Copyright © 2010 Boeing. All rights reserved. 9E991

BOEING

Commercial Aviation Services
Maintenance Engineering

International Perspective on Maintenance Human Factors Programs with Special Emphasis on Maintenance Error Decision Aid (MEDA) Implementation Issues

NO LICENSE IS REQUIRED FOR THE DISSEMINATION OF THE COMMERCIAL INFORMATION CONTAINED HEREIN TO FOREIGN PERSONS OTHER THAN THOSE FROM OR IN TERRORIST SUPPORTING COUNTRIES IDENTIFIED IN THE EAR. IT IS THE RESPONSIBILITY OF THE INDIVIDUAL IN CONTROL OF THIS DATA TO ABIDE BY U.S. EXPORT LAWS.

THE EXPORT CONTROL VALUE OF THIS OBJECT IS ECCN VALUE 9E991 AND HAS BEEN MARKED COM FOR PURPOSES OF EAR ACCESS CONTROL.

Copyright © 2010 Boeing. All rights reserved. 9E991

Presentation Outline

- Existing regulations/requirements on Maintenance Human Factors (Mx HF)
  - European Aviation Safety Agency
  - Federal Aviation Administration
  - Other countries
- Existing Mx HF programs at airlines/MROs
- MEDA implementation issues
- Summary

Copyright © 2010 Boeing. All rights reserved. 9E991

EASA 145 Maintenance Human Factors Program Requirements

1. Safety Culture
2. Incident investigation and internal/external reporting of findings
3. Design/maintenance Interface (poor maintenance data)
4. Maintenance Human Factors training
5. Procedural non-compliance
6. Planning of tasks, equipment and spares
7. Fatigue
8. Shift handover and task handover
9. Error capturing (duplicate inspections, etc.)
10. Signing off tasks not seen nor checked.

Note: Requirements in blue are recommended by the FAA.

Copyright © 2010 Boeing. All rights reserved. 9E991

EASA 145 Maintenance Human Factors Training Requirements

1. General / Introduction to human factors
2. Safety Culture / Organizational factors
3. Human Error
4. Human Performance & Limitations
5. Environment
6. Procedures, Information, Tools and Practices
7. Communication
8. Teamwork
9. Professionalism and integrity
10. Organization's HF Program

Copyright © 2010 Boeing. All rights reserved. 9E991

Other Countries

- If the National Aviation Authority (NAA) follows the EASA regulatory framework, they should have the same requirements as in Europe.
- If the NAAs follow the FAA regulatory framework…
  - They still typically require Maintenance HF initial training and 2-year recurrent training.
  - They may also require a maintenance-caused event investigation process like MEDA.

Copyright © 2010 Boeing. All rights reserved. 9E991

Do Not Forget that…

- Regardless of where an airline Maintenance & Engineering organization or an MRO is located, if they have an EASA 145 certificate, they should be following the EASA 145 Mx HF regulations.
  - Typically do not see this, but with some exceptions.

Copyright © 2010 Boeing. All rights reserved. 9E991

Maintenance Human Factors Training

- EASA requirements most prescriptive in terms of subject matter to be covered.
- Other NAAs typically just require an initial Mx HF training and 2-year recurrent training requirements without specifying content.
  - It is common for the organizations to use MEDA-type findings in the recurrent training.

Copyright © 2010 Boeing. All rights reserved. 9E991

Other Training Differences

- Who does the training?
  - Training Instructor
  - Instructor plus "guest management"
- Who is in a particular class?
  - Only mechanics/technicians
  - Mechanics/technicians, managers, engineering staff, administrative staff, etc.

Copyright © 2010 Boeing. All rights reserved. 9E991

Other Maintenance HF Programs

- Programs where someone asks "how can we help you do your job better?"
  - Qantas "Traveling HF Group" program
  - Japan Airlines "Old Men" program
- "Sign and Do" type programs
  - Northwest Airlines "Key Behaviors" based on escapes from letter checks
  - Aviation Technical Services "Ten Commandments"
  - Garuda Maintenance & Engineering "Do and Don't Policy"
  - jetBlue "Personal Minimums" checklist based on MEDA findings.
- Fatigue Risk Management program.

Copyright © 2010 Boeing. All rights reserved. 9E991

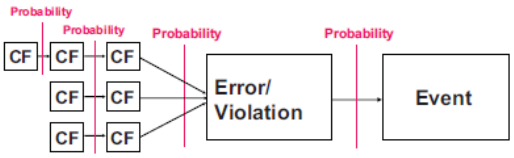
What Is MEDA?

MEDA is a process that is used to investigate events caused by mechanic/inspector performance.

- A maintenance-related event can be caused by an error, by not following company policies, processes, and procedures (violation), or by an error/violation combination.
- Maintenance errors are not made on purpose.
- Errors result from a series of contributing factors in the workplace.
- Violations, while intentional, are also caused by contributing factors.
- Most of the contributing factors to errors and/or violations are under management control.
- Therefore, improvements can be made so that these contributing factors do not contribute to future events.
- The maintenance organization must be viewed as a system, where the mechanic/inspector is one part of the system.
- Addressing lower level events helps prevent more serious events.

Copyright © 2010 Boeing. All rights reserved. 9E991

MEDA Causal Model



Copyright © 2010 Boeing. All rights reserved. 9E991

MEDA Results Form

- General Information
- Events
- Maintenance System Failure
- Contributing Factors
- Event Prevention Strategies

Copyright © 2010 Boeing. All rights reserved. 9E991

Results Form General Information

Section I -- General Information

Reference #: _____
Airline: _____
Station of Error: _____
Aircraft Type: _____
Engine Type: _____
Reg. #: _____
Fleet Number: _____
ATA #: _____
Aircraft Zone: _____
Ref. # of previous related event: _____

Interviewer's Name: _____
Interviewer's Telephone #: _____
Date of Investigation: ___/___/___
Date of Event: ___/___/___
Time of Event: __:__ am pm
Shift of Error: _____
Type of Maintenance (Circle):
1. Line – If Line, what type? _____
2. Base – If Base, what type? _____
Date Changes Implemented: ___/___/___

- This information can be useful for categorizing MEDA results.
- We provide the Results Form in a digital format so that maintenance organizations can change these categories.

Copyright © 2010 Boeing. All rights reserved. 9E991

Results Form Event

Section II—Event

Please select the event (check all that apply)

1. Operations Process Event
( ) a. Flight Delay _ days__ hrs_ _ min.
( ) b. Flight Cancellation
( ) c. Gate Return
( ) d. In-Flight Shut Down
( ) e. Air Turn-Back
( ) f. Diversion
( ) g. Other (explain below)

( ) **2. Aircraft Damage Event**
( ) **3. Personal Injury Event**
( ) **4. Rework**
( ) **5. Airworthiness Control**
( ) **6. Other Event (explain below)**

Describe the incident/degradation/failure (e.g., could not pressurize) that caused the event.

- **Process loss**
- **Aircraft damage**
- **Personal injury**
- **Rework**
- **Airworthiness control**

Copyright © 2010 Boeing. All rights reserved. 9E991

Results Form Maintenance System Failure

Section III—Maintenance System Failure

Please select the maintenance system failure(s) that caused the event:

1. Installation failure
( ) a. Equipment/part not installed
( ) b. Wrong equipment/part installed
( ) c. Wrong orientation
( ) d. Improper location
( ) e. Incomplete installation
( ) f. Extra parts installed
( ) g. Access not closed
( ) h. System/equipment not reactivated/deactivated
( ) i. Damaged on installation
( ) j. Cross connection
( ) k. Mis-rigging (controls, doors, etc.)
( ) l. Other (explain below)

2. Servicing failure
( ) a. Not enough fluid
( ) b. Too much fluid
( ) c. Wrong fluid type
( ) d. Required servicing not performed
( ) e. Access not closed
( ) f. System/equipment not deactivated/reactivated
( ) g. Other (explain below)

3. Repair failure (e.g., component or structural repair)
( ) a. Incorrect
( ) b. Unapproved
( ) c. Other (explain below)

4. Fault Isolation/Test/Inspection failure
( ) a. Did not detect fault
( ) b. Not found by fault isolation
( ) c. Not found by operational/functional test
( ) d. Not found by inspection
( ) e. Access not closed
( ) f. System/equipment not deactivated/reactivated
( ) g. Other (explain below)

5. Foreign Object Damage
( ) a. Material left in aircraft/engine
( ) b. Debris on ramp
( ) c. Debris falling into open systems
( ) d. Other (explain below)

6. Airplane/Equipment Damage
( ) a. Tool/equipment used improperly
( ) b. Defective tools/equipment used
( ) c. Struck by/against
( ) d. Pulled/pushed/drove into
( ) e. Other (explain below)

7. Personal Injury
( ) a. Slip/trip/fall
( ) b. Caught in/in/between
( ) c. Struck by/against
( ) d. Hazard contacted (e.g., electricity, hot or cold surfaces, and sharp surfaces)
( ) e. Hazardous substance exposure (e.g., toxic or noxious substances)
( ) f. Hazardous thermal environment exposure (heat, cold, or humidity)
( ) g. Other (explain below)

8. Maintenance Control
( ) a. Scheduled task omitted/late
( ) b. Incorrectly controlled deferred defect
( ) c. Incorrectly deferred defect
( ) d. Airworthiness data misinterpretation
( ) e. Technical log oversight
( ) f. Airworthiness Directive oversight
( ) g. Modification control
( ) h. MEL interpretation
( ) i. Configuration control
( ) j. Records control
( ) k. Component rotatory control
( ) l. Other (explain below)

( ) **9. Other** (explain below)

Describe the specific maintenance failure (e.g., auto pressure controller installed in wrong location).

Copyright © 2010 Boeing. All rights reserved. 9E991

Results Form Contributing Factors

- Information
- Equipment/Tools/ Safety Equipment
- Airplane Design/ Configuration/Parts
- Job/Task
- Knowledge/Skills
- Individual Factors
- Environment/Facilities
- Organizational Factors
- Leadership/ Supervision
- Communication

Copyright © 2010 Boeing. All rights reserved. 9E991

Results Form Event Prevention Strategies (Failed Barriers)

Section V – Event Prevention Strategies

A. What current existing procedures, processes, and/or policies in your organization are intended to prevent the incident, but didn't?

( ) **Maintenance Policies or Processes** (specify) _____
( ) **Inspection or Functional Check** (specify) _____

Required Maintenance Documentation
( ) Maintenance manuals (specify) _____
( ) Logbooks (specify) _____
( ) Work cards (specify) _____
( ) Engineering documents (specify) _____
( ) Other (specify) _____

Supporting Documentation
( ) Service Bulletins (specify) _____
( ) Training materials (specify) _____
( ) All-operator letters (specify) _____
( ) Inter-company bulletins (specify) _____
( ) Other (specify) _____

( ) **Other** (specify) _____

Copyright © 2010 Boeing. All rights reserved. 9E991

Results Form Prevention Strategies

B. List recommendations for event prevention strategies.

Recommendation #	Contributing Factor #	

(Use additional pages, as necessary)

Copyright © 2010 Boeing. All rights reserved. 9E991

MEDA Successes

- Estimate that >800 maintenance organizations are using MEDA
- Awarded the
  - Int'l Federation of Airworthiness Whittle Safety Award 2000 and
  - Flight Safety Foundation/Airbus Human Factors in Aviation Safety Award in 2010.

Copyright © 2010 Boeing. All rights reserved. 9E991

Why Does MEDA "Fail" at Some Maintenance Organizations?

- Management simply does not implement the process after MEDA implementation support.
- Fear of punishment by the mechanic.
- MEDA investigators who "already know why the mechanic failed."
- MEDA investigators who do not have good interview skills.

Copyright © 2010 Boeing. All rights reserved. 9E991

A Final Note

- Who does the Maintenance Human Factors work at a maintenance organization?
  - HF training handled by the Training Department.
  - MEDA-type investigations often owned/done by QA group, although there are some exceptions.
  - While there are a few exceptions, maintenance organizations typically have not hired a degreed HF person to do this work. Usually pick an internal candidate and promote/transfer that person into the HF job.

Copyright © 2010 Boeing. All rights reserved. 9E991

Summary

- The most common Mx HF requirement is for <u>training</u> followed by maintenance <u>event investigation</u>.

Copyright © 2010 Boeing. All rights reserved. 9E991

BOEING

Copyright © 2010 Boeing. All rights reserved. 9E991

Speaker	Dialogue
Bill Rankin	It's very nice to be here today. This is a presentation that I gave for Bill Johnson a couple of years ago, and I added something about the MEDA process to it. Bill said I travel around the world doing human factors training for Boeing customer airlines. So he asked "What do you see out there? What are the international human factors regulations as far as you can tell?" So I'm going to talk about existing regulations/ requirements on maintenance human factors from EASA, the FAA, and other countries that I've visited. I purposely left out Transport Canada because I knew Martin was going to make his presentation. I will talk about some existing maintenance human factors programs at airlines and at MROs. And then I'll talk about the Maintenance Error Decision Aid (MEDA) process and some of the implementation issues regarding the MEDA process. This is the EASA 145 maintenance human factors program requirements. I'm not going to read these ten lines to you--you can read them yourself. You can see that maintenance human factors training is number four of the ten. The program requirements in blue are recommended by the FAA. Bill Johnson headed the committee to develop an Operators Manual for Maintenance Human Factors. Bill Johnson knew all these ten because he developed a maintenance human factors training program for Lufthansa Technik that met all the requirements. But you can see the requirements are not just for training. There are other issues--safety culture, incident investigation, how to deal with poor maintenance documentation, and so on. EASA also specifies what they want to see in the human factors training. If the National Aviation Authority follows the EASA regulatory framework--and as you probably all know most of the world either follows the FAA or EASA--they should have the same requirement. If the NAA follows the FAA regulatory framework, I still typically see a requirement for an initial human factors training and a two-year recurrent human factors training as a regulation, not as a recommendation. The other regulators may also require a maintenance event investigation process like our Maintenance Error Decision Aid (MEDA) process. Regardless of where the MRO is, if they have an EASA 145 certificate, they ought to be following those ten programmatic human factors requirements. I don't typically see this. There are a lot of MROs in the US that have the EASA 145, and I do not believe they have that ten point program. But there are some exceptions. I've done evaluation of a Maintenance & Engineering organization in Colombia, and they follow the EASA 10 point program to the letter. The EASA requirements are the most prescriptive in terms of subject matter covered in a human factors training program. Most other national aviation authorities typically just require initial and recurrent maintenance human factors training, but don't specify the content. But it is common for the organization to use MEDA type findings in recurrent training, because those are incidents that have happened at that organization. One of the problems we had was when the initial training was done, we used examples from Canada and other places, and people said "that will never happen here." But when you use your own MEDA data, then you can't say that because it did happen "here."

Speaker	Dialogue
	Who does the training? There's usually a training instructor that is assigned to do the human factors training. A lot of times guest management will come in to speak. Who is in a particular class? I was asking Martin who was required to be in the class in Canada. There are some organizations that only train the mechanics or technicians, but a lot of others have everybody from the Maintenance & Engineering organization take the training. And those classes seem to work the best from my perspective, because they mix the class with mechanics and supervisors and administrative staff. I think a lot times in human factors training, if you only have mechanics in the class, they start complaining about management. They start talking "they"—"they do this, they do that." If you have only management class, they talk about mechanics doing this or that. But if you have them both in the class, it really changes that discussion, because then they can talk together about the issues. So I think those classes work pretty well. I think the EASA regulation requires that everybody in Maintenance & Engineering get the training, including the administrative staff. I have seen some other maintenance human factors programs. There are a few programs that ask mechanics "how can we help you do your job better?" The answers usually have a lot to do with ladders, specific tools and things like that. In Japan it's a little hard for them to do MEDA investigations because it's a loss of face that you didn't do a maintenance task correctly and now somebody is investigating you for it. In Japan the older people are venerated rather than pushed off to the side. So the "old men" as they are called, at the end of the day they will go over to the younger mechanics and ask "What kind of problems did you have today? What can I do for you to make you not have that problem tomorrow?" Those problems have to do with tooling, material and sometimes documentation that was hard to read and follow. Then the "old men" try to do something about that over the next several days.
Bill Rankin	I've seen several what I call "Sign and Do" programs. Northwest Airlines at one time had a Key Behaviors program that was based on escapes from their heavy letter checks. They found that if the mechanics would carry out 10 Key Behaviors that they could have prevented half of the escapes. For example, before you close an access panel, take one last visual scan to make sure there is no tooling left in, no disconnected wiring and that kind of thing. Aviation Technical Services, which used to be called BF Goodrich Tramco, have something called the Ten Commandments. These are ten behaviors that they always want done, Garuda Maintenance and Engineering out of Indonesia has a "Do and Don't" policy. These are things they don't want you to do and things they do want you to do. It is something you sign and say you will follow. Jet Blue had a "Personal Minimum" checklist that was based on their MEDA findings. Then I am starting to see fatigue risk management programs. EASA 145 regulations require you to do something about fatigue. I think that fatigue risk management program is the easiest way to deal with that.
Dr. Bill Johnson	EASA just tells you to address fatigue. They don't get very prescriptive.
Bill Rankin	That's correct. Well, the UK CAA's CAP 716 does give you an example of a work schedule based on Fatigue Risk Management principles, although it does look somewhat European to me because it recommends

Speaker	Dialogue
	twenty days of vacation. The other example that is given for meeting the EASA 145 regulation is not to schedule complicated maintenance for the midnight shift. For example, don't do important Non-Destructive Testing structural inspections at 2:00 am in the morning. Now let's talk about the Boeing Maintenance Error Decision Aid (MEDA) process. Back in the early 90's Boeing worked with some of our customer airlines to develop this Maintenance Error Decision Aid process or MEDA as I'll call it from now on. It's a process that's used to investigate events that are caused by mechanic or inspector performance. MEDA used to just deal with errors, but we've added violations to the MEDA philosophy, and I'll talk about that in a second.
Bill Rankin	The MEDA philosophy is that a maintenance-related event can be caused by an error, by not following company policies, processes, and procedures, which I'll call a violation, or by an error/violation combination. Maintenance errors are not made on purpose. In fact a lot of times you can make an error and you don't know that you've made it. The errors result from the series of what we called contributing factors in the workplace. You've taken a course in human factors, so you've probably heard the term "performance shaping factor." Performance shaping factors are the same thing as contributing factors, except we call them contributing factors because they have already contributed to an error or to a violation. Most of the violations, while intentional, are also caused by contributing factors. People don't violate randomly. There's a reason that they violate policies, processes, and procedures. Part of the MEDA investigation would determine if there was a violation and why somebody did that violation. Often it's a normative violation. Most of these contributing factors to errors/violations are under management control. That's the good news. Therefore improvements can be made to these contributing factors, so they do not contribute to future events or are less likely contribute to future events. Also, the MEDA process views the organization as a system with the mechanic and inspectors as just one part of that system. I might as well admit that I have a little bias against the Dirty Dozen. I might as well get this out on the table. Problem I have with the Dirty Dozen is that it doesn't look at maintenance as a system. The Dirty Dozen just deals with mechanics. And it doesn't deal with other things in the system that lead people to making errors, and there are a lot of other ones. The other good news is if we address/deal with lower level events, then we help prevent more serious events. I've got some good data from a friend of mine in the Navy that shows that the same contributing factors lead to low cost events as well as to high cost events or serious injury type of events. So if you address lower level events and fix the contributing factors, you'll be preventing higher level, more serious events. This slide shows the MEDA causal model. CF is for "contributing factors." Contributing factors with some probability leads to errors and violations, and these errors/violations with some probability lead to

Speaker	Dialogue
	events. Also, there are contributing factors to contributing factors. So, if you're doing an interview and the guy admits that he was tired on the job. Then you don't stop there. You ask “why were you tired?” Response--I only got five hours of sleep last night. “Well why did you only get five hours of sleep?” Response--Well I worked a 16-hour shift and it’s an hour drive home and an hour drive back, had dinner with the wife and kids. So that left five hours for sleep. “Why did you work 16 hours?” Response--Well, they asked me to work a double shift yesterday. “Why did they do that?” Response--Well everybody knows we've been understaffed the last six months. So you need to follow that contributing factors process until you get to the main cause of his fatigue, which, in this case, is understaffing.
Bill Rankin	The MEDA Results Form, which is used to collect the contributing factors information, has five sections in it. The first section is General Information. This is just some things about who the interviewer is, and what the aircraft was. This information could be useful for categorizing MEDA results. We provide this Results Form to, actually, anybody, but especially our customers, in digital form. We have it written in Microsoft Word, and we encourage users to change the Results Form to be most useful for their needs. The place where they would typically change the form is the General Information section. Sometimes they also change the name from MEDA. I think we estimate there are over 800 users of the MEDA process now and probably only 200 call it MEDA. Just a guess. Everybody else has a different name for it, which is fine with me. In the SMS terminology, this is a reactive hazard identification process. So you have an event, and then you do the MEDA investigation. These are the types of events--process loss, like flight delays, cancellations, air turn backs; in-flight engine shutdown; aircraft damage; personal injury events; and re-work. That's on aircraft re-work not back shop re-work. And airworthiness control as an investigatable event is a recent addition to the MEDA process. The third section used to be called the Maintenance Error section, but now that we added the violation concept, we call it the Maintenance System Failure. As you can see, we've tried to be very specific about what the system failure is. We don't just use terms like slip, lapse, and mistake or error of omission/commission. You probably can't read that on the projector, so let me just go through the Installation Failure portion of the Maintenance System Failure. Not installed, partially uninstalled, wrong parts installed, installed in the wrong orientation, the wrong location, incomplete installation, extra parts installed, access panel not closed, system wasn't deactivated to do the maintenance or wasn't re-activated after the maintenance, damaged the part installation, cross connected, and then an “other” category in case we didn't get the actually installation failure. Maintenance Control I just added recently at the request of the UK Civil Aviation Authority. They are having troubles with those types of issues, like missing a scheduled task during a heavy check, incorrectly controlling a defect, misinterpretation of the MEL, and those types of airworthiness issues.
Bill Rankin	The fourth section is Contributing Factors. The Results Form has ten categories of contributing factors, and then within each category we give several examples of how that might of contributed. Like for Information, it might have been hard to read and understand; it might have been out

Speaker	Dialogue
	of date; or maybe the mechanic didn't use it. So we list those things so people don't have to memorize those to do the investigation. And these are the ten categories. Then on the last page of the Results Form we have the fifth section—Event Prevention Strategies. The airlines that helped us develop MEDA wanted to have a section that said "what should have prevented this at the airline, but didn't?" So things like maintenance policies/processes in case you didn't follow them. Inspection or functional check--maybe the inspector missed something, or maybe you didn't do the operational check at the end of the task. Those types of things. This blank area is for listing all contributing factors that you got out of the interview. At the end of the interview you ask the mechanic how he/she would fix these problems, because, at that point in time, would be the world's expert in that particular error. And so you want to get their feedback from them. I've never met a mechanic who was happy that he or she made an error that led to a problem on airplane. They kick themselves for this. And so when you ask them for how to improve, you get to move them into the "continuous improvement" phase rather than "kicking themselves for making the error" phase. So it has a positive effect on them as well as they actually have very good information to give you about fixing the contributing factors to the error. That doesn't mean you do everything they suggest, however. Some of these improvements cost money, so it's going to be a management decision. Other improvements are free. But the manager eventually has to make the decisions on what improvements to make. We have estimated that over 800 organizations are using MEDA, and I've already mentioned the two awards we got because of it. Why does MEDA implementation fail at some organizations? I've done MEDA training and after I've left, the management simply doesn't implement the process for whatever reason. Gets too busy or whatever. But they don't support, they don't implement the process. Once you have the MEDA process in place, it could fail because you haven't addressed the punishment issue. Mechanics are afraid that they are going to get punished. They're going to be careful about what they tell you, let me put it that way. So I've seen several programs that have failed. Qantas had a very good presentation at one of the maintenance human factors seminars this year. They've had to implement three times, and they finally got it right on the third try. They were finally successful, because they implemented a discipline policy first, and then implemented the MEDA process second. The first two implementations the mechanics thought it was a witch hunt and refused to cooperate in the investigations. It's a strongly unionized airline, so if they didn't want to cooperate, they didn't have to. I've also seen MEDA fail because the people who do the investigation say something like, "I don't even need to do this investigation, I know what the problem is--its training. It's always training." When investigators have that attitude—I know what the problem is, so I don't have to do the investigation--the program is going to fail. Because it's not always training. It's any of those ten contributing factors.

Speaker	Dialogue
	Also investigators who don't have good interviewing skills can affect the success of using the process. The MEDA investigation is basically an interview with the person who did the work. If you're not a good interviewer, you're not going to get the information you need. I do train people to be interviewers, but some people are sort of naturally born interviewers and others aren't that good at it. So what I often find is I'll train thirty people to be a MEDA investigator, and I'll go back to that airline a year later and two people are doing the interviews. Because they were the ones that could do good interviews, so management started sending them out to do all of the MEDA investigations.
Bill Rankin	Who does the maintenance human factors work in a maintenance organization? The human factors training is handled by the training department. The MEDA type investigation--I'd say 80% of them are carried out by quality assurance--quality assurance owns the process, and a QA auditor often leads the interview. They often take a senior mechanic with them that's been trained. Qantas, when they have an event, they analyze it for risk. High risk events are investigated by QA. Medium and low risk events are investigated by production people. So they can train mechanics to go out and interview their friends to do MEDA investigations, and the mechanics, believe it or not, consider doing MEDA investigations the most fun part of their job. There only disappointment comes when their management won't release them to do a MEDA investigation because of a time crunch on getting a letter check finished. While there are a few exceptions, I do not see maintenance organizations hiring a degreed human factors person to be the human factors person at the airline. David Marx was one exception at Northwest, but he's not there anymore. When I go to Europe and say "who's doing the human factors training?" the answer is some mechanic with good interpersonal skills. They don't hire people that actually have a human factors degree and background. So that's why my work is important, because I've developed these processes and I go train airlines to use them. The airlines don't have to have their own personnel to come up with those processes. But I think this is sort of funny. I mean, we're pumping out these people at the universities with human factors degrees, but they not going to get hired at airlines because the airlines brings their own people up.
Dr. Bill Johnson	Bill, I can remember another--not naming the airline--that hired a highly degreed human factors expert to run their maintenance human factors program, and it just simply didn't work. They spoke a different language, and didn't get acceptance from the maintenance personnel.
Bill Rankin	Well, that person was largely what we call a factory ergonomist, if we're talking about the person.
Dr. Bill Johnson	We are.
Bill Rankin	They knew how to lift properly and they knew how to twist, turn and get in the small areas, but they didn't know anything about the type of human factors that you've been promoting. So that's a true statement.
Dr. Bill Johnson	But the statement that you're making that there's not necessarily human factor degreed people running this. That's not a negative statement is it?
Bill Rankin	It's just an observation.
Dr. Bill Johnson	Observation. Okay. Because really it seems like the success in my many observations is that you get people from the organization that have

Speaker	Dialogue
	come up through the ranks of maintenance. It's probably more feasible to teach them and get them schooled up in the area of human factors, quite honestly, than it is to take the greatest human factors expert in the world and get them schooled up to the intricacies and politics and etc. of maintenance.
Bill Rankin	I don't disagree with that. Two caveats here. One, they usually bring up personnel to do the human factors training, which they can learn. But that person doesn't know how to go out and deal with coming up with a good shift and task hand over report. So, two, they don't have the human factors background that would allow them to do some of these other things that the regulations are asking for. But that's the trade off, and that's the choice they make.
Dr. Bill Johnson	You're looking for real action items from FAA. I think Jay and I have worked with so many others and stepped up to help develop that tool set to empower the people that are out there in the field. I think in the next two days, if we find ideas of what those tools need to be, we need to be developing those tools, not necessarily as a regulation, but as a tool to support the human factors community. Let's identify those and get moving on them.
Bill Rankin	Good. So my summary is that the most common maintenance human factor requirement I see around the world is a requirement for human factors training. I also see some requirements for event investigation. But I don't see regulations as specific as the EASA requirements or even Transport Canada in the rest of the world. Thank you. Any questions?
Unknown	Can I ask a question please?
Bill Rankin	Sure.
Unknown	Can't take too much time. If you were a regulator or FAA person or someone with regulatory oversight and someone gave you a MEDA outcome would you be skeptical? Or would you, in other words, would you continue to do your own investigation or would you find what rank of competency would you give in that MEDA? Would you give it 100% or would you say maybe 80 - 85% because, as a regulator, I've seen MEDA outcomes, so I just wanted your opinion and let me share mine?
Bill Rankin	Okay.
Unknown	If you don't mind me asking?
Bill Rankin	No you can ask. Am I going to answer?
group	laughter
Bill Rankin	So a lot of times a company, when I go visit them a second time, will show me their MEDA investigation and say what do you think? Okay. And I've seen good ones, and I've seen not so good ones. Or it was clear that some personal bias led to some contributing factor, or, this isn't bad, but every once in awhile you'll find something that wasn't causal to the event but was a violation of the policy/process/procedures. And they've put down in the MEDA form, which I don't have a problem with, but really wasn't causal for the event, but it was a serendipitous finding that they do need to do something about.
Unknown	I like that answer because I don't always focus on a procedure/failure either beyond that. So you may get that as a routine but it may not be the root cause.
Bill Rankin	So some airlines I've seen doing very good MEDA investigations. Others not so good. And, if I were the FAA person, I would probably want to look a little further into that one myself.
Unknown	So it varies on the operator?
Bill Rankin	It depends on the interviewer. Truthfully. It comes right down to the

Speaker	Dialogue
	interviewer. How good they are?
Unknown	Thank you.
Unknown	Can I add, Bill, that one of the things we were talking about was trying to gather this data, and we don't (FAA doesn't) have any system out there. I've seen this MEDA tool, being called a different name, being used by an air carrier, and I was surprised to learn that we weren't even using or even had a requirement in the ASAP program that wasn't utilizing this form. I think there's a lot of maintenance ASAP programs out there, where there should be a golden opportunity for us to be gathering that data, at least as a starting point. Then find other ways of implementing this tool or similar tool in the program and even in our enforcement. We already have a risk analysis. I'm personally not really crazy about it, but this is another opportunity to gather that data. Again, it depends on the persons filling out the form, but you know
Bill Rankin	I firmly agree with you--you shouldn't wait until an ASAP Event Review Committee (ERC) meeting to ask all your questions. American Airlines does a MEDA investigation prior to the ERC. I think Southwest is going to start. Plus you know more than I do about these. But I wouldn't wait until the ERC meeting with three people sitting there asking questions to do the MEDA investigation. That’s not a good place to do a MEDA type investigation, because that's too high stress of a place for the mechanic.
Unknown	That's the environment where you should be worry free. You know that's the most inviting environment for the mechanics for spilling their guts, if you will, on what really happened.
Bill Rankin	Right in front of the FAA?
Unknown	You know for the - that's what I understand that you UCEF is you know an opportunity. That's why you have to grab that human factors data.
Bill Rankin	Right but I’m saying I'd get that data before the ERC and then use the ERC to finalize some questions. I personally think the mechanics are stressed out when they go into that meeting because they have their union rep there with them and then they got somebody representing management, and somebody representing the FAA. That isn't the greatest place to spill your guts I don't think. But.
Dr. Bill Johnson	But by the time you are in ERC, you've already done all this homework.
Bill Rankin	Not necessarily. There's not a requirement to do a MEDA investigation before you get to the ERC. Some airlines do all of the investigation at the ERC meeting.
Unknown	I think part 2 of what I've seen is a program to do the analysis of the data. A lot of it right now is, from what I've seen again I'm just looking at one little world where I’m familiar with it, is being able to push that button get all that analytical data without having to do my own hand hacking. I think that the program that the system's in you may be able to some basic searching but no analysis of the data.
Bill Rankin	Boeing doesn't supply MEDA software to the airlines. Most of them develop their own. But there's no repository of MEDA data. Also, there's no requirement for people at the airlines to send their MEDA data to me. One place that does collect MEDA data is in England. The CHIRP system, if you've ever heard of that system (Confidential Human Factors Incident Reporting Program), they have a system whereby MROs can send MEDA data in there, they de-identify, then add it to a database, and then summarize it. And we've heard a presentation on that from Nick Skinner, who runs that part of the CHIRP program over in England.
Unknown	That's a good point too. The NASA Aviation Safety Reporting System (ASRS) form people can view the records in the database. So why can't

Speaker	Dialogue
	we take it to the next step and make sure we're able to get some analysis of that data.
Unknown	In that data that we're all looking for.
Unknown	Bill Johnson, I don't want to get between thirty people and pizza. So maybe we can go offline, but if we're going to use MEDA and PEAT forms up in the Central region to do our data collection, one of the things that would be essential is to be able to audit those forms for the kind of quality you're talking about. And probably some sort of QMS process that we use for [unintelligible] programs. Do you have some tool or some methodology that you've developed to audit or?
Bill Rankin	No, other than I go and evaluate a MEDA program at an airline's request. I go spend a couple of days there, but that's all I know.
Unknown	Okay.
Unknown	Maybe I can talk with you later about how I would build something like that.
Unknown	Sure.
Bill Rankin	Okay, thank you very much.
Dr. Bill Johnson	Thank you, Bill.

Appendix D: Fatigue Risk Management for Aviation Maintenance: A Status Report (Dr. Katrina Avers)

Fatigue Issues for Aviation Maintenance: A Status Report

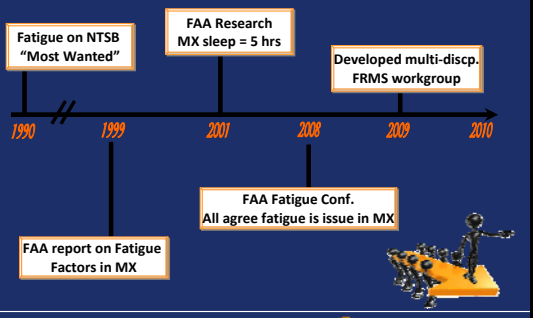
Federal Aviation Administration

Presented to: MX Human Factors Leaders Workshop

By: Katrina Avers, Ph.D., FAA - CAMI

Date: Aug 4-5, 2010

Aircraft Maintenance Fatigue History



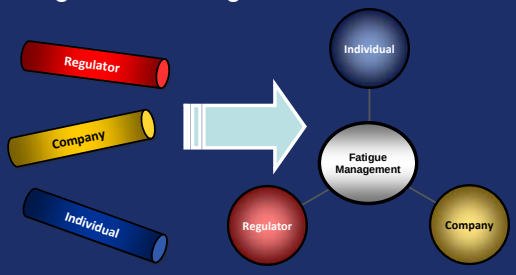
Talking Points

- Aircraft Maintenance Fatigue History
- Current Research and Development
- Next Steps

Current R&D for Maintenance Fatigue

- Multi-disciplinary workgroup
- Developing integrated, scientifically-based, practical solutions
  - Short-term
  - Long-term

Fatigue Risk Management



Fatigue Management PRESENT

Fatigue Risk Management FUTURE

Short-Term Solutions

- Fatigue Awareness
- Fatigue Assessment
- Fatigue Countermeasure Training
  - Mechanics
  - Managers

Fatigue Awareness Tools

Maintenance Fatigue Website

https://hfskyway.faa.gov/hfskyway/fatigueHome.aspx

Fatigue Assessment Tools

- Sleep diary
- Symptom checklist
- Supplemental incident form

(see handouts)

Fatigue Countermeasure Training

- CBT course currently under development
- CDs available Oct. 1

Long-Term Solutions

- Develop clearly defined responsibilities for Fatigue Risk Management:

Individual | Company | Regulator

- Develop guidelines and tools necessary for instituting a science-based fatigue risk management system
- Provide hours of service recommendations

Next Steps

- Operational handbook
  - Instructions for implementing a fatigue risk management system
  - Tools needed for implementing a fatigue risk management system
- Return-on-investment assessment for fatigue management interventions
- Development of hours of service recommendations

Discussion Points

- Use of fatigue questionnaire in accidents/incidents
- Data for Return on Investment model
- Potential weaknesses in proposed system
- Special considerations for GA
- Future Research

Contacts

Principal Investigator

Katrina Avers, Ph.D.
Industrial/Organizational
Research Psychologist
Email: Katrina.Avers@faa.gov
Phone: (405) 954-1199

Research Program Manager

Glen R. Gallaway
Maintenance Human Factors Research Program Mgr.
Human Factors Research and Engineering Group, ATO-P
Email: Glen.Gallaway@faa.gov
Phone: (202) 267-3173

Sponsors

Mr. Jay Hiles
ASI-National Staff Specialist-
Human Factors
Email: John.J.Hiles@faa.gov
Phone: (202) 385-6421

Bill Johnson, Ph.D.
Chief Scientific and Technical
Advisor for Human Factors
Email: Bill-Dr.Johnson@faa.gov
Phone: (770) 458-7921

Speaker	Dialogue
Katrina Avers	Today I'm going to talk about fatigue issues for aviation maintenance. Rather than give you the fatigue 101 presentation - since all of you guys are human factors experts - we really want to talk about what we're doing in the area of fatigue as it applies to maintenance. We want to talk about the history of fatigue research in maintenance very briefly, what we are doing currently, what we plan on doing, and then really get feedback on what we're missing; what do we need to do to improve our efforts right now, and what your ideas are for the future. So, if we look at the aircraft maintenance fatigue history we see in 1990 the NTSB put fatigue on its most wanted list; specifically for maintenance in aviation. In '99 we see some FAA reports on fatigue factors in maintenance. Dr. Bill Johnson as well as a number of others in a study sponsored by the FAA, conducted a research study and found that our mechanics are sleeping approximately 5 hours and 5 minutes a night, on average. And really, there wasn't much difference between morning, afternoon, or night shift. So across the board, we are seeing an obvious reduction in the amount of sleep, in terms of what we would expect or what we want to see people sleeping. In 2008 there was an FAA fatigue conference, I would expect that probably many of you were there, and at that point in time, really, everybody kind of came to an agreement; industry, government, the unions, everything pointed toward that, yes fatigue is an issue in maintenance and we need to be doing something about it. That FAA conference on fatigue led to a program directive, or a research tasking for us to examine the issue of fatigue, and how we can incorporate risk management strategies, and potentially provide recommendations to the FAA.
Katrina Avers	As a result, in 2009 we developed a multi-disciplinary work group involving industry representatives from all types of airline operations, union representation, government representation as well as academic researchers. Today we're going to talk about where we're at currently in our development and the next steps. So this is the first picture of our maintenance fatigue working group, you might not be able to see all of the pictures up there, but you'll probably recognize a few faces in the room. As a group, we've been working on developing integrated, scientifically-based, practical solutions for the maintenance industry. We have looked at the issue of fatigue in terms of both short term solutions and long term solutions. We did a survey of our work group members and asked them if we needed regulations regarding scheduling and duty time, twenty-one of the twenty-five members responded and said 100% yes. We didn't actually get a response back from the other four. So of those that responded, everybody was saying, "Yes we do need a regulation." However, we all know that sometimes regulations take a while, so that's kind of a long-term solution. We want to do something right now, what can we start incorporating into our training programs, into our operations, to improve our fatigue risk management right now instead of 4 or 5 years from now.
Katrina Avers	So we looked at short term and long term solutions, and looked at how fatigue risk management is right now. When we look at fatigue risk management, we see the regulator has some duty time regulations right now from the FAA. Sometimes companies have fatigue policies, sometimes they have training for fatigue counter measures, and sometimes individuals are doing things on their own; getting information on how to better manage fatigue, improve their sleep problems, and improve their sleep routine. So we have right now, 3 invested parties working independently. What we're working towards is more of a fatigue risk

	management approach where we have clearly defined responsibilities, and we're working towards the same goal together - ultimately fatigue risk management in maintenance operations.
Katrina Avers	In terms of short term solutions, the first thing we need to make sure is that people know what fatigue is and the implications that it has, both for us personally, and on the job. There are a number of health related issues associated with fatigue and then there are also work related effects in terms of on-the-job injuries and incidents or accidents. We need to improve fatigue assessment. On the META form, on the ASRS reports, on the ASAP reporting forms that I've seen, you've been able to check a box if it was fatigue related. One thing we know about fatigue though, is people aren't necessarily very good about identifying it in themselves. A lot of times by the time people think they're fatigued; they are actually physiologically fatigued way before that point. And so a simple fatigue check box, while it's a step in the right direction, it's not really getting at that objective assessment. In fact the feedback that I've gotten from industry, airline representatives, or MRO's is, people just use that as a copout. So what we really want to do is improve fatigue assessment. So we've developed some objective, data collection techniques that are incorporated in several of our working group members' operations right now to ask some basic questions, to look at sleep and wake histories, so we can plug that data into a model, get objective results in terms of expected effectiveness for a given work schedule, or a given incident. So instead of just checking a box for fatigue, we're able to say, "Yes, this really was a fatigue related incident". In fact for all of those incidents, the ones where people didn't check the box 'fatigue', we can go ahead and plug in that work and duty schedule only can look, is fatigue an issue here. So we're really getting a more objective assessment and improving that linkage, 'cause that's one of the things that people ask about is, "Well how many accidents were attributed to fatigue. Well we don't really have an accurate assessment right now because of the assessment tools that we're using.
Katrina Avers	So we're working to improve that, and then also, as a short-term solution instituting fatigue awareness and fatigue counter-measure training. What I mean by fatigue counter-measure training is how to avoid fatigue, and then you can also incorporate in there, "If you are experiencing fatigue, how do you best manage it? What kind of systems can you have in place to minimize the risks"? And so that's necessary for both mechanics and managers because there are some different issues that a manager will have control over in terms of scheduling, and then there is personal responsibility on the part of the mechanic.
Katrina Avers	We have some tools available right now. How many of you guys got a fatigue survival tool box calendar this year? The FAAST team was distributing them. Good. That was actually a team effort between the FAAST team and our maintenance fatigue working group, in terms of improving awareness. So you'll notice each of the issues identified in this calendar is relating to fatigue and some tips for improving your sleep habits, work environment, preparation to come to work, things like that. Fatigue posters are also available as a supplement to that, we will have a sign-up list for any of you guys that want some sent to your organization, and we can get those sent to you.
unknown	Are you going to reprint because I know they ran out?
Katrina Avers	Yes! We are.
unknown	Good.
Katrina Avers	We're going to actually reprint specifically for this work group so we'll be able to send out to you guys. If there are other things that you are wanting

	like the survival videos that Rogers Shaw showed us earlier, we can send packages back with you, including, calendars, posters, etc.. We also have a maintenance fatigue focus newsletter which keeps people up to date on what's going on in our work group, where the issues are being identified, the directions that we're taking, success stories, the successes and failures - the things that we're learning as we are beta testing, essentially these different tools that we're using. So these are all available - yes.
Katrina Avers	Another aspect of our fatigue awareness materials we've been working on putting together is a maintenance section on the HF Skyway human factors website. And in the maintenance section we have all of the tools that we currently have available on there, we also have links to Transport Canada's material. If you clicked on the fatigue management tool box it would come up and it has FAA's tools that we have available right now which includes some of the things I just talked to you about. And then there's also a Transport Canada tool box, it has the tools listed there so you can click on the link and you can download it. Transport Canada has a full toolbox right now. So they have recommendations on how to write a fatigue policy. They have recommendations on scheduling tools for low cost operations as well as for bigger operations. And so we're putting some tweeks on it for the FAA and to adapt to some of the US operations, but Transport Canada's is already a completely full toolbox, it's ready right now to be used by any operator that Transport Canada's made available and it's all on-line. And there is plenty of description in there as well. You might be over inundated by information, they have a training program on there, and they have scheduling tools, they have assessment tools, a number of different things.
Bill Rankin	Katrina.
Katrina Avers	Yes.
Bill Rankin	I have a question about Doctor Johnson's statements including fatigue. The five hours and five minutes of maintenance, do we know why US mechanics are getting that little of sleep? Or more generally, do we know if that generalizes the countries like China and Japan?
Katrina Avers	Well China's regs limit duty time on mechanics to eight hours.
Bill Rankin	Well, so we know this is due to a lot of overtime or just due to a second job.
Unknown	Oh man.
Bill Johnson	First of all we asked them how much they slept after they wore the watches. They wore the actigraph watches, collected fifty thousand dollars worth of data in 1999 and 2000. And Jerry said the number correctly, that was North, South, East and West, all shifts. So we had from repair stations on the West Coast to the airlines in the South, in Atlanta and etc. They said they were sleeping seven hours a night. But the same people that said they were sleeping seven hours a night, their actigraph said they were sleeping five hours a night. So first of all, they didn't know how much they were sleeping. Well, Bill, to answer your question, we also asked, and it's in the report written nine years ago - if they had second jobs, and there was some second job talk, but it was not a significant amount. 'Cause we made a list of, we asked the most questions to ourselves - well why are they not sleeping that much? It's almost like a cultural thing. Just, they're not doing what their mama told them to do when they were little boys and girls. I mean it's sounds funny, but they're just bad, bad habits.
Jim	So is it likely that the problem is worse now with the time and place.
Bill Johnson	You took the words, Jim, right out of my mouth, and that was 2000, before 9-11 and before people took thirty five percent pay cuts, and didn't get well, they start working more overtime, and on and on and on. That same study done today may be even scarier than that.

Katrina Avers	Well a lot of what we hear in our workgroup right now is overtime usage. Also, actually set schedules. In California, I think there was a company that's doing three sixteen's? Is that right? Three sixteen's so that they'll have four days off, because they have such a long commute, because they can't afford the cost of living in the areas close to their base of operations. And so we're seeing some of those contributing factors where actually people are being scheduled to maximum limits. And we're seeing it across the aviation industry. It's not specific to maintenance, it's only that maintenance doesn't have, really, a cap very well in place to limit that. So we'll see people working either doubles or triples to get their hours in, or to make the extra money.
Unknown	Then for general aviation.
Katrina Avers	Yeah.
Unknown	Yeah well we didn't have it on GAD. It was all, it was all one twenty one point forty five. I can remember working thirty hours straight to make an engine change.
Katrina Avers	That happens across the board because we've been starting to collect data on that. What's been really interesting with our work group, which is all people who are highly vested in the topic area, is they're starting to use the supplemental form that asks objective fatigue related questions and they are surprising themselves. I've heard some of them say, "I didn't really realize that this was happening in my organization". But they'll have somebody working twenty eight - thirty hours on an engine change, or commuting to a location - working a shift here, then commuting to a location and working there as soon as they land, while the flight crew goes and takes a nap, or catches their required sleep. And so, it's really opened the eyes of some of the operators and some of the union leaders as far as, "Wow, this is really what's happening, we didn't even realize it was to the extent that it is". Would you guys agree with that?
Unknown	We get, you're covering - go ahead.
Unknown	No, I just, I'm floored that we found out that one of the ones that sticks out in my mind was American. Because they work ten hour shifts. So they can work double shifts, so these guys are working twenty hour - twenty hours a day. It just blew me away.
Unknown	Well Jay, another example is we taught a class, we actually, CAMI taught a class and I just happened to be there. And it was an airline and a bunch of students that were dedicated to the whole fatigue issue. And after the class, one of them dropped me off at where I was staying, and he said, "Yeah, I just finished a double, but" he said his schedule for the last three years was two sixteen's and an eight. And that was an airline that was dedicated to doing the right thing, with a class room full of students dedicated to doing the right thing, and we sat through the whole class, and I didn't find out 'til afterwards that his schedule - on paper - was two sixteen's and an eight. Get real, you know, it just - it's going on, it's just what happens.
Unknown	Well I think we have a sleeping giant. How many one twenty one carriers are there? One ninety seven, ninety eight?
Unknown	[Unintelligible].
Unknown	How many one thirty five operators are out there, from single pilot up to, even the largest one. They've got a large one on the East Coast now that's going to make it very prevalent in the daylight that we don't even look at, we don't even - were not there's no regulation for the one thirty five, there's no requirements for paying attention to fatigue. Those boys work regular shifts. You say two sixteen's, three sixteen's?
Unknown	Two sixteen's and an eight.

Unknown	Some of those boys work, I'd like to know what they work anymore because I haven't been there for fourteen years, but they work a lot of hours and they're not regulated; there is no regulation there.
Unknown	And they're.
Unknown	That's right.
Unknown	They have no union to speak for them.
Unknown	[Unintelligible].
Unknown	They work only on their own, and what's the Agency doing? See we, I think we have a huge problem brewing that hasn't even come to light yet, and part of it's right here. And there's how many - there's what, over two thousand I think now, one thirty five operators.
Unknown	That's part of the group – the great thing about the work group because the work group is going to, hopefully, identify those issues so we can move forward with that and.
Katrina Avers	Yeah, I was actually - early this morning I had to skip out for a little while, I was doing a fatigue counter measures training to a cabin safety group. And a part ninety one representative came up to me and he said, "We need this in part ninety one corporate because there are so many of us. He said we're not restricted at all, we actually don't have any of this type of education in our operations, you know, we really need some research and some applications in part ninety one as well.
Unknown	There's no union to protect them yet.
Katrina Avers	But.
Dr. Bill Johnson	With respect to this group, you know, as I said at the outset, we definitely are writing a report, and if we had even within this group, we're only together for two days, made some very specific recommendations. At least we get them into the, you know, the public documents, on our position on what needs to be done. So, I don't need it, it's important, but by everything you are doing.
Katrina Avers	Um hum.
Dr. Bill Johnson	But not [Unintelligible] if this group thinks it's a good idea, re-enforce, okay you're doing the right things and that's nice, but also do this, this, this, and this. I'm just sitting here saying, my gosh, all the great things that are in that calendar are sort of gone when the calendar's gone, and what are we going to do to make sure that you know how do you know you're fatigued? What are the symptoms? How to avoid them? How do you deal with them? The only place that really exists is in the calendar or.
Katrina Avers	On the posters right now to some extent.
Dr. Bill Johnson	Something to put in the mechanics pocket.
Katrina Avers	So other things that are on the website are sleep logs, that's one of things that really get people aware of how much they are sleeping. People typically overestimate their sleep, but when they start writing it down and tracking it, you see oh wow I'm not and these are the results whenever I'm not. So we have sleep logs on there, there's education materials, links to the current regulations, as well as regulations from other countries, so this is really a great resource as far as a one stop - one stop shop. And we're continually updating it.
Katherine Wilson	Is there anything on sleep disorders?
Katrina Avers	There are - there's a section on sleep disorders. There sure is.
Katrina Avers	So for fatigue assessment tools they put together a sleep diary, sleep log, symptom checklist and supplemental incident form. And if you turn right past my presentation the next thing that's in there is going to be just a very simple symptom checklist that's actually in the 2010 calendar. And then the next thing in there I believe is the supplemental incident/accident form, and the next thing in there is an example sleep log or sleep diary. So these

	are some thing's that you can even take home as a resource if you'd like. And they're available on the website as well. The symptom checklist you can see are things that we encourage you to use if you're working with somebody else, and if you're looking for these symptoms in them as well as in yourself. You can use the checklist to really operationalize how to identify when I'm fatigued? Because what we found as researchers is that people are not very good self assessors whenever it comes to fatigue. Usually by the time that we think that we're fatigued the physiologically effects of fatigue have already been in place for a longer period of time. So we aren't very good assessors. And then the supplemental incident and accident form we have been using this in our workgroup you guys are more than welcome to disseminate it and use it and collect that type of information what we are doing right now is we are inputting that data into a fatigue modeling software like we mentioned earlier. And it gives us risks. So for example I received a incident report from one of our workgroup members earlier this week and we input into the system and it told us that - that individual at the time of the event was operating at 42% effectiveness based on their sleep and wake cycle. Using this data we're being able to improve our assessment of when fatigue might be a contributor and when it is not. And that's not to say that fatigue is the one and only contributor but whenever you start having compounding factors if you're working you know multiple shifts you have continuous wakefulness. You're working back to the clock the operations. We want to be tracking this data as far as when fatigue is a potential contributor to these incidences and accidents. You can see there's not a whole lot of questions involved in it right now. We're still working on form revisions - there is some room there for improvement. Okay we're also working on fatigue counter measure training and a CBT course. Its currently under development by the contractor and we will have it available October 1st. So if everybody in here wants a copy of the CD we can send that to you. We're getting 5,000 burnt initially and we'll disseminate those until we don't have them and then we will also have it on the website as a downloadable program. It will have knowledge checks, things like that so this is part of those short term solutions to get people informed, to get people knowing the information they need to know to come to work fit for duty. So improving sleep habits, improving sleep routine things like that. And then also management techniques on the job. Long term solutions, obviously developing these clearly, I have responsibilities for fatigue risk management. Which we've actually kind of touched on a little bit here as far as the individual coming to work fit for duty, utilizing the information that they have provided. The company providing them the information so that they can act on it. Improving work load and scheduling tools. And then the regulator putting the regulations in place to provide the company with the guidelines to implement those systems. And so we are working on developing guidelines and tools that are necessary for having a fatigue risk management system. So some of those have already developed those will plug very nicely into this. We'll also have work load and scheduling tools like transport Canada and then ultimately we're also planning on providing hours and service recommendations. We alluded to it earlier and that we've already been working on that. I don't have them up in this presentation because it hasn't been finalized by the work group but I think we can talk about them.
Dr. Bill Johnson	Sure.

Katrina Avers	So they are actually closely aligned with the recommendations of Simon Folkard in terms of a 12 hour work day with potential for a 16 hour extension, minimized within a week time period. So it has week duty time red caps and then also daily duty time caps. And then we have a [unintelligible] that if you can demonstrate an equally effective or an equally effective schedule with less hours or with a different type of operation then that could be approved. So that kind of ties into the whole fatigue risk management scheduling. So yes if we have you know set it up for prescriptive duty kind of limit a 12 hour day but if you can demonstrate to us that you can operate safely and effectively with a different type of schedule then that could be reviewed and approved. So we're trying to have some type of hard and fast rule as well as the flexibility that we see in Transport Canada. Yes Bill.
Dr. Bill Johnson	Well the next big question is this a recommendation or regular?
Katrina Avers	Well, we as the work group only provide it as a recommendation we'll provide it as a recommendation to flight standards and then whoever right now that would be Jay but later on that will be somebody else. And then flight standards will take that recommendation and take the next steps on it. Is that fair to say?
Unknown	Yeah, and I'll explain those steps tomorrow.
Katrina Avers	Okay perfect.
Dr. Bill Johnson	Well we as a committee we got together and made that table and prepared all these materials. We were playing the game that what if the administrator said tomorrow what's the rule? What should it be? We wouldn't have to say um we would need to conduct some research and figure this out. We scientifically know what the rules should be and would be really prepared to make that recommendation.
Unknown	Me too.
Dr. Bill Johnson	In five minutes we know what's going on with the materials.
Katrina Avers	Yeah.
Dr. Bill Johnson	And we've got all this support and materials.
Katrina Avers	And that's our goal is to have all of the.
Dr. Bill Johnson	If only NTSB would beat up the FAA more.
Katherine Wilson	Would you bite your tongue?
group	Laughter
Unknown	My question on that Bill would be the oversight part. I mean if they have to show equivalency does that mean that all every ASI then will have to be trained on the use of the table and what timeline would you use to do that and how in depth would the ASI have to be trained in order to do the oversight?
Dr. Bill Johnson	[unintelligible].
Katrina Avers	I think those are excellent questions. And I don't know if every ASI would have to or if once your policy was approved then you would have random checks and just have you know a team of people that would do those random checks.
Unknown	Its called bureaucracy.
Katrina Avers	I don't know I think that's more to flight standards although if its something where all the ASI's need to be trained we can definitely develop the materials for that. One thing that we're working to do right now I should have mentioned this before is those supplemental questionnaire or fatigue questionnaire. People have been sending those in, I'm putting them in the system and then I give them back their effectiveness score because I have purchased a license to be able to do that. We're actually working right now in developing a tool that will be available as free ware. So any of you that are involved in an incident or accident investigation could go online enter

	the data from this form and that would give you somewhat like a fuel gauge it will tell you - you know if you're in the red, yellow or green and then also it would give a numerically effectiveness score associated with that. And see you could look at any point and time what their risk goal was. We're also working to develop a system that we can upload batched files so if you have your whole employees work schedule into it - it would have to be based on the work schedule and then average sleep patterns for maintenance technicians. We will put that into the system and it would flag any schedules that put somebody at below lets say a 70% effectiveness if that's you know what the cut off score is. So those are in the works right now. Right now there are tools out there that you can do it with you have to purchase licenses and you have to input the data and really most of them are more their tailored both to academic use and practical use but probably a little bit more on the academic side so there not very layman friendly. And what we're working on developing is something that's very practical and gives you the information that you need to know rather than all the information that as researchers we like to have.
Dr. Bill Johnson	Katrina what I've been asking a few air stations to do sometimes soon is this form that's the accident supplemental report form which we need an easier title to that.
Katrina Avers	I know we do.
Dr. Bill Johnson	Are you tired form? But you wouldn't have to wait till someone has a problem there's no reason why in fact I was talking with the guys at the AAR meeting [unintelligible] today there's no reason why they could if they wanted to give it a shot and once we give them that software model they can ask their employees to fill this out for a 2 week period in the morning or whenever they start their shift and they can actually get some sense in their own organization without even showing to anyone FAA or anybody else. Are your guys is your workforce tired? No. Great answer we don't even need to build a forum to know what they are. Here, there and everywhere. But at least you get some sense of just how tired they are and you saw from these questions they're not too complicated.
Unknown	However from a [unintelligible] stand point they fill out this form and they violate a regulation, identify violation regulation.
Katrina Avers	Well there's not a regulation violation that can be identified in there right now.
Unknown	[unintelligible] one and seven so they bought a one and seven on this form they've all [unintelligible].
group	talking together.
Unknown	Or an equivalent amount in thirty days.
Unknown	Right.
Katrina Avers	Right.
Unknown	I thought that was 121 only.
Dr. Bill Johnson	They're breaking 24 hours a day 28 days straight. They work 28 days straight and 24 hours a day.
Unknown	That's what they got to do to break our rule.
Unknown	Right.
Unknown	Yes.
Dr. Bill Johnson	They're dead by then.
Katrina Avers	You can actually even get in more than 28 because if you work the first four in the month and the last four in the second month the coverage of thirty you covered your first thirty or your days off in the first thirty and then your days off in the last of the thirty. So you can actually do.
Dr. Bill Johnson	Two days 24 hours straight.
Unknown	Right [unintelligible].

Vickie	I'm really worried you know I'm listening to this and I agree that there's got to be some kind of controls. I don't know if mandating 8hr, 10hr, 12hr whatever type day because when you go 12 hrs you automatically eliminated the individual from doing double shifts period. So that puts them outside. I know when I worked two jobs when I was going to school to do my undergraduate I was I mean I was in the best of health and I never really felt the fatigue because I was in good health and you know I'm still doing two jobs you know. I was maybe either going to school at night or was working at night and weekends. My point is its an individual basis you know now if I were to put a 10 hr in I'm dead. You know a lot of it has to do with the stress and other fatigue factors that are involved in what you are doing. And so if you're telling them you are going to mandate 12 hr day that individual has got rent to pay and a family to feed you're going to go somewhere else to get that money and then you even got less controls of that fatigue and there always kind of going back to the individual.
Dr. Bill Johnson	Well you know.
Vickie	I don't know if mandating a work schedule is really [unintelligible].
Unknown	But the company's are never going to allow this to happen anyway because you know.
Katherine Wilson	We're union.
Unknown	Well its no its not the union at least. You got to remember that most of the 121's have gone to contract maintenance within a very few line stations so when that airplane is dead in the water out wherever x, y, z their going to have to send a crew out if its not something that a contract guy can make go away. Okay. So those guys they they sent out there they'll be on the clock until that airplane is ready to go period. Their not going to care if its 10 hrs, 12 hrs they don't know.
Unknown	Right.
Unknown	So you know we've seen guys stay on duty well over 24 hours.
Dr. Bill Johnson	But if scientifically we know for a fact that its unsafe. Don't we have a responsibility to step up and say I don't care what you want to do we don't want the guy to kill somebody.
Unknown	Absolutely. We should put it in front of them and have debates certainly. Because their going to pilot.
Unknown	Absolutely.
Katrina Avers	We thought that we would never come to consensus. Within a day timeframe with us all working together on the same issue we had airlines we had big union representation and we had government all coming to agreement on some guidelines. And so I think that there is help I think that its something that you know we're starting to mess with money, starting to mess with you know the number of people employed in the work force, we're starting to mess with a lot of things that will have to be investigated.
Vickie	And I agree with that.
Katrina Avers	What we also know is that we're not very good assessors of our own fatigue level, and just like an individual that is drunk we think we can drive and we're safe when we're not. And number of accidents and incidents associated with that are evidence of it. And so I think that we have a culture in the US that thinks I can do it, I can work through it, you know this is a mind game or this a mind battle for me or a physical battle and I can overcome it and I'm stronger for it. And I think that's a culture mentality that we're going to have to work through.
Unknown	Well that and we're all just one red bull away from 4 more hours.
group	Laughter
Katrina Avers	Yeah.
Unknown	We have accidents, we have data on the flying side of it you know a lot of

	us got started but do we have the data that says that we've got accidents caused from maintenance fatigue? We know their fatigued, we know that their doing that but can you stand up and say how many accidents was caused by that?
Katrina Avers	Uh huh. Right now ASRS has as many as ninety accidents that are attributed to fatigue and the maintenance person performing it.
Unknown	[unintelligible].
Katrina Avers	Unfortunately what we seen in investigations is the investigation don't go far enough to the mechanic or even to ask the right questions to identify if fatigue was an issue. A lot of times these are written off as a maintenance error and whenever we look at NTSB reports and even in the ASRS and ASRS reports we don't see the level of investigation that we would need to be able to really identify. What are some key causes here?
Unknown	And I think that's the first step is we've got to get a data collection.
Dr. Bill Johnson	Well we do but we don't. And here's my response if you would add my answer yeah we do. Now we don't have aircraft accident data but if there's a 100,000 people a year killed in automobiles were they investigated enough to know that fatigue was an issue? There's been enough scientific research done to compare hours of wakefulness and you know it impaired decision making and [unintelligible] motor skills like alcohol. We know that and as you said Brian we know that people are working X number of hours therefore we know that its an issue whether it was airplane accident or not. That's the logic I would use. I probably say it better if I had time to write down.
Unknown	The other side of it is you know we keep saying airlines and you know and I can see that under the structure you can do it with a 145, you can do for you know 121 A135 but the ninety one world you know I was in a drug enforcement and we used to say all the time you can make any law you want want but its a matter of enforcing it and how you going to enforce when I'm with DOM I'm the DOM for four or five different small 135 operators and I'm bouncing from one to the next just keeping them all going whose going to say you will quit working. And unless you're standing there and you catch him.
Dr. Bill Johnson	Don't people sort of follow some - don't you follow some rules just in case anything goes wrong and they go back and look they're going to find out hey you weren't following the road you're busted.
Unknown	Pay cash.
group	talking together.
Dr. Bill Johnson	But that's the truck driving industry to clean that act up and [unintelligible].
group	talking together.
Dr. Bill Johnson	What happened to 8 o'clock this morning, we went around the room and said where's the problems and almost everyone said fatigue so we should think of what we're going to do to attack it. Because to me its realistic to realize where the challenges are. But lets blindly attack this that's what we're doing so far and we're pretty proud of what we've done but we've got to to the next step. This kind of people in this room are the ones that are going to make that list with those next steps going to be.
Vickie	That was my point you know is I just don't want to sit here and think that a regulation is going to be the answer it all goes back to self regulated if you will or monitoring and when I was doing my two jobs I did four hours so I had a max of twelve you know of course you're up a little bit longer but again I knew my limits.
Unknown	I'll say this again you get right down to it it goes back to a financial issue. If you want the mechanics to get more sleep pay them more money and give them less hours. They're not making more money they're going to work a

	2nd job or their going to work more hours in a facility I can tell you that going back to my AAR 8 years ago the first 40 hours I worked there was the only time I was on regular time after that I was on overtime. I've always been given my 7th day off because that was my dump time there. So I worked a double time pay 12-16 hours I'd come back in on my first day of the pay period that started my seven days over again on overtime and I stayed that way just day after day, week, month after month. And the money was rolling in.
Unknown	Yeah.
Unknown	If AAR were to cut down my hours and said now you need to take your 7th day off I would of found something else to do probably. Because I was there to make money I wasn't there to get off and go home and go to sleep. That wasn't going to happen.
Dr. Bill Johnson	And you were also trying to get well from the fact that the industry [unintelligible].
Unknown	This was before that.
Unknown	Yeah.
group	talking together.
Unknown	Even in the GA world I was at my hanger at 5:30-6:00 in the morning getting the day laid out when the guy showed up at 7 or 8 I got him all the job assignments, when they went home at 5 I had my friends that work at other airports run up there and we started our second shift 6 and we worked sometimes 1-2 o'clock in the morning to get these airplanes out. I had airplanes that had to fly because they're generating revenue and then I get on home and get into bed about 2 and back up at 6 and be back to the airport by 6:30 doing it all over again.
Dr. Bill Johnson	If there is a risk.
Unknown	That's just the industry standard - that's [unintelligible].
Katrina Avers	But do we have a culture of safety or not?
group	Laughter
Unknown	How much personal responsibility did you have to ensure you were rested to do your job correctly?
Unknown	One of my first personal responsibilities was a roof over my head, my families head, food on the table, bills paid, kids in school I mean that was my personal responsibility.
group	talking together.
Unknown	Prior to that when I was in the military I was in 18 hour days on a [unintelligible].
group	laughter
Unknown	I guess my point is where do you enforce it? Where does it come down that you can say here's our route problem how do we fix the route problem? Sounds to me like the route problem is with the individual.
group	talking together.
Unknown	Experience I was a director of maintenance had twenty airplanes to take care of I was the only mechanic out in the middle of [unintelligible]. And I see the airplanes off in the morning, board departs from the East Coast and then go home, sleep for 2 or 3 hours unless there was a maintenance problem which time I go fix the airplane then I get there early enough to see the airplanes arrive and interview the pilots find out what the discrepancies were to work those off. Do a 100 hour inspection. Do the routine maintenance. And start the sequence all over again.
Unknown	So how do you stop that?
Unknown	I called the FAA and say you know doesn't this guy have to hire another mechanic? No. Isn't there a minimum number of mechanics per a certain fleet of airplanes?

Unknown	No.
Unknown	No there's not. So I went to the owner and said I need another mechanic he said well there's only got 20 airplanes you do a 100 to 100 hour once a night that leaves that's 20 nights take the rest of the nights off.
Unknown	You know that doesn't work.
Katrina Avers	Yeah.
Katrina Avers	And I think that there's probably you know 20 more stories that we could hear just like that. And the re-curring theme is we're working longer hours than we should, we know that it is resulting in operational safety concerns. So as a group here what can we do? And I think that's what we need to focus on in this meeting because I think we all have these incidents in our head that we can think of and so what can we do as the next step, what can we do to address the issue? And that's what we've been trying to do in our work group as far as developing the tools necessary for fatigue risk management system. And developing our hours of service recommendation as a baseline. Ultimately right now what we're working on is developing an operational handbook that can provide instructions for how to implement an FRMS. And provide the tools necessary for it. We're developing them so it will be a full blown system that anybody could use whether you're a small operation or a large operation. We're working on a return on investment package because believe it or not if people are working fatigued they are costing the company money because their making accidents or incidents. The problem is - the company hasn't really been able to identify how much fatigue is really costing them until now. Until we started doing these objective assessments. That's why its so critical to improve our objective analysis.
Katrina Avers	Yeah.
Kevin Gileda	Well let's be careful with the accidents and incidents because it's going to be hard to show. But it's easier to show that their working to reduce capacity.
Katrina Avers	Right.
Kevin Gileda	So if their working at 42% of capacity on that second eight hours I have maybe this guy needs to leave but managements going to look at this and say why am I letting this guy work 16 hours when I'm only getting four hours worth of work out of him on the last 8.
Katrina Avers	And really and truly that.
Unknown	[unintelligible] And I would think the answer would be if he's not there somebody else is not there.
Dr. Bill Johnson	But I got another answer.
Unknown	They get half the work out of you. You've got more than no body being there at all.
Unknown	Well you hire more people.
group	talking together.
Unknown	If you're a bean counter you know you look at the cost of hiring another employee and benefits and what not and it is cheaper to let this guy work fatigued.
Unknown	And well do that going to. It's cheaper than paying somebody overtime to hire another [unintelligible].
group	talking together.
Katrina Avers	Alright Kevin.
Kevin Gileda	But think about the problem you got a 16 profit margins within [unintelligible] part 91's. They are operating on a shoe string so if you do maybe try to change the corporate culture I think that's important but there going to be looking at all the other part time volunteers they are having to compete against. 135, 121 is the same situation so in order if we want to

	make things so that if we'd like to see at this situation really have two employees rather than just that one in order to make the plane feel level, and remove that incentive to cut corners and just put it all on that one guy or gal I would think you need to regulate it and say yes everybody has to do this.
Dr. Bill Johnson	But it seems also like that rule needs to more strong [unintelligible] Part 65, to rest you might not be doing the kind of schedule you just described and you realize if you get caught you're going to lose your license.
Unknown	Exactly that was part of it. I was willing to do it because there was no regulation against it and I thought you know this was pretty normal that I was in my early twenties.
group	talking together.
Unknown	[unintelligible] from his second job.
Katrina Avers	How the regulations are being or this is my understanding how the regulations are being written now for the on the pilot side is that they cover all operations so its not just for 135, 121 it's for every single class of operation so its not a FAR like we've seen in the past we're its you know 135....it encompasses all types of operations. And that's kind of what we're in visioning for you know our requirements for FRMS for maintenance as well.
group	talking together.
Unknown	Its going to be a whole new FAR part and I think we're just kind of waiting to see how that all falls down.
Unknown	I think we can all agree that the existing duty time limitation rule for the operators is basically a non rule because its got the easy out. But so would we be doing any good to make it to say change that rule to say that an operator under part whatever 121, 134, 145 shall have a fatigue management program approved by the administrator and the set forth with guidance material what that should look like. Maybe [unintelligible] for it or something like that.
Unknown	The whole system you got to have a cast and their air carriers up there other than majors that take the rules very lightly from the very minimum so they'll have a cast manual that's cut and pasted from A to Z and you're fighting as a ASI for them trying to explain to them why this cut and paste AC is not a true cast program so you just have to battle and I'm afraid if we just have program now you're back to the ASI trying to explain to them why you don't think its adequate.
Katrina Avers	Although fatigue risk management program have requirements for assessment, there are requirements for data collection, on the part of the operator. And so that's one thing that can be tested very easily and that's also how you know if you can plug in an excel file into your computer and it spits out there's no violations then that's a pretty easy of way doing some checks.
Katrina Avers	Do they have a fatigue policy yes or no? Sorry go ahead.
Unknown	And to add to that we currently we have an off spec or we have you know provisions for short term installations and things like that we collect data to make sure they're not abusing it. And as you had such a such a mechanism for the management program. You can capture. What it does it allows the flexibility for the airline not to have an airplane sitting out there and not be able to manage that unusual situation. But yet they can still demonstrate that they're not abusing it by having you know rather than staffing with sufficient staff they're running guys 7 days a week. You know non stop in their own hangar and their own maintenance place. You see what I mean I don't know if I said that. But at least you can capture data management situation and not abuse it. You know that's her point.

Katrina Avers	Yeah. If you had some special circumstances and they're documented is that what you're saying?
Unknown	Yeah well their collecting information they're having to report back to the administrator. For example now all they do short term escalations they have to provide a monthly report, monthly or quarterly?
Unknown	Quarterly.
Unknown	A quarterly on STAE usage so the principles know that their not abusing it just pushing maintenance items out you know arbitrarily or as a matter of course.
Unknown	There's only if they got the short term escalation [unintelligible] believe they just got to tell them within certain findings the usage for short term escalation. And I'm [unintelligible] on them.
Unknown	There's a report. I've seen too many of them. I use to.
Unknown	The point is there is a feedback list for data to make sure something's, programs not being abused.
Katrina Avers	Right.
Unknown	That's my whole point.
Katrina Avers	Okay.
Unknown	I'm just trying to.
Katrina Avers	Yeah. You know that is the core to safety management systems and fatigue risk management, having a feedback loop always working to improve and documenting.
Dr. Bill Johnson	I think if we remain optimistic that the economy is going to recover and that industry is going to get bigger, and better I think there's already MOR's and even airline maintenance organizations that are fighting to get enough new qualified employees in a new higher class with five and they really need twenty. And this improves. Did you raise your hand?
group	Laughter
Dr. Bill Johnson	So as that improves this matter is going to worse before it gets better if government doesn't take some kind of action [unintelligible] I think its inevitable.
Unknown	And look at the output at AMP schools. AMP schools are shut down.
Unknown	Yeah.
Katrina Avers	And where do the majority of the graduates go to. Are they going into aviation or they going somewhere else
group	talking together.
Dr. Bill Johnson	Well one can say you don't need the MP.
Unknown	One and I’m not one of them.
Dr. Bill Johnson	Well we say you know the AMP schools because you're probably all out to MOR's and they don't need candidates with AMP licenses therefore I don't agree with that but even if you don't want the AMP with a new employee when you get new employees. Just getting qualified employees to come into a MOR and be able to fix airplanes whether they got AMP or not. People are aren't there. Is that a true finding?
Unknown	You can't even get the non certified personnel with the right qualifications that can pass a drug test, and show up to work everyday.
Unknown	[unintelligible] having to work crappy hours with crappy pay and treat you like crap.
group	Laughter
Unknown	No human factors ought to be a part of a 147 curriculum but it's not.
Dr. Bill Johnson	That's good recommendations from [unintelligible]
Unknown	Actually I will its been [unintelligible] like three times.
Unknown	Is it?
Unknown	Yes.

group	Laughter
Katrina Avers	You're looking awfully tan have you been golfing a lot?
Unknown	Good point.
Kevin Gileda	So one point to the solution is to require the study of it [unintelligible] and when I took the posters to the GA guys I showed them [unintelligible] equated powers of wake to performance level I got this prized reaction. People didn't know that. People in aviation are pretty responsible so I think marketing these ideas, and training people is really helpful. I realize its not the entire solution.
Katrina Avers	Right.
Unknown	And I don't think [unintelligible] they are already seeing the benefits of the human factor part of the place.
Katrina Avers	You say that and we've done some training programs at a couple of majors recently and people were coming off doubles and actually it was a major that Bill was talking about.
Dr. Bill Johnson	No we don't want to go anywhere.
Katrina Avers	No I'm not saying the name of it I'm not going to say the name of it but two sixteens and an eight and that's on the clock at that job.
Unknown	Normal schedule?
Katrina Avers	Yeah.
Unknown	I showed that.
Katrina Avers	And our union - our union leadership on the work group has said that they have actually multiple violations with some of the majors that they're having to work through with the FAA. So they are violating the FAA's current regulations that we consider kind of a non rule. So.
Dr. Bill Johnson	Could you repeat that please?
Katrina Avers	I don't know how their violating it Bill because I don't have.
Dr. Bill Johnson	[unintelligible].
Katrina Avers	That - they are having violations in their organization for duty time wrecks.
Unknown	On maintenance?
Katrina Avers	Uh huh.
Unknown	Wow.
Dr. Bill Johnson	How could you even work different hours to [unintelligible].
Katrina Avers	I 'm guessing that they worked too many consecutive days.
Unknown	Katrina I gave that same presentation that Guy gave to 121 there in Honolulu and the mechanics were all amazed you know about the fact that they were working as if they were drunk and at the end I was packing up getting ready to go and a couple of the old timers come over and go like yeah that's probably true for other people but I've been doing this for 25 years and it isn't me.
Katrina Avers	Exactly.
group	Laughter
Unknown	You can tell them, they can understand but you know unless they internalize it and I know it really is them.
Katrina Avers	Downstairs I was asking so how many of you guys had a beer before you went to bed last night, you know to help you go to sleep or how many of you watched tv while you were in bed, or read a book while you were in bed. By the time I asked all these questions everyone had raised their hand. They all had violations and they were all talking about issues of fatigue and yet they weren't doing the right stuff at home, off the job or even on you know on a easy training day schedule that they needed to do to get the right amount of sleep. So, there is definitely a role for awareness and training that I think we'll take us you know quite a ways. The issue is then so once we have individual's operating responsibly on information that they have learned then what's the role of the company as far as creating

	schedules so that unsafe schedules aren't mandatory – some have said that if they refuse overtime they are fired. That's where the employer really comes into play because the individual can only do so much. From everything that we've heard that's not going to happen unless there's regulations or recommendations from the FAA.
Katrina Avers	Yes.
Unknown	Any of the other industries you know the Petro chemical industry I know they do a lot of stuff and.
Unknown	[unintelligible].
Unknown	What are they doing in fatigue?
Katrina Avers	They have. It varies by industry a little bit. The majority of industries are moving towards this fatigue risk management system approach and some of them also have the I know [unintelligible] has a specific duty time regulation, they have some idiosyncrasy depending on the type of operation - type of [unintelligible] operation but that's really the direction that they have gone and they've actually probably made more advances than we have on the industry side in the last 10 years I would say.
Unknown	Is there something we can take from those organizations or have you already?
Katrina Avers	Definitely and that's kind of what we're working off right now. We started looking at all of the practices that are out, including programs specific to maintenance and other industries.
Unknown	You know we do all the helicopters and you know the requirements that they put on the helicopter operators way exceed what we do. We're just kind of like all we got to do is we whisper in Michelle's ear hey look at this and the next thing you know its fixed. And they have a lot of [unintelligible] and they do a lot of things that in fact I think they require if an PHI has a duty time thing now.
Unknown	I think something interesting to know I would like to know just the not aviation maintenance the US cultural sleep habits that are four from five point five themselves with a social network here, buy all computers they leave home their still working their email.
Dr. Bill Johnson	The initial sleep foundation publishes a lot of things like that.
Unknown	Yeah.
Dr. Bill Johnson	Really focuses a lot of that and I use it in some presentations to put the average American to sleep I forget what it is but its.
Katrina Avers	It's higher than it is for mechanics.
Unknown	It is?
Katrina Avers	Uh hum.
Unknown	Yeah. But I think its based on self reporting or something like that. Which of course would be higher because we all think the same.
Katrina Avers	And what we've been finding in the maintenance study we found is about an hour off we just finished a flight attendant study and they were an hour off as well. So people are thinking they're getting about an hour more of sleep than they actually are getting each night. That's been pretty consistent across studies that I've seen.
Dr. Bill Johnson	What's the status of that first year report that we did that looked at other countries and put it all together?
Katrina Avers	The best practices report? It should actually be ready August 15th for the committee to review and then we'll put it into final - final approval.
Dr. Bill Johnson	Did any of other note takers make a list for recommendations? I've written down six things that people say we ought to be doing. I don't know if you have or not. Do you have a list? Is this okay Katrina to talk about?
Katrina Avers	Yes.
Unknown	No I really haven't really been looking at.

Dr. Bill Johnson	Well guys by this list I think that we should just add you said sorry I didn't attribute it to names and I prefer to do that actually more than one of you said that we would really what we as a committee need to be doing is okay this stuff is real nice what if formulize this into a training program within the research project that we're doing and by the way its applied research its stuff we can use. Train ASI's start dealing with the enforcement issues that are in common with proper regulation. So that's one of things that you're recommendation was made back then. And Jim I think that was your words?
Katrina Avers	And actually we've been contacted quite a few times by ASI's across modes in our industry asking for training materials in this area and in fact we just got one the other day. I think you were CC'd on it.
Dr. Bill Johnson	Now the whole discussions around the issues of personal responsibility our approach has been educate, educate, educate but I think you also said part 65 except for Keith who said part 66. So personal responsibilities in part 65 we need to address that as a recommendation though.
Unknown	Behavioral shift I mean that's maybe an educational piece in that area.
Unknown	We got that issue in air traffic right now hugely and they're working on it and I don't know where they are with it but they work double backs so they can have 3 days off as opposed to so they can go play with all their toys that they get with this big salary.
group	laughter
Unknown	The fact is they don't want to give that up even though the FAA wants them to. To be safer and they don't want to give it up and they're working on it right now in one of their programs. So I don't know what you do but that is personal responsibility side [unintelligible].
Unknown	They also in air traffic let people pick their own shift and work their own overtime. Management makes me to do their job better but they can stop all that.
Unknown	Yes you're right they could [unintelligible] they can count it as well for whatever reason it is the controllers want to keep that. They'll of course give it up but that's like your talking about the mechanics they don't want to give up that opportunity to make more money.
Unknown	Sure, absolutely.
Unknown	Get paid for six hours worth of work then sometimes go elsewhere. Like she was saying maybe we'll go elsewhere, if we cut those hours their gone.
Unknown	Yeah into another industry.
Unknown	No they'll go to another company, another industry or whatever to make up for that.
Unknown	Well I just felt the revolving door.
Dr. Bill Johnson	Whether [unintelligible] if you're not I think we. I speak for myself I feel that for 25 some years the NTSB has been talking about this.
Dr. Bill Johnson	Continuously on and off because FAA on it. And we certainly all know the gripe so why don't we instead of making excuses of why its not done step up and get it done and these are steps in the right direction that if again if administrator says lets do it tomorrow well how about 121, 145, how about Part 65 how about its on the list. Part 147 Jay says you think we'll get some pretty good language in there coming down the pipe on human factors but fatigue as well.
Unknown	How to you enforce that rule?
Unknown	[unintelligible].
Unknown	Put a Part 65 rule out there see you got to be fit for duty or you can't be fatigued and what evidence do you have that they are? And what would be the outcome in other words did it was there a negative effect?
Dr. Bill Johnson	Well that was the first thing that you said we need to do is figure out to

	enforce some of the stuff their talking about. I don't really want to represent that I even know that answer but it's a hard issue we got to address but oh yeah somebody's got to do it. That's what our job is.
Unknown	There's a lot time that mechanics.
group	talking together.
Unknown	[unintelligible] industry do you know how to enforce it?
Katrina Avers	I don't but we can check on that though.
Unknown	[unintelligible].
Katrina Avers	Okay somebody went to the plain language class.
Unknown	And then there's EMRETS that they are even they are aren't.
Unknown	I think 65 you're not going to cover everything. I said the same thing rules only include if you can enforce it. But what I think it does what I've done with a lot of mechanics out there just what I heard Jim over there talking. He called the FAA looking for a reason so at least in some arenas the mechanic will be able to stand up and go huh I can't do that because you know my license is on the line for this rule. And so it would be tied into professionalism on himself plus it would give him. I have mechanics call me all the time the company's doing this the company's doing that I become the bad guy for them yes you're not going to be able to the DOM guy that's running around doing the five on his own wants the money unless we catch him and we're not out there looking at him that's for sure. Yeah we won't get those but we do have to start somewhere.
Unknown	Is that Jim? Jim did you ever regulate this stuff? Did you ever say no - did you ever feel confident?
Jim	No I never did and it ended up costing the company $15,000.
Unknown	You feel capable of doing all those duties or did you ever say I can't do this job?
Jim	No.
Unknown	Why? Because you felt you could right?
Jim	Well because it was explained to me that this is the stack of applications for people who want my job.
Unknown	Waiting for your job?
Unknown	That's just intimidation.
Unknown	That's just intimidation just tell them no.
Unknown	Oh absolutely.
group	talking together.
Unknown	You should have a regulatory basis to say no from.
Jim	Right if I could have told them no I'm not going to do it because the FAA won't allow me to do it.
Unknown	So its enforceable if the guy reports it?
Unknown	Yeah.
Unknown	Right.
Unknown	Well its enforceable if the self reports if the rules say that I can't.
Unknown	Yeah. It says you can't you say I didn't.
Unknown	The problem with 65 is you're throwing such a wide net that you're going to run into the challenges like this. If you have a guy that has a AMP certificate, and has a hangar in his backyard and he's out there wanting to change his own engine he's got to watch the clock and make sure that he stops, puts he's tools down, goes in there and starts drinking beer after X amount of hours right? Meanwhile his neighbor next door who is either the retired air traffic controller, the retired Delta pilot, to whose building his RV can work 24 hours a day 7 days a week building his airplane if he wants to because he doesn't have an AMP license.
group	laughter
Unknown	The difference between experimental and certificate airplanes

	[unintelligible].
Unknown	They're has been different so that's not [unintelligible].
Unknown	And we keep saying 65 what about Part 43. Yeah.
group	talking together.
Unknown	Six five more certification probably part 43 is where the meat is.
Dr. Bill Johnson	We need to do additional marketing of even we don't have to do a hand show but we've been doing a lot and I'm not going to say how many people knew all this was going on but we probably need to even do more marketing, we've got it in tons of magazines if we [unintelligible] FAA news would consider this kind of information but are we even getting the message to our own FAA colleagues you that all this stuff has been going on and all these deliverables are out there.
group	talking together.
Katrina Avers	Yeah it is really deep in there so its very hard to get to. That's where they put it.
Dr. Bill Johnson	And then the only other one that I've heard that's concrete is [unintelligible].
Katrina Avers	It's on there I'll have to look I mean I usually have to dig to find it in there.
Dr. Bill Johnson	To formalize the studies that we've done I don't think Katrina we haven't made a table that we can present to anybody to say here's what the [unintelligible] here's what the truckers do we don't have that do we?
Katrina Avers	No.
Dr. Bill Johnson	So we'll formalize the out of aviation industry things that are going on and that's where we'll get our answer pretty easily and these don't all have to impossible problems like change part 43.
Unknown	I do think you ought - I do think you ought to give consideration to making the fatigue management an approved program for certificate holders. I mean give that a little bit of thought.
Unknown	I think that's about the only place you can put it even 43 if I were a mechanic I would just reduce my effectiveness so I would be ensure that I would have an air worthy outcome so if I had a lot of work to do in a I can slow down to make sure I met those current part 43 requirements. In other words if it takes me a little bit longer to get the job done as long as when I signed products good. In other words 43 still stands for a value that it has. But awareness training program giving that mechanic the opportunity to assess himself so he can say I'm not as effective so I need to slow down or go home and take a nap or hire somebody else.
Unknown	It gives you a lot of control though because what are they talking about RVS them or [unintelligible] reliability or some of these other programs you know I understand the guidance material you know and all the different circumstances that play into that standard okay. And then you approve it off spec or what have you. I just saying.
Dr. Bill Johnson	I don't understand where that goes. Where does that fit for under as a regulation or policy?
Unknown	It fits under the GAM.
Unknown	They shall have a continuous air maintenance person covering their airplanes.
Unknown	And there's an off spec that where the FAA goes out and blesses, approves the maintenance program that they submit. And that maintenance program was supposedly designed and verified to be consistent with the guidelines provided by the FAA. Similarly you define the standard expectation in guidance material for FAA fatigue management program for certificate holders. I know this doesn't address the 91 issue. And make it either an off spec or otherwise an FAA approved program to set the standards, they either meet the standard or they don't PMI [unintelligible] off when it does.

Dr. Bill Johnson	That's still a new regulation though?
Unknown	Yeah.
Unknown	I think it would be - I would say changing it would change the existing one.
group	talking together.
Unknown	So it doesn't have to be a rule [unintelligible].
Dr. Bill Johnson	[unintelligible].
Unknown	[unintelligible].
Unknown	Put under a cast because you're going to ensure continuous airworthiness through fatigue awareness. Or you're going to benchmark into the cast program so they can get into [unintelligible] your duty time or whatever.
Unknown	Is that regulatory?
Unknown	[unintelligible].
Dr. Bill Johnson	So you put it under what then.
Unknown	Under [unintelligible].
Dr. Bill Johnson	Aeronautical or repair station comes in that's an example comes along later and says by the way you've slipped a new rule on us under guidance materials.
Unknown	Right.
Dr. Bill Johnson	Is that what we're trying to do?
Unknown	Because we'll have to.
Dr. Bill Johnson	This is pretty biggy to be slipping in on.
group	talking together.
Unknown	Bill, you have a cast for 91 K, I think that's 125, 135, 145 [unintelligible] working for.
Dr. Bill Johnson	Is that realistic though on something this significant?
Unknown	Sure. You can do a cast program you just got to get the people to come up with a useful viable program and it takes time to develop that.
Unknown	I'm not understanding tucking it under another program but I can certainly see changing the existing rule and come up with a new one to require the certificate holders have an FAA approved fatigue measure.
Dr. Bill Johnson	Oh absolutely.
Unknown	[unintelligible].
Unknown	I don’t see folding it under another one. I'm not just discounting it I just want to see it.
Unknown	We have a rule now in place for the pilots right? Does it work?
Katrina Avers	For FMRS? Not right now.
Unknown	What about 21?
Unknown	It does because it draws better [unintelligible].
Unknown	I said does it work? It lays out how much they work, how much they can't work, how many hours can they work, how many hours they can fly a quarter, a year whatever. Alright the basis works but we don't have we don't have a basis like that for the maintenance or for air worthiness.
Unknown	It doesn't cover that community pilot. Now does it?
Unknown	It doesn't but see there's a basis that works that we can violate on right now for maintenance there isn't anything we can say.
Unknown	The pilot to commute for 2 days to get to his duty place.
Unknown	What he is saying though is that draws definitive line its not blurred and all over our's is like you know its' easy to weasel out of our world he's right it draws clear lines.
Unknown	It draws a line that says okay this is where we start from because we don't have that for the air worthiness for the maintenance for the mechanics.
Unknown	Right.
Unknown	It's not there. And we haven't talked of that at all.
Unknown	What we're talking about is how to fit it in the program, how to fit into

	something else what we need is we need a starting basis. We don't have the starting basis yet.
Katrina Avers	For the hours of service.
Dr. Bill Johnson	[unintelligible] where you can work a million days.
Unknown	Well we don't have that. What I'm saying is its not there.
group	Laughter
Katrina Avers	Not a real - you see we don't have a real rule.
Unknown	[unintelligible].
Unknown	But to piggyback up what you're saying there. What's - what are the repercussions if they bust those minimums. I mean bust their sleep cycle? You got everybody should know right a specific action against it.
Unknown	Right.
Unknown	Well they don't have a certificate in action in place for air worthiness and that's what I'm saying we don't have starting point. We don't have a basis to go from. If you're going to change the culture you've got to establish a way to change the culture.
Dr. Bill Johnson	Well actually we're sorting taking it ass backwards we know that we can start doing the things that Katrina just described.
Unknown	Right.
Dr. Bill Johnson	Immediately. And that's I think is going to slowly start changing the culture even stipulates this kind of of conversation.
Unknown	It is a way, but.
Unknown	We're talking - you're talking about the mechanics themselves?
Unknown	Yes sir.
Unknown	To change the culture. What makes a 121 company limit their pilots on how many hours they can fly? The regulation.
Dr. Bill Johnson	Absolutely.
Unknown	We don't have the regulation for air worthiness for maintenance to do that.
Dr. Bill Johnson	And that's why a 100% of the people that voted in our survey on our panel said yeah you need a rule.
Unknown	That's what I'm saying we're talking to - we're talking to the maintenance issue we're not talking to the actual operator or company issued because that's where the culture needs to change as well. We need to tell the company and not just the 121, the little guys 125's large 135's that have no rule. We need to talk to the owners, to the operators of those companies to change their culture as well not just to tell the mechanic Carl he can't work 24 hours a day 7 days a week anymore.
Unknown	Well if you have a rule what would it tell you to do?
Unknown	I don't know that's why where here today.
Unknown	It will tell you to have a program.
Unknown	But we don't have the ability to start a program.
Katrina Avers	So you guys are talking about essentially having hours of service rules as a baseline and then we're also talking about having a fatigue risk management system as far as guidelines on what would be involved in one.
Dave	No, I think that sounded pretty good. You know SMS supposedly is going to be such a high level regulation that its I think they are actually going to try and implement the SMS piece through an ops something like that because you know Bill and I became very concerned when the whole SMS piece started and its like where well is all the maintenance stuff, where's the maintenance people involved in the SMS process, there wasn't any. We had several discussions with the SMS folks and they kind of told us well its really not going to be like that you know its going to be way up here its not going to be specifics about maintenance or officer or that kind of deal. So, I don't know what's coming with SMS to be honest with you.

Katrina Avers	So we do really need to look into potentially a fatigue risk management recommendation then?
Kevin Gileda	I wondered if - you know the part 121 seems like they did a really good job when something like that comes out and then implementing something of that nature [unintelligible] 135 and 91's where we would like to see that. Would it make sense to rather than push that responsibility off onto them since we has maybe CAMI be the right organization to be able to tackle this but develop a fatigue risk management program that's off the shelve. It may not be perfect but its something I'm a part 91 operator I don't have the money to deal with this. I don't have the personnel to deal with this. You know I can't have somebody take a month of personal hours to develop this program.
Katrina Avers	And right now we're putting together the guidelines for fatigue risk management system and the tools necessary a fatigue risk management system.
Unknown	The common rule to maintenance is part 43 if you see in the shell chart part 43 applies to all these different operational rulings. So I think if we were to make a recommendation or a regulation we would certainly considered part 43 because that's the foundation for the [unintelligible].
Dr. Bill Johnson	You know I have that written down. I'm sort of sitting here feeling guilty as part of the scientific community to sort of know we know about bad performance based on a emergency level and then say and we're sitting here ready to make guidelines anytime, we're making guidelines and someday when somebody in Washington decides we need a rule we'll be ready to give them the information. Are we not being assertive enough or is there a way for the scientific community as small as we are in FAA to say hey you know we've got the answers, we know it needs to be done come on rule makers get me. Am I being naive? Should we be waiting or should we be pushing it. And if so I don't even know who you push.
Unknown	Well Bill keep.
Dr. Bill Johnson	I don't know the answers to these questions that's why you're all here.
Unknown	Because accident data really accident data and one is stretch it to enforcing it in FAR incidents if the data you know doesn't support it its just another warmy fuzzy thing over there and yeah okay you recognize it but the end result is you know there's no problem.
Unknown	Yeah what I hear you say though its okay to have the quality escape as long as it doesn't result in an accident or incident but a maintenance.
Unknown	I think bottom line when it comes to trying to do any kind of rule enforcement and stuff out of Washington yeah or trying to write a rule and convince [unintelligible].
Unknown	[unintelligible] has the potential.
Unknown	That's why you got cast programs and you got this other stuff in place its suppose to be monitoring that as a human factors portion while they are doing their investigation.
Unknown	[unintelligible].
Unknown	Responsibility that I did find the route cause.
Unknown	You know for air carriers and it probably isn't as big of a problem as it is for small like little 91 ma and pa local air fueler operator if you make a rule and say okay you got to have two mechanics instead of one because of the number of hours that they have to work there just going to call a senator and the senator's going to say you know part of the FAA's [unintelligible] to make aviation happen not to shut aviation down. So of course if you start threatening these little 91 operators with the fact they have to do something that's going to put them out of business then there's no senator that's going to allow that to happen

Katrina Avers	Although part 91 is where we see the most of our accident's and is a big target area for the FAA as far as area of improvement.
group	talking together.
Katrina Avers	Yeah.
Unknown	Fifteen hundred hours for what to not - to fly for a 121 or for corporate?
Unknown	[unintelligible] ATP writing.
Unknown	Alright. How did that happen?
Unknown	Congress - Congress.
Unknown	Hands on the canvas. And how did it come before Congress and why did that happen?
Unknown	Cohen Air.
Unknown	Absolutely.
Unknown	Which Keith was referring to here a minute ago. Why don't we be proactive and rather than react on a [unintelligible] basis be proactive and do something before that happens.
Unknown	I can speak to that because we've had this discussion many, many times. We anyone of us in this room could submit a rule request tomorrow and but you've got to have your ducks in a row. You can't say okay I want to take this to management rule anywhere I want to redo the duty time limitation. Okay great - why? Tell me why, give me the data, where were the accidents it goes on, on, on and on. Then you submit then you have to submit up to me John Allen. John Allen has to buy off on that and say well Jay I'm not here you're going to have to go back and do some more. Let's say John Allen does sign off on it its going to end up on a B list somewhere because its going not be high priority. There's only so many attorneys, some many in Congress, and some many subject matter experts that are available to work this stuff. So you know we can submit it but its going to go sit in an empty box for years, years and years. I think we're on a better path right now we talked about this at the beginning of the workgroup by saying okay we know down the road hopefully we're going to get a rule but until then let's be proactive and do the calendars, do the posters get the awareness out on it. You know start talking to these carriers, start talking to [unintelligible] so that's the approach that we've taken.
Dr. Bill Johnson	Absolutely.
Unknown	Well and.
Unknown	Education.
Unknown	Yeah.
Unknown	I like that. [unintelligible] its a cad to approach but we've gotten rules to go from our B list to our A list because of NTSB recommendations and as we keep getting many of the same accidents.
Unknown	But what kind of rules something that I think is more definitive as opposed to saying [unintelligible] fatigue management system you know wiring rule or something like that I'm just kind of pulling off the top of my head. More maintenance specific as opposed to some kind of system. Or correct me if I'm wrong that's what I'm thinking getting those rules passed quicker in Washington.
Unknown	Yeah and he's right.
Unknown	And result in significant accidents.
Unknown	Well you know the thing with of rule would be put in place tomorrow if an Airbus 380 crashed and killed everybody because of fatigued mechanic left a copper pin out of one of the wheels.
Dr. Bill Johnson	If there was a route cause analysis sufficient enough to ever know [unintelligible] causing it.
Unknown	I see fatigue as a rip off.
Unknown	Katherine this goes back to you. I mean what could we do to ask the board

	to do the same kind of background check on mechanics that they do on the pilots.
Katherine Wilson	When there's a maintenance related accident or incident because we have them all the time I don't think it ever goes back that far.
Unknown	Well I mean I know that I've worked two recent maintenance incidents that have happened and they called me into it specifically for that reason. And so you know I've gone in there and done the same fatigue analysis that I do for pilots. So twenty-four hour history, what their work schedule was like, and in these we just didn't have fatigue in those incidents but you know its a matter of above my pay grade I just recognizing the human performance needs to be called into that because definitely working with our maintenance folks you know they have their mechanics, they know the ins and outs of how to take the airplane apart and put it back together but they don't know anything about asking about the sleep history in fatigue so.
Unknown	So how/what can we do to help you and the rest of the people in your division is do a better more in-depth investigation with the accidents and incidents that we have.
Katherine Wilson	You know I think that this is the constant trouble that we have internally as to I mean there are sometimes where they don't even say human performance on regular accidents. So you know this is the trouble that we've had that we're trying to just get them made aware of the issues and trying to really encourage them to do it. But you know that's going to take like I said somebody above my pay grade their the ones who determine who goes and when. And maybe its a meeting of FAA and you know I don't know whether its Hoover, meeting with Tom or somebody at the higher levels.
unknown	You want higher levels to come over and ask you to do [unintelligible].
Katherine Wilson	No, not today.
group	Laughter
Unknown	It’s a discussion of how can we improve [unintelligible].
unknown	Well you should of.
group	Laughter
Unknown	Well you know and that's the thought that now that Rose Kind is there that everybody is going to be more interested in fatigued.
Unknown	[unintelligible] Weavers is a new board member, he's a former boss of mine. He's pretty good with performance oriented.
group	talking together.
Katherine Wilson	Right and you know they've only be on for a few weeks so you know we haven't had any major launches since then. But you know I think that and this is something that I was talking about actually with Mary earlier either just us getting involved in these types of meetings to know what the concerns are in industry and with the FAA that we know we see it from the accident side but we don't know about the everyday necessarily those the issues that you all are seeing. And so the more that we can get involved and see the issues and then you know I have to do a report when I get back to you know to say what we've discussed so and that's one of things that I want to talk about is on how important it is for us to hear these sorts of things and you know where the issue lies so that hopefully the next investigation that we have they'll be more aware of it.
Katrina Avers	Yeah.
Unknown	Well and the other thing your next recommendation might be more clearly stated as some of the things we're looking for right here and you can recommend that the FAA do a better job.
Katherine Wilson	Exactly.
Dr. Bill Johnson	They have been shy about the clarity recommendation of fatigue for a long

	time.
Unknown	Well no but they don't get down to where really well at least I haven't seen in this area they will say FAA needs to deal with fatigue.
Dr. Bill Johnson	Yeah.
Unknown	But then they leave it with us which is good in some ways I'm not saying its not but maybe some of these areas that we're identifying now could be identified more clearly.
Katrina Avers	Well I know.
Dr. Bill Johnson	I really hope not just for the sake of NTSB but for our own sake that like the answer that Jay just gave was a very reasonable, practical answer that really thought maybe was a call to action with a group like this and I don't want this thing to end in fifteen more minutes or less where wow yeah this is hard its really frustrating good luck. You know that just beats us all up and that's not a good answer. One of things that I heard from Mr. Hiles here is if we're going to be able to answer that next level of question Jay they say or John or above him would say show me the data okay we could make the case that a human is a human whether they are driving a car, or driving a train or at work fixing an airplane. I think we can make that as logical okay. But we really need to perhaps with FAA accident investigation which may work also with the NTSB is increase FAA and maybe even NTSB route cause analysis with that focus specifically on the fatigue issue in maintenance and.
Katrina Avers	And I think for ASAP also. For the ASAP team.
Dr. Bill Johnson	And the ASAP yeah because that way you're working up way deeper into the iceberg before anything goes wrong.
Unknown	Yeah.
Unknown	And the great thing is all that data lives in [unintelligible] AVS.
Dr. Bill Johnson	Yeah it should.
Unknown	It's not even very far away.
Unknown	Yeah. The problem that I've had because I know what Jay and I talked about what needs to be in place before we before recommendation can be acted on so we've been working on putting together a report with okay here's the scientific data, we have the scientific data, we have the ASRS reports, we have 90 of them although how ASRS reports are analyzed is depending on what the they don't analysis all of them. They analysis a sample of them based on what is most interesting to the analyst. So we may not be seeing all that's out there they don't have the budget to be able to do all of that. On the NTSB side we have the recommendation, we have the easy Jet accident but going to get data from you guys to even be able to provide the justification that the FAA needs to take action and the data is not being collected in a way that we can use it. I've called and tried to ask okay you know is there anyway that we can get this data and its just not even there. So that might be something on the NTSB side that you know as far as proactive action improving that assessment because really and truly that's part of the information that we need to have whenever we go to justification for any type of rule making. Although that's a long term and I know we want to look at short term and long term.
Unknown	[unintelligible].
Unknown	Well we talk about the data is what we mean when we say the data as we mean accidents right? I mean that's pretty much what we've been talking about is.
Unknown	Well I think whenever we talk about NTSB we're talking about accidents I think and we can look at even smaller scale stuff precursors as far as incidents within a company and our workgroup people are doing company reports that include that supplemental fatigue questionnaire to identify to

	help them identify the cost associated with fatigue related incidents because right now that isn't unidentified. And we've all talked about how hard it is to get to get the management side to buy in to incorporating you know the training, that costs money, all of these things because their not really seeing the cost of fatigue even though its the elephant in the room everybody here has said this is a big issue and that's before we even came to this discussion that was something that we all brought to it independently.
Dr. Bill Johnson	Actually 15 people had that thought.
Katrina Avers	So 15 of us.
Dr. Bill Johnson	Darren gave me the list to give to everybody.
Unknown	The point I wanted to make was that accident data doesn't fuel the data.
Katrina Avers	Right.
Unknown	So the issue is that in SMS and systems safety we're trying to listen to the lower [unintelligible] ratio signals.
Katrina Avers	Uh hum.
Kevin Gileda	And so those signals are hazards in the risk associated with the hazards. So for instance runway incursions its like they say runway incursion but I know inside all of you are going eww runway incursions we're tired of hearing but runway incursions. How many accidents do we have per year due to runway incursions? Almost none. But we have a whole national program for runway incursions why is that? That's because they justify their existence by the potential of two 747's coming together on the runway so the risk is really high. What's the risk of maintenance induced accident?
Katrina Avers	Yeah and then probably. And that's what we can see across industries, and across operations because we know that it’s a physiological phenomenon and our schedules are creating this situation if that makes sense.
Kevin Gileda	We have an issue we have an issue that keep or working drunk. Basically their working drunk. I mean that's a really high risk problem.
Unknown	That's not acceptable.
Kevin Gileda	Its not acceptable. And so we need to break away from this counting accidents business and look at the potential to [unintelligible].
Unknown	I agree with you 100% standard deviation.
Unknown	Really what we need to look at is any maintenance error and right now one of our best sources for that information is ASAP. And I don't know if you talked to UTRS or somebody but if you came up with a couple of fields or something that to stick into the UTRS data base that a lot airlines are using not enough. Yours isn't using it. But we could capture some fatigue data that's most over 95% of those reports are accepted, there investigated, and we can look at them for fatigue information and provide that.
Unknown	Will they put that UTRS database.
Unknown	It's just a check box right now.
Unknown	According to [unintelligible] you could actually drop down and fill out that form.
Katrina Avers	So that's the same as W-bat?
Unknown	Yeah.
Katrina Avers	Okay.
Unknown	It should be in there right now.
Katrina Avers	And I have instructions for how it is and I have instructions for how to turn it on. Its not automatically turned on but you can request them to turn it on for you.
Dr. Bill Johnson	I hate to be the spoiler on this but gosh we could talk about this all day long.
group	Laughter

Dr. Bill Johnson	[unintelligible] to assist a program that we need one of these work shops on fatigue but I don't think they knew we were going to turn this one into the fatigue workshop. For that reason we really did help you [unintelligible] I've added up twelve here.

Appendix E: Current Aviation Safety Inspector Training and Discussion of Recurrent Training Ideas (Mr. Rick Anglemyer)

So Far …….

2008, 2009 & 2010

52 Classes
1175 ASIs

2

Teaching Methodology

Experiential Learning

Integrated, Interactive Classroom Workshop

Lecture
Group Discussions
Exercises
Video Analysis
Case Studies
Practical Breakout Sessions
Student Presentations

3

Program Objectives

- **Increase mission effectiveness and safety through application of HF skills**
- **Bring about observable changes in behavior and attitude**
- **Institutionalize HF in Aviation Maintenance**

SCSI 4

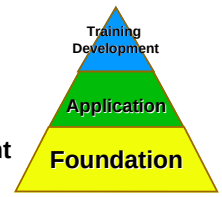
Workshop Objectives

Awareness of the human aspect of aircraft maintenance
Knowledge of the benefits and importance of a HF training
Tools to assist in developing, evaluating and advocating HF training to their operators

SCSI 5

WORKSHOP OUTLINE

- **Introduction**
- **Foundation**
- **Application**
- **Training Development**



HF Pyramid

6

WORKSHOP OUTLINE

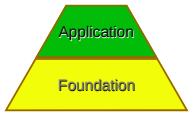
- History & FAA Regulations
- Definition
- Importance
- Statistics
- Human Error
  - 12 common causes of maintenance error
- Stress & Fatigue
- Situation Awareness
- Communications – Barriers

HF Pyramid

7

WORKSHOP OUTLINE

- Application
  - Systems model
  - Applied PEAR
  - Teamwork
  - Event Investigation



HF Pyramid

8

WORKSHOP OUTLINE

- Training Development
  - Conflict Resolution
  - Event Investigation
  - Eagle Lake Case Study
  - Building a HF training program
  - Evaluating a HF training program

HF Pyramid

9

MODELS

1. Reason's Accident Causation
   - Swiss Cheese
2. Chain of Events
3. The PEAR model

SCSI 10

Eagle Lake Case Study

9/11/91 Continental Express EMB 120

1) Event Investigation

   Analyze maintenance related facts contributing to the accident.

2) Chain of Events

   Determine events in causation chain

3) Safety Nets

   Develop HF training program to address specific problems identified within organization

SCSI 11

- Summary
- Test
- Closing Remarks

12

HF Requisites for Success

- Provide Training
- Motivate to use
- Monitor & Evaluate Outcomes

SCSI 13

Conclusion...

The intent of HFAM training is to raise the ASI's awareness of the effect of the human element in maintenance and develop ways to prevent or reduce the occurrence and consequences of human error.

SCSI 14

What's next?

Follow on training …….

- Topics
- Curriculum
- Objectives
- Etc.

SCSI 15

Critiques

Recent events
More case studies (BP oil spill)
More on safety nets
Use US movies not Canadian
Determining why people didn't follow procedures
ASI's influence on Mx personnel
Management's role in HF
Proposed rules changes relating to HFs
More on risk
How do we implement change?
More GA stuff – maybe separate classes
How to show ROI
HF best practices
Specifics on how to use MEDA or HFACS for Mx
Emphasize current environment not future regulated environment

SCSI 16

Speaker	Dialogue
Dr. Bill Johnson	Rick Anglemyer is the next speaker. He probably knows more about aviation safety inspectors and what they're thinking than the rest of us do. Because he deals with them every week.
Unknown	Thank you very much.
Dr. Bill Johnson	Jay, we see a lot of the evaluations on from the ASI's I know you see more than I do on their level of satisfaction with the 3-day course that their getting from Southern California Safety Institute. And we're just delighted the way you guys are delivering it, the ASI's are extremely delighted so keep up the good work. What are you up to and please force this group to tell you what other additional things you ought to be doing.
Rick Anglemyer	And that's what we're looking for, things to be looking at in the future with this type of training. I'm going to start initially and just go over where we are so far. And I know quiet a few of the guys and gals in here that have been in the human factors training. How many have had human factors from Southern California? Wow quite a few of you. Basically we started this training in 2008 we had the prototype down in Atlanta and we've been doing it basically for three years. We've been extended into the fourth year and so far, like it says up there, we've held fifty two classes and we've trained eleven hundred and seventy five ASI's. So I've been told there's about 1800 of you. Is that about right?
Dr. Bill Johnson	Yes.
Rick Anglemyer	Still? Not firing them or anything?
Dr. Bill Johnson	We're hiring more.
Rick Anglemyer	Hiring more huh?
Rick Anglemyer	So, you know what we're trying to do. We have next year, eleven and then twelve to finish off the rest of the group. And we're going to, kind of look, at this as initial training. And we're looking maybe into the future to do some kind of a recurrent training. This is the basic - the background of the class and how we like to operate with it. It's strictly an experiential learning type of workshop. It's interactive, much like what we're trying to do in here. And here's some of the methodology we used in the class, so we get everybody involved in what we're doing. Now, when we set this up, what we were looking for was program objectives long term. Okay, this isn't for just the class this is for out into the future and something that they can take with them back to their operators and say, "Okay, we need to set up a human factors training program: long term not just this year. And this is basically what we're after: effectiveness and safety. Basically, I think for any MRM program or human factors program, that's got to be the bottom line. Second is to bring about observable changes in attitude and behavior. Can you do that in a work shop? Can you change somebody's behavior in a workshop?
Unknown	For the short term.
Unknown	Give them foundation.
Rick Anglemyer	Okay. How about attitude? Can you change somebody's attitude?
Unknown	No.
Rick Anglemyer	Probably a little better on the attitude, than the behavior. I think the only way I could change somebody's behavior is if I stuck a gun to their head and asked them to do something. Maybe temporarily we would have a behavioral change. But what we're looking for long term once again, in this type of training with the operators is this behavioral change. And then the last thing of course is to institutionalize this type

Speaker	Dialogue
	of training. Make it part of the culture, part of their safety culture. And this has happened I was responsible for part of the initial training in CRM with United Airlines and I think right now it's truly their culture. As is the same with Continental, Delta, the big airlines to have human factors training. Now for the workshop what we're looking for basically is an awareness. I have them 3 days, 24 hours, its awareness. We're not going to make them PhD's in human factors but we're going to give them a level of awareness that they can take away from this and back with them. Knowledge - we need to increase the knowledge a little bit for the benefits and importance of this training and then give them some tools. A system with their operators. Tools they can take back with them. I'm just going to go briefly over the outline, show you what we teach now and then I'm going to ask you what do we need to do in the future? You know where should we take this? We have an introduction, foundation, application phase and then training development. I kind of look at this as, what I call my human factors pyramid. Okay. We build this; we get the foundation, which is the biggest chunk of what we talk about. These are the concepts of human factors, the basic building blocks. So they have the knowledge of human factors. On top of that, we say, "How do we apply this?" You've all been in courses where they talk about theory. Well, this is what you should do; this is the theory behind it. We go through a phase where we say "here's the information and now this is how we apply it. This is how you're going to use it." And then finish that off with training development. We actually go through a case study and have them come up with a human factors training program. They don't always like that part of the training, as it's a little uncomfortable, but it gives them an idea what ought to be included. In the foundation phase these are some items. I'll just let you read what we talk about. And you can see we have stress and fatigue. We talk a lot about fatigue in here and we spend at least an hour on it in the workshop. Then we go through the regulations, definition, importance, the statistics, human error, the twelve common causes of maintenance error, or the Dirty Dozen, as we call it. And go through all of these building blocks for the foundation. Once that's done, we work into the application phase and to do this we look at systems models. Certainly James [Reason] model is one we take a look at it. I have what I call the applied PEAR That's Dr. Bill's PEAR in lieu of the SHEL model. And we talked about the PEAR. How you can use it? How the operators can use it and the mechanics can use it?
Dr. Bill Johnson	What's it stand for just in case anyone doesn't know.
Rick Anglemyer	Oh gee I'm not sure. Do you know, people?
Unknown	People
Rick Anglemyer	Environment, Actions and Resources.
Dr. Bill Johnson	Thank you sir.
Rick Anglemyer	And that comes out in the DVD which we also pass out the presentation model or DVD that Dr. Bill's put together.
Dr. Bill Johnson	With others.
Rick Anglemyer	Well yeah. But you're the one they see on the video when we show it.
Dr. Bill Johnson	unintelligible
Rick Anglemyer	You and Dagmar
Group	laughter
Rick Anglemyer	The last thing in the application phase we do is what I call event investigation. We're going to apply; now we're going to look at an

Speaker	Dialogue
	event as a case study and then we're going to analyze it and then from that we actually take the next step into the training development. We talk about conflict resolution, the event itself, the Eagle Lake case study, build a program and then we evaluate that program. And I actually put them in a role of being you know the contractor, and then FAA in accepting or rejecting the programs that other teams have developed. Now these are some of the models that we use and I know there are more out there and you may figure or realize there's some that we ought to be using in here and that's what I want to get out of you. We use the Eagle Lake case study. I realize it's a little bit old but for our purposes in what we're doing it's a perfect fit. Happened 9-11-91 and it has everything that we're looking for: unsafe acts or near events, the clues that were going on in that organization somebody should have identified before the accident occurred. And that's what we're after. Can we identify what's going on in an organization before the accident. What do you think? Can we do that?
Unknown	unintelligible
Rick Anglemyer	Yeah? I mean, we can, if we know what to look for. And then we get into the contributing factors from Dr. Rankin, what I call error producing conditions and analyze the case in that way. Okay, this is the case study. Basically it's been around, like I say, quite a while. We analyze this and the facts contributing to the accident. What we're really looking for is what contributed to this, what was the culture in the organization at the time, how did this accident occur and then we take it from there as to what do we need to know where we could of stopped this, actually from occurring. We look at the chain of events and accident causation chain and then we look at safety nets that are involved in this, identifying them within the organization like you say what could have of been done? That pretty much wraps up the workshop, except we do a summary and, of course, we have to have a test, right?
Unknown	Yeah.
Rick Anglemyer	Everybody loves the test. Anybody in here remember the answer to question six?
Unknown	Probably C like they all are.
Rick Anglemyer	Well, I know it's been a long time. I don't dare ask you what the answer to the question is I just figured you could remember the 6A in there. I have a few closing remarks, passed out a certificate, and actually decide on a date for our reunion later in the year. Now these are some of the requisites for success. If we're going to do this training of ASI's, or with the mechanics, number one we have to provide the training. Okay and we've talked about training in here it seems to be the way of getting things done. We have to motivate the organization to use the training, whatever that takes. Somehow they have to be motivated and I know that ASIs are just because the ASI's know how to motivate people. No intimidate, no motivate people.
group	laughter
Unknown	D, all of the above.
Rick Anglemyer	All of the above? And then the last thing of course is to monitor and evaluate the outcomes within any program. You want to see is it working? Or is it not working? I'll let you read this. This is basically the intent of this type of training that we just concluded in here. Looking at the human element in maintenance, develop ways to prevent or reduce the occurrence. And that's basically the bottom line, like you say we spent three days trying to accomplish this. So what's next? Okay,

Speaker	Dialogue
	what I'd like to do is just open it up and we have somebody I believe taking notes, somewhere. And a little bit of feedback from you and your thoughts on what can we do in the future in this type of training? Very briefly we have seen what we're doing up to this point. If we would go to a re-current phase or a continuation type phase of training, what are we looking for? I'll just leave this up here. (Referring to slide on screen.) This is information that I have pulled from the critiques that we get from the students. We have one section in there that asks what you think we need to do to improve the course and what should we add to it. And this is their feedback and a lot of it has to do with more recent case studies, which includes more recent videos. We look at a couple of old Canadian video's if you remember in the class. Which brings the point home but when you're looking at a guy in maintenance talking on a dial telephone. But that's all they have Canada right Martin? Just dial telephones?
Unknown	unintelligible
Rick Anglemyer	As a matter of fact that - that video was taken in Transport Canada.
Unknown	unintelligible
Rick Anglemyer	How about specifics on how to use MEDA? Should we do that? We don't do it now and quite honestly my impression is, and I don't mean to offend anybody, I always ask the class how many of you are familiar with MEDA or REDA? One, two maybe. About the same in the class so a lot of them say I want more information about that. A Tap Root is something that they use in Alaska for root cause analysis. This might be another thing that we could talk about. But what do you think? What's your input? You're the experts, this is the brain trust.
Unknown	You and I talked about this earlier but we need sales strategy because right now, in the absence of a rule, we have to sell it to the operator and, I see already have up there how to show return on investment that's key to that. And also, I just wanted to some way smoke and mirrors being what they are, to measure the accidents that have taken place, to measure the errors and their consequences that haven't happened or someway some creative way to show a return on the investment. Because not everybody will throw three airplanes into each other costs themselves millions of dollars.
Unknown	Risk assessment and hazard analysis
Unknown	We have [unintelligible] of fifty right now.
Unknown	Yeah.
Unknown	And a lot of these inspectors don't even know why there doing or how to do a risk assessment, a true risk assessment. I think they don’t even do a hazard analysis. So something like that added in would probably go a long way when they're doing their [unintelligible] enforcement investigation report they have to run a risk assessment on that, they don't know why their doing it. They know their doing it but they don't realize what the benefits are.
Rick Anglemyer	And you're talking about the operators?
Unknown	No I'm talking about the ASI.
Rick Anglemyer	ASI's
Unknown	And your critique of part of a recurrence.
Rick Anglemyer	Okay. One of the things we do talk about there is operational risk management we show the risk management matrix, it's out of AC120.92, I think. Everybody seems familiar but do we need to go deeper into that?
Unknown	Yeah. Have them do some real, true risk assessments on actual case

Speaker	Dialogue
	studies.
Unknown	Good idea.
Unknown	Go a long way and knowing why they're doing a risk assessment and what the outcomes and the benefits of a true risk assessment is. We're doing the PD's now? And we're doing it and EIR enforcement investigative reports.
Unknown	Yeah good point, whoever's taking notes [unintelligible].
Vickie	Are you wanting to stay focused on the human factors? I guess that's my first question, are you wanting to, I mean you're teaching human factors are you wanting to go the next step on teaching the human factors or are you looking for a different topic?
Rick Anglemyer	No. Human factors. What we're trying to do is - is get the ASI's an awareness level on human factors, so if and when there is a rule making that requires 145, 121, that the ASI's have an idea of, you know, maybe what should happen within the organization. So Vickie, yeah, stay within human factors.
Vickie	I would drill more into human factors [ten degrees] or whatever when I did my thesis this is again years ago this was in '92 and my challenge was when I was doing all of my human factors it was, at the time, we were looking at pilot error and kind of stopped and the complaint was okay lets drill down to a route cause, so I did a 10 year study when I asked NTSB for all the accidents with 21 domestic and first, I wanted to see if I agreed that it was a human error, pilot error, and then I found when I was breaking down the different types of events like a near miss or whatever, that I found myself teaching myself and studying about the CNI concept which would lead you into more, you know, drilling down different colors and stuff like that into the real human element of the different events seeing eye concept is one idea and I'm kind of stumped right now as far as other ideas, but just drilling down into more of what human factors are.
Rick Anglemyer	We like to take NTSB reports, old accidents that have happened or previous accidents and drill down as well and when I do that what I'm trying to do is to get them to apply that principal before the accident happens.
Vickie	And let's do it again.
Rick Anglemyer	How do you do it within the operator and how do you identify that chain of events which is a very difficult thing to do if you're in the middle of it.
Vickie	Understanding more of what human factors is so to look for it on our day to day surveillance, and what kind of occurrences or events of drilling down and recognizing just like this with fatigue having this here is teaching us and reminding me with what the definition of fatigue is and that's sleep, loss of sleep, you're stressed, all of that and its such a valuable tool, 'cause it's really drilling down into the meat and potatoes of what fatigue is - you could do something similar, expand more on what human factors are and how it again, I'm just thinking of CNI, what's on the [Unintelligible] of CNI
Dr. Bill Johnson	I'm afraid of that recommendation because I can see critiques coming back, you're trying to turn me into a graduate student in human factors.
Unknown	unintelligible
Dr. Bill Johnson	Rather than here "show me how to go look at someone else's human factors program." So I have mixed emotions about whether or not that's a good idea, in fact, over the years as I've played human factors classes, sometimes I'd get feedback that you went too far down into a certain concept, you could notch it up a couple of levels and give me

Speaker	Dialogue
	three other examples other than better off than too much theory.
Unknown	unintelligible
Dr. Bill Johnson	We're just talking back and forth.
Rick Anglemyer	Well, let me set the level of general experience we have in a class of ASI's. We have some who have PhD's in human factors, and others come in and they can't spell human factors. I mean that's such a difference and what I try to do is bring the level up within the class to a certain level that everybody can understand. Now I know the Ph.D's and the advanced degrees are probably thinking, boy this is going to be basic, but I'm trying to explain in the beginning that this is what we're doing and hopefully when we leave at least everybody has achieved a basic understanding and so we can go into the next level. And also remember the timing on this. I cover all that information in 24 hours. A lot of information when we're done, I think everybody in the class is going 'wow' we really covered a lot of stuff. Maybe we could make it longer or just totally reduce the topics that we talk about.
Dr. Bill Johnson	Rick, a lot of these guys and women have to oversee EASA certificates for 145. I can't remember whether or not you're covering the EASA regulations?
Rick Anglemyer	No, we covered just our regulations. And I talked to Dr. Rankin and he's going to send me the EASA regs. The only thing that we talked about is if it's a 145 repair station associated through EASA you have to have a human factors program. I, quite honestly, didn't realize that all that stuff that he put up there was actually required.
Dr. Bill Johnson	Sure.
Rick Anglemyer	So that is certainly something we can look at in the future. We're at a point now where the course went through a prototype and once is accepted at prototype we try to leave alone. Until everybody gets the same training. Even just an update of training for the future.
Unknown	[unintelligible] are you thinking of what is going to happen after your year extension is over, are you going to start a new course?
Rick Anglemyer	Well, that will certainly be up to the FAA, but they're going to have to, I don't know, extend the contract, get a new contract. I just think maybe if the thought process is here as well, what could we do for recurrence? I know Dr. Bill, do you have any more guidance on that?
Dr. Bill Johnson	Probably.
group	laughter
Rick Anglemyer	Thank you.
Unknown	I have a bit of a suggestion, my issue is this, the FAA is the perpetuator of blame culture in aviation. And rightly so, you know, we're given this ultimate tool which was the violation, we punish people for not complying with rules and procedures and stuff like that. So, that's what we do. What would be nice is if you could teach the inspectors.
Unknown	It would be nice.
Unknown	The things that they need to know to erode this idea that punishment is a worthwhile learning tool, that gaining the data and teaching people to proactively prevent the issue before we write the violation. That would be great. What I mean by that are issues like [unintelligible] back to your suggestion playing continuation error [unintelligible] inspectors what happens to people when they get home-i-tis and you know they're stressed and they have a high hormone level that shuts down their brain and they do stupid things, we ask what were you thinking? The answer is he wasn't thinking because hormones had shut his brain off. It's difficult to prevent untoward action that you didn't intend to do in the

Speaker	Dialogue
	first place. And so I think that's towards the basis for a more just view of violating mistakes.
Rick Anglemyer	Yeah, we do talk about the just culture and go over a bit of that. I did that with the Air Force too and believe it or not they're trying to adopt that type of philosophy. But that's a good point.
Unknown	I remember your slide on fundamental attribution error, and I went “hallelujah” when I saw that.
Unknown	Yeah we're moving further away from a just culture in the FAA.
Unknown	Is that the proper direction to go?
Unknown	I don't agree it's the proper direction, but that's the direction I'm getting from my superiors. I've been told I accept too many voluntary disclosures I've been told I do not produce enough DIR's I just
Dr. Bill Johnson	I think you’re right.
Unknown	I have been told.
Unknown	I see that myself.
Unknown	And I've been told that [unintelligible].
Dr. Bill Johnson	Unless you go to a presentation by the administrator or associate administrator, safety and you here different stories and then you go into the real world and it’s not that way.
Unknown	Right - that's not the best way to do the training.
Dr. Bill Johnson	That's what industry guys say to me all the time. Geez I went to this meeting and your big bosses said this and then I got slapped.
Unknown	[unintelligible]
Unknown	With another very large carriers threatening.
Unknown	Delta is threatening to shut down their ASAP and [unintelligible].
Dr. Bill Johnson	And there's no big carrier that's got in on the table, as well.
Unknown	Comair's
Unknown	unintelligible
Rick Anglemyer	Comair's pulling that one.
Unknown	They were accepting too many of them and it’s like, that’s what the whole program was about.
Unknown	That's correct.
Unknown	I have an [unintelligible] reporting at me right now with me that I've accepted voluntary disclosure [unintelligible].
Unknown	You can go read it its right there.
Rick Anglemyer	Well, what we're teaching in human factors is that contrary to what you guys operate?
Unknown	Yeah.
Dr. Bill Johnson	That's a yes.
Unknown	unintelligible
Unknown	Yeah kind of like what Guy was saying, because even though it may not be the flavor of the month or the flavor for the next few months have that attitude, maybe its still a good forum to plant a seed if you will or my recommendation here and based on my highlights was I like the idea of your bet you bet investigation but what you come up with for models might be 12 examples i.e., that the 12 dirty dozen being one of the root causes and the other item is how you monitor and evaluate those outcomes so you can have those preventions. So I think Guy's idea will work with the ASI if he's going out there and feeling like he has an effective surveillance. Even though he may have a finding and that may be addressed separately the idea is to prevent as much as possible for it to mitigate down, if you will, to administrative action potential on those findings.

Speaker	Dialogue
Unknown	But if you teach the ASI these things, you're teaching managers in training.
Unknown	Yeah, well maybe through managers of the future.
Rick Anglemyer	Uh, that's true.
Unknown	A question Guy? On that thought do our orders allow for that [unintelligible] a little leniency there does like a 2150.
Unknown	unintelligible
Unknown	I'm saying that the ASI's acting on his orders then?
Unknown	Yeah.
Unknown	How does he act the way you want him to? You're saying that I'm just being devils advocate.
Unknown	Well it's a lot harder as you see.
Unknown	That was just a thought.
Unknown	I've seen cases just recently where they should have been remedial training but the inspector should if he had actually applied the 2150 and done a matrix the way that his instructions are, it would have been a remedial training instead they were going for full blown.
Rick Anglemyer	And, like I said ….
Unknown	And I asked him about it and I asked his supervisor about it his supervisor said, "I know he's wrong, but that was his decision and we're going to go with it."
Unknown	And that's why I was being a devils advocate because bringing that up [unintelligible]
Unknown	It wasn't [unintelligible].
Unknown	Yeah.
Rick Anglemyer	Well, what other ideas do we have I've got about 5 minutes left.
Unknown	If we're going to be advocate's and, I assume because you're discussing the MEDA, we're going to be advocate's for that form as an inspector wide oversight, I always like taking a tool back with me when I went to a class so, if you're going to give, if you're going to discuss it I think you should teach him how to do the interview because I would take that, along with a electronic version back to the operator and say, "hey here's what you could use internally and to do your own internal investigations to tie back your CAS program and here's how you perform those skills and by the way you can call this person here if you need some additional support, go to [unintelligible]." and but I like to leave with the tools so I would suggest electronic and do teach them how to do an interview.
Rick Anglemyer	Yeah and that's the idea. To talk to them about MEDA and REDA and then the one thing that we don't talk about now is HFACS and I don't know what you all think about it, but I know that Shappell and Weigmann, who came up with it but I know they have a maintenance extension for that. And once again they're using it proactively, preventing accidents as well as kind of a database to collect information so that would be a tool. I don't know is this something you want to get involved in?
Unknown	Something to follow on Bobby there and I agree we are 1825's are investigators. You're hired for your technical expertise from the field and, to follow along Bobby, where, maybe even in this class, I don't know if this is the right venue, where are we ever taught to be investigators? How to investigate? Or how to interview?
Unknown	And that's a good point.
Unknown	Okay. So that would be - that's something that I think for adding on to follow along what Bobby was saying to add to [unintelligible] are the

Speaker	Dialogue
	inspectors ever taught how to do? Because they're hired for their technical knowledge.
Rick Anglemyer	Uh, hum that's right.
Unknown	We're hired for our ability, for our knowledge on a aircraft. Where were we ever taught to be an investigator or to correctly conduct a correct interview?
Rick Anglemyer	Is that something that the FAA should provide?
Unknown	We provide it ourselves.
Dr. Bill Johnson	Yes, but probably not a human factors class.
Unknown	No.
Rick Anglemyer	Well, you can have a different class for that, but I agree, I don't think that's necessarily part of human factors.
Unknown	Well that's part of it because it is, I don't know just a thought [unintelligible].
Rick Anglemyer	Well I still don't mind being an agent to culture change. I think that's kind of what we're being asked to be.
Unknown	Uh huh.
Rick Anglemyer	To a certain extent.
Unknown	Yeah.
Unknown	The question I have for you is, are you envisioning this to be an update to HF1 or are you looking for to re-do this for an HF2? Do you understand what I mean? Are we going to take HF1 and just go through it again with updates or we going to go an HF2 class that's a recurrent?
Rick Anglemyer	I think we're looking more at the recurrent.
Unknown	The reason I ask is because Bill's point about not getting too deep in the leads, on the other hand in an HF2 we've already been exposed to the dirty dozen so and so I'd like to get into the guys head quite frankly, especially as it applies to intentional risk taking. I want to know what kind of psychology is behind that kind of behavior, how else am I ever going to get my arms around it or even attempt in a one-on-one situation where I'm trying to counsel a guy or take his ticket or make that decision. Because if you look in our guide and say, “I can have his ticket for 120 days, like that, over intentionally risk taking.” And anyway, you see what I'm getting at?
Unknown	Yeah.
Unknown	I want to understand - I want to understand how to change this guy's behavior, how do I do it without taking him off the line?
Unknown	Having a psychology course.
Unknown	Yeah.
Unknown	Well it’s improved but no question [unintelligible].
Unknown	Well that's why I was asking is it an HF1 or HF2 because some people may not need HF2. They're not going to play that game.
Unknown	Probably a 2.
Dr. Bill Johnson	I mean you got 70 or 80% of the people trained.
Unknown	unintelligible
Dr. Bill Johnson	It’s really a time to start thinking about number 2.
Rick Anglemyer	Yeah because everybody will have this training and they're going to have the basics now, do we want to go into more detail? On a HF2?
Unknown	If I were, I've taken your course, and if I were to go back and to me to make it feel like it was worth while for my knowledge or for to give me tools to take to the my operators, it would be more I would second what somebody's already said up there and get more into the safety mess - would you cover the dirty dozen? Everybody knows and understands

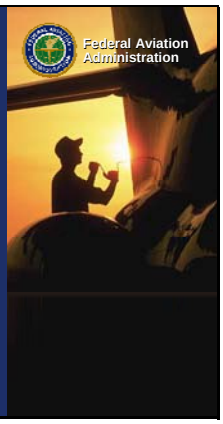
Speaker	Dialogue
	what problems are, maybe more in-depth into the mitigating practices for each one of them. With maybe a little case, a mini-case study for each type and how a decision was made to give positive outcome.
Rick Anglemyer	Okay. So we can identify the problems, now what do we do about them?
Unknown	We know what the problems are so now let's work on fixes.
Rick Anglemyer	Okay. Guy you've had your hand up.
Guy	You ask should we get into HFACS and what I would say is that politically HFACS is known to you as a great thing as far as I know. My experience with working with SMS I tried to use HFACS I got really hammered for it. But human error is so much more than the dirty dozen. ICAO's handbook on human factors Directing an Accident Investigation has about 325 precursors to human error, and there needs to be some bridge from these 12 topics, which don't cover much, to the 325 HFACS has about 126 of them something like that so HFACS is a really good framework to explain human error as an organizational issue it is a bridge between human error and SMS. It's a great thing I think maybe you should teach it.
Rick Anglemyer	Certainly helps for understanding but if nobody's going to use it, to me, it's once again it's a tool. I don't know if we're going to use it or not. Somebody else had a response.
Dr. Bill Johnson	I just want to say maybe one or two more at the very most make sure we finish on time.
Rick Anglemyer	Okay.
Unknown	Yeah well I've been agree with Guy that although HFACS is theory. It's a theory thing. It does have its use in order to understand the path from the organizational problem down to the individual who just happened to be holding the wrench and making the mistake. It really wasn't the guy holding the stake that was the ultimate cause it was an organization. To answer your question about things I think this culture change we should really maybe try to give, I would like for you to give the inspectors some tools to go out to the operators and then use those tools to help institute culture change in their organizations to understand that culture changes are necessary. If you go to an operator, especially a 91 operator and you say, "boy your organization doesn't have a safety culture" you know they're going to look at you with a deer in the headlights. I mean they aren't going to believe what you're saying so you've got to have some tools so that they can understand what you're talking about when you say culture change. Give us some mitigation strategies for you know we've got we know what where the hazards and risks are and we know how to identify the hazardous and risks but the inspectors need to help the organizations develop and install mitigation strategies that will thwart the risks that they're taking or at least to understand the levels of risk that are - that they didn't know.
Rick Anglemyer	Kind of like the safety nets?
Unknown	Yes just like the safety nets.
Rick Anglemyer	Maybe that ought to be our focus, We identified in the course how to identify the problems? What they are now? We're going to see how what do we need to do to stop them, or fix them, or mitigate the consequences?
Unknown	Hands on ways to do that. When I got to operators while I was doing SMS, I was working with Don Ark. That would be one the questions that they ask well this is great theory but how do I come up with a good

Speaker	Dialogue
	strategy. So if we had strategy tools we could teach the inspectors to take to their operators and it would be a big help.
Rick Anglemyer	Yes, I'd like to make this courses apply something that you can actually use. I know my time's up, but I would ask of everybody I think all of our email addresses are in the folder in the book. If you think of something maybe you had something you wanted to say here but we ran out of time, please email me. I check those all the time and am happy to listen to what you have to say and when we start to put together the course I'll certainly take these recommendations into consideration.
Dr. Bill Johnson	Thank you very much.

Appendix F: Human Factors from the AAR Corporation Perspective (Mr. Bill Huntley)

AVS Maintenance Human Factors Leader's Workshop

My Top 5 Concerns about Human Factors in Maintenance



Presented by: Bill Huntley

Office Affiliation: AAR CORP Director Human Factors & Safety Management Systems

Primary industry segment experience: DoD, Part 121, 145, – Quality, Safety, Training and Maint.

Years in Aviation: 26 **A&P, ASQ CQA**

My Top 5 HF in MX Concerns are:

1. **Not accepted as a required or common practice – "Norm"**
2. **Operational needs tend to push the HF theory and practice aside**
3. **The business case for HF and ROI is not very strong – Leaders don't see the value**
4. **Most training still relies on outdated (however important) information – new material should focus on every level in an organization – not just Technicians.**
5. **Lack Strategies for correction**

Typical Challenges at Repair Stations

1. **Initial cost for HF training**
2. **Training covers theory, case studies, Investigations – Stops at training door**
3. **Operational needs dictate**
4. **Revolving Door – very cyclical business**
5. **Contract Labor Force should get involved**
6. **Part 147 Training Facilities should equip Technicians with more "HF Tools" Requirement?**

Challenges of Having Multiple Repair Stations

1. **Maintaining Standardization**
2. **Looking for specific strategies or programs to impact the organization to break the "Dirty Dozen" such as:**
   - Complacency
   - Distraction
   - Situational Awareness
3. **Stuck in the investigation cycle – cant get over the hump**

Do ASI's make HF Easy or Hard?

Our Experience:

1. **PMI's PAI's are not to familiar with HF**
2. **Look at Training Only – Not as a Program**
3. **Violate the Repair Station**
4. **Haven't really been involved with HF the focus is on Regulatory and Safety issues (As they should be)**

What Should the FAA ASI Need to Know?

1. **Go beyond just looking at HF training**
2. **Should understand HF program elements**
3. **Look for effectiveness in practice on the shop floors**
4. **Help pass on industry best practices**

How Can FAA ASI Add Value to HF Programs?

1. **FAA Violation and LOI responses should be reformatted to include investigation data that identifies and corrects any human errors. Only look at Technical aspects**
2. **Would help ID the Root Cause**
3. **Better corrective actions to prevent re-occurrence**
4. **Data collection possibility by the FAA for industry focus**

What We Do to Comply with EASA Regulations on HF

1. **Our Program was built following EASA Part 145 (e)(30) And MIP-G**
2. **Most of AAR's Repair Stations are dual certificated**
3. **Audited annually for compliance**

What about the fatigue challenge?

1. **Hard to control**
2. **Many Technicians have other jobs**
3. **We control through our internal StAAR System**
   - Wont allow a tech to work over 14 hours
   - Not perfect
   - Still have found those with only 5 hours of sleep daily

How Do We Find Qualified HF Leaders in Our Organizations?

1. **Very difficult to Identify and Very rare to find**
2. **Cant hire indirect labor for HF position**
3. **Usually HF is an added responsibility to Quality, Safety, or Training Departments**
4. **Would like to see a "Certificated" Course offered by the FAA or EASA**
   - Something that equips a person with the KSA's

Speaker	Dialogue
Bill Huntley	I revised my slides and I sent them again so the next slide I have is just kind of an overview of some of my concerns. I did change them a little bit but I want to whip through them real quick. I really don't see human factors in our business or in what we do out there, being practiced or accepted as a norm on the shop floor. I think a lot of the operational needs that we have pushes that aside when they walk out of the training room, well it all sounded great in the room thanks a bunch, but what really happens on the floor is different. We've talked today about the business case, return on investments, so this is just another bullet to go there. I don't see a strong ROI out there for business case for human factors and leaders just don't see the value. I mentioned the outdated however important information that's available for training. I think there needs to be some focus training for every level of the organization not just focused at the technician's because walking out of there some techs think well we're the problem, that's what you're telling us, that we're not able to do our jobs right. But we lack strategies for correction. And I'm going to talk a little bit about that on another slide when I get there but some of the typically challenges we see specifically our repair stations initial cost for human factors training is a lot of money to take a guy off the floor, put him through 8, 10, 12 hours of training and then we don't see a return on investment after that basically or we don't track it very well. A lot of the training covers the theory and we have case studies some of our own case studies as well, investigations but again that training does stop at the door because operational needs will dictate what transpires out there. Another huge problem we have is we have a revolving door. We have almost an entire new workforce working for us we'll have people coming in 3, 6 months a lot of that is driven by our contractor labor force. And I think they're kind of missing the boat you know these companies that provide labor to businesses like ours. They're not involved with any of this stuff. They don't provide any training for the labor that they're providing to us. And then we touched on the 147 training facilities as well. Kind of maybe a quick technicians when they're coming out of their schools with a little bit more of a human factors tools or more of a I guess an introduction to what it all is. What they should be responsible for when they hit the floor? So they already have an idea of what we're looking for to get out. Multiple repair stations we've got what do we have 15 I think. Its maintaining the standardization when I first took over and started bringing in our human factors program and developing it and everything we were all over the map everybody had their own great ideas and everything and we had a lot of different presentations out there. We had 2 hours, thirty minutes, things weren't really covered well. So we've pulled it all together and now its trying to maintain that standardization because its easy to break off and go different directions. Look for specific strategies this is what I was kind of talking about a minute ago about strategies for corrections but programs that impact the organization break the dirty dozen cycle it's we get caught into this investigation loop. Where we go out and we identify you know somebody damaged an airplane. And we identify, we had complacency, distractions, situational awareness okay great. We identified that now what? And we don't we can dig up a lot of different research and things on it but how to apply it like an organizational structure and how to correct some of these things to make people a little bit more aware I think we're lacking across the board on that. That's what I meant by we

Speaker	Dialogue
	get stuck in that investigation cycle we just can't get over that hump, we keep identifying it and I can pull up a whole bunch of data from our database and we have all these hits on these certain areas but we don't know what to do. Fatigue is another one. Some of the other bullets that Bill gave me some ideas to present here. For the ASI's do they make human factors easier or hard on his. Well our experience we really found that our PMI's, PAI's are really not that familiar with human factors. I mean they may have gone to a training class, I'm not sure, but it seems to me that they come in with buzz words and they know that we're suppose to have training, and they really don't see it as a program. So they'll come in and violate us which is their job, they're the enforcement business they will violate the repair station because we missed a training requirement or we didn't get out recurrency entered or something like that. Haven't really been involved with human factors focus on regulatory and safety issues as they should be. So I think they're a little bit disconnected when they walk into our repair stations just again from our experience what we've seen. And these are the same guys that are in charge with making sure that we're compliant with EASA and everything else.
Bill Huntley	So what should they need to know maybe going beyond just looking at the training. Training is training - maybe you understand some of the program elements. What's it take? You know we can go through the dirty dozen but more onto the investigator side look for effectiveness and the practice on the shop floor. So when we have our inspectors coming in to inspect us, are we actually doing what we're saying we're doing? Maybe to look into that avenue. We do that all the time we can walk in and kind of audit against our own program but many a third party coming in and looking at it and going okay you've trained all these things but are you actually practicing it? Maybe this will help pass on some industry best practices I already heard that mentioned just a little bit ago. You know share some the experiences with us and help us get better that's what we're looking for. So ASI's, do they add value to our programs? In some ways yes but the violation and LOI responses from us. Whenever we get violated for something I think maybe the format of that should be changed a little bit where the FAA starts looking for some of these other human error or human factor issues that are out there. Because right now we only look at the technical aspects of it. We fill out the response for an LOI and then yeah we changed this policy or procedure we did this or that but we really don't bring into that piece of human error what caused it to happen? Maybe that would be something better to re-format some of the responses out there. I think this would help us identify root cause a little bit. And better correct them - corrective actions are going to come out of that to prevent reoccurrence. Data collection possibly can come from that if we kind of went to that little change if you will the way respond to LOI's or whatever that's the best example I can use right now but start collecting some of that data. What are some of things that we are seeing out there when companies are violated that we could pull that together and maybe there's a way to take that information and come up with some strategies for correction. What we do to comply with EASA I built a program following part 145 from EASA and mid G most of our repair stations are dual certificated so I took their information basically and build our whole program for that. We are audited annually for compliance and they get that's mostly from the FAA. Fatigue challenge? This is very hard for us to control; technicians have other jobs, we do have an internally system to where are employees are clocking on the

Speaker	Dialogue
	jobs and it won't allow the technician to work over 14 hours however, every good system you build there's always ways to get around that and we always do so its not perfect. We still find people with five hours of sleep a lot of times that's after an event has taken place and we start pulling the information out of the individual that we can get that information but a lot of times their like no, no I'm fine I go home after work they don't want to expose themselves. How do we find qualified human factor leaders in our organizations, we can't. Very, very rare we'll find great people that are interested and want to do this and go forth but we can't hire indirect labor, it's cost. Usually this is added responsibility somewhere in quality and safety or in the training of departments and unfortunately if you give it to a training department what do you get? Training. So you don't get a full program implementation you just get the training requirements covered. One thing I would like to see is possibly a certificated course maybe offered by the FAA, EASA, or some industry standard that would say [Sky] you know I'm the VOR with this guy and he's good to go and he's certified in human factors to be a champion in an organization. How to get somebody with the knowledge skills and abilities they need to perform a duty like that. That's all I have for my slides. Any questions?
Unknown	Have you invited the PMI's, PAI's to the human factor courses at ARB?
Bill Huntley	Yeah we have.
Unknown	Did they attend
Bill Huntley	Rare occasions they will. We've actually here in Oklahoma its been a lot better because we started an ASAP program over here and our PAI, PMI and actually other people from the center have gone over there to attend. So I mean that's been one plus for us.
Unknown	Do you guys have an ASAP program for AAR?
Bill Huntley	Right here in Oklahoma that's the only one for now, trying to get another one.
Dr.Bill Johnson	But Bill correct me if I'm wrong - Aren't there only two maintenance ASAP's? Does anyone know the answer to that?
Unknown	There's only two that exist anywhere.
Unknown	Continental has one.
Bill Huntley	Strictly repair stations?
Dr.Bill Johnson	Yeah repair stations.
Dr. Bill Johnson	So [unintelligible] one going onto two is a pretty good thing.
Bill Huntley	Yeah. I'd like to see that all four our majors has something like this.
Dr. Bill Johnson	You allow us with your guys on Monday and they said that you guys did a great job initially introducing ASAP to everyone and it looked like it was really going to roll but they - they the middle level managers among others emphasize that once you start that kind of program you really need to keep re-enforcing it. That you get a bunch of reports early on and then unless you promote it, and re-train it and do all those kinds of things you really got to work it to keep it going.
Bill Huntley	Yep.
Dr. Bill Johnson	As you know.
Bill Huntley	And I know when you - you know its like I think most other programs we lack of a communication feedback and that's what kills it. So that's kind of a re-vamp going on right now over here.
Unknown	You get that revolving door too.
Unknown	Yeah its all that trust your needing you know
Unknown	That's correct.
Unknown	Depending if that guy was there 3 months or 3 years.

Speaker	Dialogue
Bill Huntley	And like we were talking about earlier just guys will leave for 25 cents, they'll leave for 50 cents, or if they get upset or if their involved in a incident and they're disciplined for damaging an aircraft. Their gone.
Unknown	Even noew?
Bill Huntley	Yeah. I'd like to see that all four our majors has something like this.
Unknown	Bill have your internal [auto pilots] identify any return on investment? Or lets re-word or?
Bill Huntley	We are - we are a targeting rework right now. Because we know there's significant amount of money that's right there and I think that's going to kind of get us over a big hump as far as once that's identified and we can kind of forecast, hey we're going to save you this much this quarter then we start building a more of a little money coffer to keep these things going. So that's a big, big focus right now for us.
Bill Huntley	Anything else?
Dr. Bill Johnson	And thanks for staying part of all our FAA committees.
Bill Huntley	Oh sure.

Appendix G: Human Factor Challenges at an Original Equipment Manufacturer (OEM) with Multiple Repair Stations (Mr. Fred Etheridge)

Speaker	Dialogue
Fred Etheridge	We've only got about 15-20 minutes, what I want to talk to you about is, we do in fact have 9 out of those 10 points that Mr. Rankin was talking about this morning in our [unintelligible] program. The one of course, the one that we talked about the most this afternoon is the one that we really need to pay more attention to. And actually you know I've thought about that a lot and I have concerns with it.
Fred Etheridge	So what I want to talk to you about, because we do have those in place I'll give you kind of a timeline when we did this. I also want to show you where we've implemented starting this on our SMS.
Fred Etheridge	If I don't run out of time we've only got about 20 minutes. And at anytime please feel free to ask any questions. And again I'm Fred Etheridge from Gulfstream Aerospace the technical and compliance training manager. So let me talk to you about our initial human factors class. We have 12 repair stations within our system and we call it a maintenance system, not just a repair stations. About 98% of our repair stations get this initial HF class. The other 2% would be our administrative personnel and positions such as that. Even our planners, our finance people they also get the initial class. Keep that in mind when I go through this. So the objectives of our HF training program are human factors skills appropriate for the job can be addressed. And primarily our repair stations have probably about 70% technician type employees and almost 95% of those technicians are certificated in our company so they hold A&P's.
Fred Etheridge	Additional objectives ensure a positive attitude towards safety and enhance employee awareness of individual and organizational human factors that may affect or make errors. These are the main objectives of that initial class. We really do spend a great deal of time relaying the message to our employees that 80% of the time why somebody's making a mistake is because of the organizational issues that exist. Things that we as a company have in place, not intentionally, but put you in that position to make that mistake. So we'd really beat that in there. And then when I talk about SMS a little bit I'll show you how we try to capture some of that, from our perspective. Know that Gulfstream operates under several regulatory authorities. The FAA being one of those so there are many of those folks, NAA's that we actually do have each requirement in place - which we have to abide by. Hong Kong, EASA, of course being the main one. All of our repair stations do have an EASA part 145 certificate so our initial classes actually built off the guidance material from EASA that they've used at UK CAA and there's 55 subjects in there that pertain to our maintenance system. We decided because this was also a corporate initiative for Gulfstream as well as SMS, not just the check in the box, of course that's very important as well. But we decided as a whole over our entire enterprise all 55 of those subjects pertain to us. In some form or fashion. So those folks will receive that in their initial class.
Fred Etheridge	We do know that, you mentioned it a second ago, we are the OEM of our product. We're also MRO as well. All of these human factors programs and SMS programs to date, started about 3 years ago, applies to our part 145 side of our business. Starting at the end of September we will start moving this implementation and install into the manufacturing part of our business as well, where none of that is required. But it is a corporate initiative in the same aspect as 145. But being a corporate initiative, we're going to move it into that entire corporation is acting, hopefully in the same way in regards to safety. What you see up here also comes out of the EASA part 145 guidance material these are the

Speaker	Dialogue
	folks in these positions that will require that initial training.
Unknown	unintelligible
Unknown	Yes. The safety culture survey. Are you talking about the one we did with the FAAST team?
Fred Etheridge	Um I'm not sure.
Unknown	Or is it a different one?
Fred Etheridge	I'm not sure.
Unknown	unintelligible
Fred Etheridge	I did not have a FAAST team that did not come into our organization and do it if that's what you're asking.
Unknown	Okay. Because we just did one a couple of years ago and I don't know how many people are familiar with what we did. We had a, basically, a national workgroup that developed a safety culture survey that was specifically focused on 145's that did work for 121's on flight safety critical components. And I was just, I mean I got some pretty startling feedback that a lot of folks said 'whoa, what the heck, look what we got here.'
Fred Etheridge	We didn't use that. I'm sure it was something that is pretty close to it. 92 question anonymous survey, over eight human factors categories. Some of that was safety motivation and, you know, some of those other types of things.
Unknown	Sounds familiar.
Fred Etheridge	Communication that kind of stuff, centered all below lead and below at our corporation so that we can see what their perception of safety at our company is.
Unknown	Do you run the same program for both sides of certification OEM and the repair?
Fred Etheridge	We're about to. There will be some different changes going September.
Unknown	Are you using those same programs, same training of the guys, you see that
Fred Etheridge	No, no, no, no the training is tailored differently with our company.
Unknown	Do you see a difference in the human factors
Fred Etheridge	Between OEM and MOR?
Unknown	Yeah.
Fred Etheridge	Absolutely, because our OEM they're using maybe work cards, maybe engineering documents you go to our MRO, we're actually using maintenance manuals, CP cards, work cards, things like that so there's a huge difference there. And you go to the MRO, that's primarily for us, certificated folks. OEM and for most cases the OEM does not have those types of certificated employees. So it's tailored as a matter of fact, um totally two different worlds. Even the way we implement SMS there and install it - it's going to be a little bit different just because of the nature of the work force in that area. On any of the notes it probably says Gulfstream University in the front, to you means Gulfstream University, that's the corporate entity that I work with. Currently I have five human factors practitioners; we probably spend around $30,000 per practitioner to get them trained. We do look for people that do come from the floor we also send them to the floor for very long periods of time to actually work for this specific work force and things like that. That way we can always keep things updated, at least we hope to. When we started the program back in 2007, we didn't really have human factors classes, since then, we've had 11 of those that you see listed. Our initials and our re-currents, and our re-current every two years is a requirement for us and that is a different, totally different course every

Speaker	Dialogue
	year, every two years it will be different. It will be things that have come up in our organization that need to be addressed. How we fix those, how we mitigated those, and those types items. We talked about MEDA talking in your 24 hour course, my suggestion would have been in, and I have not been in that class. We have a MEDA class as well that's three days in itself. And then we have four SMS classes right now because we are three years into our SMS communication. So that's our human factors program, a little training portion of our program. We do have accident investigation, things like that. We have a hundred and forty trained, formally trained incident/accident investigators in our corporation. That is a side job for most of them. We know human data and things like that in our corporation's research that we've done and the ties that we have with the industry. We know that in error management system and the human factors program is in fact 80% of SMS. It is. So that is a foundation for us, not just it's a requirement for many of our regulator's but it's also the foundation for our SMS. So we started back in 2007 when we started our human factors training also in the third quarter of that year we did those safety culture survey's that I mentioned. Questions on those survey's for example and I don't know if this help, Bobby was, "I am pressured by my supervisor to sign for work that I didn't do". A good question, right? Think we have that in the industry?
Unknown	uh huh.
Fred Etheridge	Yes. Probably a pretty good portion of it, stuff I'll look at. But we did those kinds of things because that data gives us the perception of safety but also can help us put in place what we need to for human factors programs and things like that. We also started, and what you're looking at right here, is our SMS timeline as of today, and its getting ready to build out we had an off site last week on part 21. We also in the same year 2007 went to all of our and when I - I don't know if I mentioned it we're just talking about part 145 right there.
Unknown	[unintelligible]
Fred Etheridge	We start September.
Unknown	Uh huh.
Fred Etheridge	We have two - we have two sites to launch SMS in Gulfstream, two one forty five sites. One's happening today. I'm flying there tomorrow to do some charter sessions with some of the teams we have there. Which is in Lincoln outside of Sacramento; and then one in our Georgia repair station in Brunswick those two, and then we'll finalize those out just starts sustainability but in the fourth quarter of that year we started doing GAP analysis at all of our sites and that's taking best practices from the industry, a lot of which, Martin, was from Transport Canada. And some consultants and things like that it wasn't, an audit it was like a check list, a very thick check list, and it was very basic in some senses, lots of interviews but like we'd go into one of our sites, and its just always funny to me because we're such an advanced company, the things that you don't realize you're not already doing or don't already have. For instance this safety policy. Kind of basic, right? Basic statement.
Unknown	All of our places had those.
Unknown	That was kind of crazy for us.
Unknown	It doesn't [unintelligible]
Fred Etheridge	What's that?
Unknown	You've already completed level three?
Fred Etheridge	We're actually going into phase five. We're doing ours a little bit different. Ours is more than if you're talking about the four pillars and

Speaker	Dialogue
	things like that.
Unknown	Yeah.
Fred Etheridge	We only have a few regulatory authorities at this point that we have to give information to. One of which is Hong Kong.
Unknown	Hong Kong.
Fred Etheridge	Yes. So when you see that the safety culture surveys and the gap analysis that's where we got commitment to actually go in and do the SMS. And from this point, we only have one or two regulators for us they are requiring us to this. Another [unintelligible] such as France they also require that primarily effects our [unintelligible] things like that.
Unknown	That GAP analysis? Is that from ICAO SMO?
Fred Etheridge	There are some things out of that, some basic elements, but it's more than that actually.
Unknown	Where does it come from?
Fred Etheridge	We developed with some consultants.
Unknown	unintelligible
Fred Etheridge	And folks like Transport Canada, steal, beg and borrow and those types of things. Best practices are what we were looking for, Martin, the best practices. But so we do have a place when we have check in the box duties, two different programs but that's where we really gained some of [unintelligible] the data from both of those sets. Then in 2008, we started going and training our very high senior leadership and down. They go through a full day SMS orientation class. Then we travel to all of our sites, our 145 sites, and we have to train their leadership team, their local leadership team on what SMS is. What's coming, the tools that are being built, things like that, the reporting structure that we have, the new policies, the maintenance through the SMS manual. We formally established an SMS department at Gulfstream in that same year.
Fred Etheridge	And then all of the site orientations start beginning, we do have SMS orientation awareness training for all of our employees. And within that training it shows you the tools, it shows the reporting structure, it shows you the policy, it gets you to understand what the just culture policy is because we have to [unintelligible] we don't call it a just culture because that's primarily a European term that we see and it also seems a little heavy handed, so its safety culture policy that we have. And it also talks about, and we've outlined, all the way from the President of the company down and safety accountabilities for those positions, like if you're the President of the company what you're responsible [unintelligible] flight safety. If you're a manager level, like I am and what I'm responsible for, all the way down to the employee and we can outline that same policy. That you are responsible when you're off duty, things like that. So it was a little bit of that. Last year we started going in and implementing and doing all of these policies, we did create an SMS manual that has several new safety policies in regards to SMS and things like that at Gulfstream. So we developed that, did our implementations, our installs which one is happening this week and another, the final one for 145 is next week. Our first regulator we had to submit some information to was Hong Kong, we had to do that last year. And then this year we're finishing things out, we're developing our SMS audit program. I actually sit on different committee's and I have colleagues of my own that do the same. We know we get a pretty good feel that we think that you might want to be looking at things when you come into audit things like SMS. Not checking the box stuff, you know, effectiveness stuff. Okay, so Fred, you're company said that you had hazard reports, let me see how you

Speaker	Dialogue
	log those, let me see how you did the risk assessment, I want you to show me what you did with them, I want you to show me what's closed, I want you to see what mitigates them. That's the direction that we have planned and built our program, on things like that. So it really is looking at culture things. And then in all of that, we've engaged different techniques of where we're going to get all this stuff. Change management issues, recovery and learning, review groups from around our corporation and industry and things like that. Any questions?
Unknown	One question. We talked about the cost of implementing human factors say at AAR, but they have a typical situation, high turnover. Do you guys have a state of work force that makes it more tolerable?
Fred Etheridge	What I say, and I didn't want to rain on anyone's parade, we have the luxury where we don't really have that. We have employees that have been with us for over forty five years. We don't have a high turnover rate there. That helps with that.
Unknown	Yeah.
Fred Etheridge	Where we do have some issues though, is when we get into the generationally differences of folks that have been there for 45 years and our new kids coming in out of, you know, engineers coming out of college and things like that. There's a big gap in, you know, the way things use to be done, they way I'm going to come as a new guy I'm going to push this on you, and in some cases that's good. Pushing good stuff. Forcing some of that change. It's very expensive to do this from my company's perspective, just human factors training alone has been costly. That's not counting all the other SMS stuff, we've spent more than that on [unintelligible].
Unknown	But I think you've come very, very far along, you probably have answers to some of the questions that came up in this work shop.
Fred Etheridge	I don't have a lot of fatigue management stuff, but that's what we're going to start working on.
Unknown	But that's still just one element.
Fred Etheridge	When I was going to offer, if I had a chance to talk to you and you asked me, should I follow the SMS umbrella, that's what plan we're going under. Because now we have distant water hazard reporting and all of that - that would be identified by our employees as a hazard report. Or just go back to our regulators and now we have to address it.
Unknown	[unintelligible] by your SMS program.
Fred Etheridge	Yes. Because that would definitely would be a hazard for sure. One of the definitions for hazard in our company is if it’s going to damage our brand, and that's a hazard for us.
Unknown	Would this be a self report or ‘I saw someone at work that was tired.’
Fred Etheridge	Absolutely.
Fred Etheridge	We did get some silly things, like the steps outside are cracked – cement is cracked, we've had that, of course that’s still a safety hazard. Well not air worthiness issues, where you know you might see that knee adjust, and I didn't mention our quality department does not own SMS process, that's held under [EHS] we decided we took that decision way in the beginning that we would take that and separate. [unintelligible].
Unknown	Well you want to maintain a certain level of privacy [unintelligible].
Fred Etheridge	Well that's simple and [unintelligible] I believe.
Unknown	Do you know what facility reports are?
Fred Etheridge	What's that?
Unknown	Troubleshooting. They just want to see if this [unintelligible].
Fred Etheridge	Oh absolutely.

Speaker	Dialogue
Unknown	So if you see a silly one, you go flush it, it doesn't work.
Unknown	How big of a staff do you have to do all this?
Fred Etheridge	For SMS? We have SMS coordinator at every location that we have [unintelligible] here I actually have five people that are dedicated to it.
Unknown	So for human factors and training and all of that.
Fred Etheridge	I have a staff of five [unintelligible]
Unknown	So you're SMS for safety [unintelligible] or personal injury, or result accredited
Fred Etheridge	Sometimes they both kind of merge but primarily every organization has safety advices.
Unknown	Are you under [unintelligible]?
Fred Etheridge	We just decided to not put that in the same issues with quality [unintelligible]
Unknown	That's more like if their under safety.
Fred Etheridge	Well you know you test theirs, safety down into four different groups, and safety is actually one of those.
Unknown	Safety of flight one of them?
Fred Etheridge	No not safety of flight. That's probably
Unknown	I thought that was what SMS is for? Safety equipment?
Unknown	No.
Fred Etheridge	Not all the time.
Unknown	The FAA can't [unintelligible] the rules that says you got a personal injury its safety [unintelligible]
Unknown	unintelligible
Fred Etheridge	Not yet.
Unknown	unintelligible
Fred Etheridge	Not yet but we do have some HF engineers, but not yet. Some are understaffed.
Unknown	Fred, is there a way, you think, I mean, why do you see that your personnel are staying longer than other companies like AAR, I mean what is the draw to a company?
Fred Etheridge	I work for a great company now. That's the only thing I can say. Generally
Unknown	unintelligible
group	talking at once.
Fred Etheridge	We have lots of people at Gulfstream that have their entire family that works there. So, it really just is great help.
Unknown	A repair station. Just a repair station? Were you talking about to repair station and manufacturing?
Fred Etheridge	Yes. I'm talking about the entire corporation.
Unknown	[unintelligible] - Say in the repair station do people get paid Gulfstream wages or MRO wages?
Unknown	Our Gulfstream wages [unintelligible]
Fred Etheridge	Well that's in [unintelligible].
Fred Etheridge	We have fantastic benefits and pretty good culture there.
Fred Etheridge	Pretty good.
Fred Etheridge	I mean we still have the same thing that you see in aviation when it is managed.
Unknown	So you differentiate SRM from SA? Safety risk management from safety assurance?
Unknown	Well the design of your
Fred Etheridge	[unintelligible] falls under SMS. Just for us.
Fred Etheridge	Well, no, well all that right now still falls under SMS recommended

Speaker	Dialogue
	program
group	talking at once.
Fred Etheridge	But they are both part of it.
Fred Etheridge	But the question then now is under [unintelligible].
Fred Etheridge	Still growing.
Unknown	I guess the question is using your SRM you come up with a list of controls to operate the company. Then using safety assurance you test those controls at the [unintelligible] basis?
Fred Etheridge	Absolutely.
Unknown	They don't work then you go back
Fred Etheridge	Go back and get another fix. Yes
Unknown	Well its not an operational thing, it could be maintenance or operations, or
Fred Etheridge	It could be
Unknown	Or industrial
Fred Etheridge	It could be absolutely.
Unknown	So who uses this
Fred Etheridge	At the corporate level that’s done.
Unknown	[unintelligible]
Fred Etheridge	That's done at a corporate level in there, and then at each site, that's done at their SMS level as well. All that's fed into the corporation.
Unknown	And what do you believe is?
Fred Etheridge	We have SMS coordinator who is trained
Unknown	[unintelligible]
Fred Etheridge	And in some places we've actually hired [unintelligible] which I think is the route where going to go with the entire gamut [unintelligible]. Better economy and for money.
Unknown	So you have individuals here?
Unknown	You said this in Gulfstream you had the beginning [unintelligible] so does the department use SRM?
Fred Etheridge	It depends, not every department. For example you recommend engineering [unintelligible] service center, repair center all that kind of you see it there. Is that a department? No I don't think any of this is.
Unknown	unintelligible.
Unknown	So, you would, the people that operator aircrafts, that people who maintain aircraft, they're the ones that use it?
Fred Etheridge	Absolutely.
Unknown	And the people who wouldn't use it would be--
Fred Etheridge	Not those types of people
group	laughter
Fred Etheridge	That’s not the answer you’re looking for.
Fred Etheridge	About 70% of the people probably use it.
Fred Etheridge	There's [unintelligible]. What else?
Unknown	Fred I noticed you did a safety culture survey in '07 and since second quarter 2010 did you basically have a baseline? And how
Fred Etheridge	That first one was a baseline and actually that has shifted, we're going to start that in the fourth quarter of this year.
Unknown	Oh, okay, so you haven't done it?
Fred Etheridge	No. And the reason we want to do that because we realized pretty quickly last year that getting the new tools of SMS in place and really getting some of the human factors types of stuff moving. We needed more time then that to actually see if the tools are being used, see what needs to be changed, what needs to built or re-built.

Speaker	Dialogue
Unknown	That's the critical component their doing an initial and never doing anything else you have no idea what you're planning for. So I'd be interested in how that works out.
Unknown	Okay. I hope its [unintelligible].
Unknown	[unintelligible]
Fred Etheridge	What else?
Fred Etheridge	My contact information is in there as well as everybody else's. She left. But the best way to get a hold of me is through email or text. And that's on there as well if you want to get a hold of me. If you think of something that you wanted to ask. If you try to call my desk, it may take me a day or two to respond.
Katrina Avers	So you're not going to be here tomorrow?
Fred Etheridge	No ma'am I have to leave tomorrow. So and I'm sorry for that
Dr. Bill Johnson	I'm glad you took the time to be here today, appreciate it. And also we really appreciate again the work that you, Bill Rankin, Bill Huntley do on all of your committee work with FAA - it's great, you know, because you really bring your industry experience into so much of our scientific critics will make as well. So I appreciate that a lot.
Fred Etheridge	I appreciate the opportunity to be invited to sit on them and give input and receive input. Really important to industry if you didn't already know that.

Appendix H: Maintenance-related Accidents (Dr. Katherine Wilson)

NTSB National Transportation Safety Board

Office of Aviation Safety

Maintenance-related accidents

Katherine Wilson, Ph.D.

Human Performance Investigator

Air Wisconsin Flt 3919 - PHL

2 NTSB

Air Wisconsin Flt 3919 - PHL

3 NTSB

Air Midwest Flt 5481 - CLT

4 NTSB

Air Sunshine Flt 527 - Bahamas

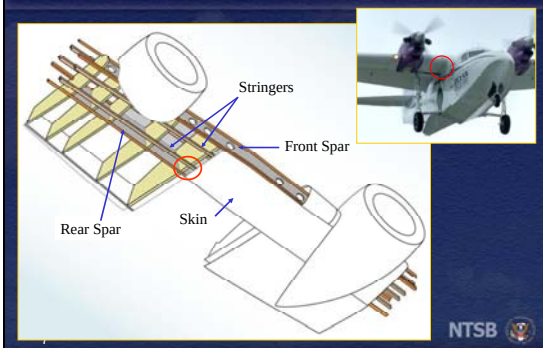
5 NTSB

Recent Recommendations

- Require that mechanics performing RII and other critical tasks receive OJT or supervision when completing the task until the mechanic demonstrates proficiency in the task. (A-10-96)
- Require that RII inspectors receive supervision or OJT training on the proper inspection of RII items until the inspector demonstrates proficiency in inspection. (A-10-97)

6 NTSB

Chalk's Ocean Airways Flt 101



NTSB

Chalk's Ocean Airways Flt 101

8

NTSB

Delta Airlines Flt 1288 - PNS

9

NTSB

What about fatigue?

10

NTSB

NATIONAL TRANSPORTATION SAFETY BOARD

NTSB

Speaker	Dialogue
Katherine Wilson	Today I'm going to discuss several accidents and incidents investigated by the NTSB that have involved human factors issues. A number of the accidents and incidents investigated by the NTSB have been the result of inadequate training and supervision. On December 13 and 14, 2008, a CRJ-600 underwent routine, heavy maintenance at the Air Wisconsin maintenance facility in Norfolk, VA. One of the tasks was to replace the left and right uplock assemblies, considered to be an RII (required inspection item). The maintenance was performed during the midnight shift. Mechanics were only able to work on one assembly at a time due to the confined space in the wheel well, so the work was divided between two mechanics. The mechanic replacing the left uplock assembly had not previously replaced an uplock assembly on a CRJ. He did not receive OJT (on the job training) for this specific task nor was it required, and he was not being directly supervised during the task. When the incident mechanic replaced the left uplock assembly, the upper attachment bolt, nut, and cotter pin assembly used to mount the left MLG uplock assembly to the structure were installed but did not engage the uplock assembly, which allowed the uplock assembly to pivot about the lower bolt. The assembly was a "blind view" and it was necessary to use a mirror and headlamp to adequately install and inspect the assembly.
Keith Frable	So when did you come to the conclusion that he required the use [of a mirror and headlamp] if it wasn't listed in the maintenance manual?
Katherine Wilson	At the time of the incident, use of the mirror and headlamp was not 'required' per the aircraft maintenance manual (AMM) to ensure proper installation, however, it was necessary to adequately see the installation. Bombardier has since revised the procedures in the AMM to indicate that inspectors should use a flashlight and mirror. The RII inspector tasked with inspecting the uplock assemblies had never inspected an uplock assembly, did not recall if he had ever replaced one as a mechanic, and had not received any training, formal or informal, regarding the removal, installation, and inspection procedures specific to an uplock assembly. During the inspection, the inspector recognized three discrepancies – replace the lower cotter pin, fix a gap measurement, and fix a hydraulic fluid leak – on the left uplock assembly that needed to be corrected. Once the discrepancies were corrected, the RII inspector did not perform a complete operational test as required. He stated that the only part of the manual extend procedure that he completed was to manually move the uplocks into the locked and unlocked position by hand in order to show a mechanic what the uplocks look like when they are in the locked position.

Speaker	Dialogue
unknown	Yeah. And with a robust procedure it really doesn't matter whether they got this hydraulic component and they can argue that landing gear some of them are sensitive to the way you're running them. But in case of this one, to me it's a hydraulic component. You know anybody work their way [unintelligible] come out of school with A&P on their chain hydraulic component [unintelligible] has a robust manual. And as well in [DePaul] so..
Katherine Wilson	We came out with some recommendations that I'm going to talk about in a little bit.
unknown	No. During the RII inspection, did he document those findings? Non compliance with the manual?
Katherine Wilson	The inspector verbally instructed a mechanic to correct the items but failed to update the maintenance logs as required.
unknown	Alright.
Katherine Wilson	Because the upper attachment bolt did not engage the uplock assembly and this was not detected during the inspection, the left MLG remained in the up-and-locked position and did not respond to the pilot's commands to lower prior to landing.
unknown	Do they have policies and procedures for him to do that?
Katherine Wilson	Yes. The discrepancies that he did find should have been documented.
unknown	Was he a full time inspector or was he just a mechanic on RII or rotation?
Katherine Wilson	He was a full time inspector.
unknown	I'm hearing a lot of organizational failures.
group	Yes.
unknown	What's the turnover rate, do people come and go quickly?
Katherine Wilson	I don't recall the answer to that.
unknown	The inspector who actually got the job was pretty new himself.
Katherine Wilson	He had been an inspector for about a year.
unknown	Sounds like they didn't want that job.
unknown	The operational check, was it completed by the RII inspector?

Speaker	Dialogue
Katherine Wilson	The RII inspector did not perform a complete operational test as required. The inspector stated that he performed the functional gear check from the cockpit of the airplane and the crew alerting system indication verified a “good swing.” The only part of the manual extend procedure that he completed was to manually move the uplocks into the locked and unlocked position by hand. Doing so would show the mechanic what the uplocks look like when they are in the locked position.
unknown	Were jacks available?
Katherine Wilson	Yes.
unknown	Was the airplane scheduled to fly like right after that maintenance?
Katherine Wilson	The airplane had been scheduled to fly but there was an extra aircraft available and they were able to swap this airplane out to continue the maintenance. They did not indicate there was any pressure to get the airplane out and the flight was later repositioned to Philadelphia which is when the incident occurred. Problems with untrained or unsupervised mechanics performing maintenance tasks for the first time have also been found at other Part 121 carriers. For example, on January 8, 2003, Air Midwest (doing business as US Airways Express) flight 5481, crashed shortly after takeoff from runway 18R at Charlotte-Douglas International Airport, Charlotte, North Carolina. Two crewmembers and 19 passengers were killed. The NTSB investigation revealed that, on January 6 and 7, 2003, the accident airplane underwent a detail six maintenance check, which included an elevator check, a rudder check, and a trim tab check. One of the mechanics assigned to check the elevator control cable tension was receiving OJT under the supervision of a quality assurance inspector (who was in charge of inspecting RIIs) who failed to adequately supervise and direct the mechanic. The accident mechanic had previous control rigging experience, but this was his first time completing the check of the elevator control cable tension on the Raytheon Beechcraft 1900D. The NTSB determined that the probable cause of this accident was the loss of pitch control during takeoff resulting from the incorrect rigging of the elevator control system compounded by the airplane’s aft center of gravity, which was substantially aft of the certified aft limit. In addition, the NTSB’s investigation of the July 13, 2003, accident involving a Cessna 402C operated by Air Sunshine, Inc. (doing business as Tropical Aviation Services, Inc.), that crashed off of Great Abaco Island, Bahamas. All passengers survived the ditching, however, there were two post-ditching fatalities. The investigation revealed that the differential compression checks performed on the right engine, which failed in flight, were completed by an unsupervised

Speaker	Dialogue
	and unassisted (Air Sunshine's Maintenance Manual indicated that two people should conduct the compression checks) assistant mechanic about a month before the accident. The mechanic did not have an airframe and powerplant certificate, had not completed OJT, and had not conducted a compression check prior to conducting the check on the accident airplane. The NTSB determined that that the right engine failure resulted from inadequate maintenance that was performed by Air Sunshine's maintenance personnel during undocumented maintenance.
unknown	You know that last one, I can almost guarantee RII wasn't required. You know that's just a 121 a large aircraft, [unintelligible] type thing. There are tons of work that goes on all of those airplanes and helicopters everything without RII. I think it's important and do that but that's not going to fix that problem.
unknown	Air Sunshine yeah.
Katherine Wilson	I didn't work that accident so I can only go off the conclusions and the probable cause
unknown	[unintelligible] so it's not a bad recommendation.
unknown	No - no.
unknown	It's just written unfortunately [unintelligible].
Katherine Wilson	Two recommendations were developed as a result of the Air Wisconsin gear up landing and previous accidents. The NTSB concluded that if the mechanics in the incident and accidents described had received OJT or adequate supervision while performing the tasks for the first time, their errors might have been recognized and corrected, either by the mechanic or by the person providing the OJT or supervision. Based on this evidence, the NTSB recommended that the FAA require that mechanics performing RII and other critical tasks receive OJT or supervision when completing the maintenance task until the mechanic demonstrates proficiency in the task. Furthermore, the NTSB concluded that incident inspector's lack of training and experience with the removal and installation procedures of the uplock assemblies may have contributed to his failure to detect installation discrepancies. The NTSB also concluded that if the incident inspector had followed the RII inspection procedures and the manual extend of the gear had been accomplished on the incident airplane, he would have likely detected the misrigging of the uplock assembly and thus prevented the incident. Therefore, the NTSB recommended that the FAA require that RII inspectors receive supervision or OJT on the proper inspection of RII items until the

Speaker	Dialogue
	inspector demonstrates proficiency in inspection.
unknown	Majority of the maintenance that's going on in 135 world is not a requirement.
unknown	Unless you make it regulatory
unknown	One of the primary issues as I recall in the Air Midwest accident was norms were taking place the maintenance manual was incorrect so they had come up with the wrong procedures. You have a really good - this accident is in an online simulation of the NTSB's website for the flight path as well as the mechanically issues and so it's an excellent training tool. I did a human factors presentation for Air Midwest after the accident on the midnight shift you know and we talked to the guys so what are you doing tonight? Well you know it's we just had dinner and in about an hour or so we're going to go out and finish this engine change and I said so - so you're at the lower part of your circadian rhythms you're going to have a full belly, you're going to be tired, you know do a double RII if you need to. And they were very proactive about human factors there after that accident. They didn't survive the business but their big complaint was the manuals are wrong. And they don't change the manuals after they've created them.
Katherine Wilson	Did anybody mention that the manuals were wrong? Did they try to get them changed?
unknown	I believe so - I believe there were a lot of documentation. I don't know about on the top end of the investigation.
unknown	That's the number one complaint. I hear the certification people need to listen to that. The number one complaint of mechanic's out there is manuals. And I've been involved with a lot of that and they submit them and those manufacturers don't you know they can't and I can see they probably can't make a change every five minutes but that is the number one factor that I hear mechanics out there and especially on smaller aircraft and it's a tough one it's a toss up but you can't write you know every little step. I mean somebody mentioned you go to do that a lot of it is you got to be a mechanic you got to use your brain.
unknown	[unintelligible] another guidance came out from headquarters that if you buy an airplane today that you never have to update your manuals ever again.
unknown	That was really bold.
unknown	That's something that we really changed substantial maintenance to essential.
unknown	Right.

Speaker	Dialogue
unknown	They purchase an aircraft the manuals are good from that day [unintelligible].
unknown	Maybe that's where some of the assertiveness issues comes in because a mechanic should be able to say 143 I can't perform that task because I've never performed it before. So the rule tells it you cannot do that. But so maybe the lack of assertiveness to tell the boss can't do it, you need somebody here to support it, a supervisor.
Brian Capone	There's tons of human factors in the air and I think it's a lot more than just, you know, what we're talking about here, its generational changes. I mean go to the A&P schools and talk to them and we're there and the young kids that are coming in there and they're good kids a lot of them but they don't grow up they never grew up in an area like a lot of us did. Look at the age in here. They don't, you know, the bicycle breaks, they throw it away and go to Walmart and buy another one. They don't fix things. In their first training is this is a Phillips screwdriver. Unless a few of them come out of the military. I don't even think the military trains them like we use to. You know its remove a box and put it in. And personally I see it in my kids, and I see it around the next generation they don't have that assertiveness. You know, my kids want to go they get the wrong change and they're too embarrassed to go tell them, you know, hey, you short changed me. And so I think it's going to get worse in my opinion.
unknown	Why is that, Brian, in your opinion?
Brian Capone	I don't know. Well it's a generationally thing, that's what I'm talking about its not just a…
unknown	Where is the lack of self confidence coming from?
Brian Capone	Yes. And I see it. Okay we have traffic in here, we've got the Baton Rouge a lot of air traffic - I still fly a lot with some Long Shore organizations and I see in air traffic side of the house just the attitude across the thing. You know everything is something's wrong with my radio its always me when they make a mistake. I mean you can feel it that the attitude over the radio it was unbelievable when the newer controllers were coming in. I don't know. I don't know what the answer is but
Katherine Wilson	Is this an area where human factors training can help with the assertiveness issue or speaking up? Included in the recommendation letter that we came out with, we reiterated a recommendation that we had for the FAA which is currently classified as open unacceptable response: Require that 14 *Code of Federal Regulations* Part 121 air carriers implement comprehensive human factors programs to reduce the likelihood of human error in aviation maintenance.

Speaker	Dialogue
Dr. Bill Johnson	Well, that letter to let you all know, I think it was about 2 months ago and that is on the administrator's desk but Jay and [unintelligible] we haven't had to respond. Did you have to respond to that?
unknown	okay.
unknown	In my SMS adventure [unintelligible]- I read a little about QMS and the Japanese have one. The idea that he should take care of an issue you ask a [unintelligible] five times. They call it the 5 why's. And I'm struck the first why is really pretty technical and the second why starts to work into organizational issues and every time you ask why it becomes more and more [unintelligible] and that's what we needed to start doing is to ask why did this happen? Why didn't they swing the gear?
unknown	We need to know why so we can fix it.
unknown	They don't want into the box.
unknown	Because they are low [unintelligible].
unknown	Well what about laziness?
Katherine Wilson	Other accidents have involved inadequate maintenance procedures and documentation, and inadequate FAA oversight. On December 19, 2005, Chalk's Ocean Airways flight 101 crashed shortly after takeoff near the Port of Miami. The airplane's right wing separated during flight and the two crewmembers and 18 passengers aboard the airplane were killed. Examination of the right wing revealed preexisting fatigue fractures and cracks in the rear Z-stringer, lower skin, and rear spar lower spar cap, each of which contributed to reducing the wing structure's ability to carry load. Although maintenance personnel detected some problems and attempted repairs, many of the repairs were ineffective in that they did not properly restore the load-carrying capability of the wing structure. Ineffective repairs observed on the accident airplane included documented repairs performed by company maintenance personnel and some undocumented repairs. Also, company inspection personnel failed to identify that the repairs were ineffective. An animation of the in-flight breakup sequence is available on the NTSB website. The NTSB determined that the probable cause of this accident was the in-flight failure and separation of the right wing during normal flight, which resulted from (1) the failure of the Chalk's Ocean Airways maintenance program to identify and properly repair fatigue cracks in the right wing and (2) the failure of the FAA to detect and correct deficiencies in the company's maintenance program. A third important issue for maintenance human factors is task induced fatigue. The last accident I want to talk about is Delta Airlines flight

Speaker	Dialogue
	1288, a MD88, which suffered an uncontained engine failure during takeoff from Pensacola, Florida, on July 6, 1996. Although it could not be determined specifically why the crack went unidentified during its fluorescent penetrant inspection 8 months before the accident, this accident highlighted the vulnerability of human error in visual inspections. It was concluded that the low expectancy of a crack in the fan hub might have caused the inspector to overlook or minimize the significance of an indication. Another concern that came from this accident was inspector vigilance. The inspector who inspected the accident hub characterized the process as tedious and monotonous and stated that he spent about 75 percent of his shift inspecting parts. Depending on the number of indications detected, inspection of the hub could take 40 minutes to 2 hours. The NTSB issued recommendations to the FAA related to these areas which have since been classified as closed unacceptable action.
unknown	Well just so you know the manufacturer requires to take a sampling of [unintelligible] so you may look at this one and not look at 5 more later on. It could be within those 5 you look at.
unknown	It's simply requirements.
unknown	Well, not that it really matters but this particular one a lot of them that knew there was a crack [unintelligible] manufacturer and they [unintelligible] and didn't tell no one about it. This accident goes a lot further beyond that one inspection.
Dr. Wilson	I want to conclude by discussing two areas outside of aviation maintenance that have examined the importance of sleep disorders and fatigue– the pilot community and the trucking industry. Fatigue has been listed on the NTSB's Most Wanted List of Transportation Safety Improvements. On February 13, 2008, Go! Airlines flight 1002 was enroute from Honolulu to Hilo, Hawaii. About 24 minutes into the 45-minute scheduled flight, communications between the pilots and ATC ceased. For about the next 18 minutes, ATC attempted to contact the pilots as the airplane continued on autopilot on a constant heading at cruising altitude. The airplane traveled 26 miles past the destination airport over open ocean before the flight crew resumed communications with ATC. If the pilots had not awaken, the airplane could have experienced fuel exhaustion with catastrophic results. The airplane returned to Hilo, landed safely, and all 40 passengers and three crewmembers deplaned safely. The pilots both reported to their company that they had unintentionally fallen asleep in flight. Before the incident, the captain had complained to his personal physician that he was experiencing excessive daytime sleepiness. He was also experiencing loud nighttime snoring, was obese with a body

Speaker	Dialogue
	mass index (BMI) of 32.1, and had hypertension that was not optimally controlled despite the use of two different blood pressure medications. The physician advised the captain to lose weight. He did not refer the captain to a sleep specialist and no sleep study was conducted at that time. Three months after the incident, the captain was tested at a sleep clinic and diagnosed with severe obstructive sleep apnea. There was no evidence that the first officer suffered from sleep disorders. However, both pilots were flying a demanding schedule with multiple consecutive days with early morning start times. The NTSB determined the probable cause of this incident was the captain and first officer inadvertently falling asleep during the cruise phase of flight. Contributing to the incident were the captain's undiagnosed obstructive sleep apnea and the flight crew's recent work schedules, which included several consecutive days of early-morning start times. Schneider National, a trucking company that operates more than 11,000 tractors, with its 14,000 drivers hauling 1.3 billion miles annually, became concerned about fatigue among their drivers and launched a study into sleep apnea. They tracked 339 drivers who suffered from sleep apnea, evaluating their safety performance and health care costs. Schneider discovered that by investing in sleep apnea screening, they: (1) Reduced preventable crashes by 30%, (2) Reduced the median cost of crashes by 48%, (3) Improved fleet retention rate by 60% over fleet average, and (4) Achieved health care savings of $539 per driver per month.
unknown	That might not work so well for pilots because I recently lost my medical over sleep apnea.
unknown	And I had gone to a cardiologist after a physical because I had told my doctor during the physical about some problems I was experiencing and I wasn't sure what the problem was. So I went to a cardiologist and they ran me through a whole battery of tests. Came back and he said hey your heart is fine, no obstruction, no problems, you're good to go. And I asked the cardiologist, well then why do I experience these things during these certain times mainly morning - early morning. I wake up just feeling like I just ran up a flight of stairs. He says maybe you just have too much stress. You know so it kept happening to my brother, he called me and I said well you know Jack I'm experiencing the same thing. He said well you need to go see a sleep doctor. So I did. I went through the sleep study. Surely I had [up] to 32 events in the first 3 hours of sleep. I reported on my medical gone.
unknown	And I'm treating by CPAP so the FAA should look at me and say well now he doesn't have a problem anymore, he's getting restful sleep all these things, but no, and I guarantee I've already talked to multiple pilots and said they will never report to doctors they are having sleep

Speaker	Dialogue
	problems because they know they're going to lose their medical.
unknown	I have a couple comments about the Go incident. They fired the pilots immediately. And the deal is - is they don't pay their pilots very much. Their pilots actually in some cases were sleeping in their cars. I've heard incidents where their pilots would sleep in the airplanes, and one case I heard where there's a pilot who would actually do jump seats to the mainland so he could get meals. Fly to the main land and get a crew meal and then fly back again. They don't pay their pilots enough to be able to get the proper rest that their supposed to get with pilots. And I don't know but I suggest that probably the sleep apnea was/is a problem for this person if it was diagnosed that way but it was exacerbated by the fact that he wasn't getting enough rest just normally.
unknown	So, the deal is though, see the organization's set these guys up, then they fired them - what's the probability that the two pilots that they hired to replace them is going to have the same problem. It didn't solve anything, and the reason that I think the reason that this guy the pilot got diagnosed said and went to the doctor was able to diagnose him with a sleep apnea he was able to get his airmen certificate back.
Katherine Wilson	That was my last slide. Thank you.

Appendix I: Maintenance-related Factors in Alaska Airlines Flight 261
(Ms. Victoria Anderson)

ALASKA AIRLINES

FLIGHT

261

Presented by Victoria Anderson

The Accident

- January 31, 2000, at about 1621 PST 2.7 Miles North of Anacapa Island, CA
- MD-83, N963AS
- 121 Scheduled Passenger Flight
- Diverting into LAX due to a mechanical problem
- Crashed into the Pacific Ocean in an uncontrollable dive
- 5 Crew and 83 passengers fatally injured

PROBABLE CAUSE

- Loss of airplane pitch control resulting from the in-flight failure of the horizontal stabilizer trim system jackscrew assembly's acme nut threads. The thread failure was caused by excessive wear resulting from Alaska Airlines' insufficient lubrication of the jackscrew assembly

Lubrication:
The Procedure

- Gain access to the tail
- Remove access panels

Lubrication:
The Proc

- Apply grease to acme nut fitting with grease gun until grease exits out top of acme nut

Lubrication: The Procedure

- Brush application of "light coat of grease" onto jackscrew threads
- Operate jackscrew "through full range of travel"

Lubrication: Observations

- Differences with method of application
- Small access panel
- Lube of nut fitting only is not adequate
- No inspection req'd
- Recommendations issued, and more proposed

The End Play Check: Background

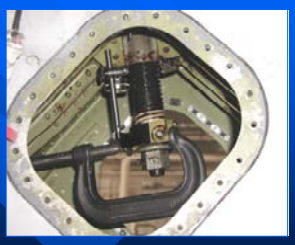
- DC-9 jackscrew life: 30,000 hrs. - No Inspection
- *1965 Sampling program*: Premature wear found during bench checks
- Changes to acme screw & wear limits
- On-wing End Play Check developed in 1967

The End Play Check:
The Procedure

- Move stabilizer to the 1 deg. ANU position
- Remove fairings
- Install restraining fixture between horizontal and vertical stabilizer
  - (*Continued*)

The End Play Check:
Observations

- Installation of dial indicator can affect end play reading



The End Play Check:
Observations

- Dial indicator can be difficult to read

The End Play Check:
Observations

- Working conditions can be adverse

The End Play Check:
Observations

- Restraining fixture condition, torque, and rotation direction can affect reading
- Jackscrew rotation during check can affect reading

QUESTIONS???

Speaker	Dialogue
Vickie Anderson	I'm Vickie Anderson from the FAA's office of accident investigation in Washington AVP-100, I've been doing this since 1994, I've worked 67 major accidents and incidents around the world in that period of time. And believe it or not, a lot of them do come from maintenance failures. Most of the one's that I've been involved with, we've never gotten down far enough, to see that some of things you're talking, the depth and into the weeds [human factors] that you get to or want to get to, we haven't been covering in accident investigation. So it's been very eye opening to me to see what we're missing that we need to be doing. Yes sir.
Unknown	What's your relationship with the NTSB on those?
Vickie Anderson	The NTSB, well in our country, we're the only country that has two government agencies required by law to do accident investigation - the board is the premier agency they're required by law to do probable cause and make safety recommendations. The FAA, under the aviation act of 1958, is required by law to look at our nine areas of responsibility and see if any of those were involved in this accident. Obviously with nine areas of responsibility you can guess we're usually involved, and if so, take appropriate action. We work together on the GO Teams because the FAA's here doing an investigation and the NTSB is over here it doesn't work nearly as well if we're together. So when we're on site, in a major particularly, we're supporting the NTSB but if we see FAA issues we turn that over to another office to start working. Immediately as opposed to waiting until a month down the road.
Unknown	And just a follow-up, if it’s a Boeing aircraft - how does Boeing fit into that picture?
Vickie Anderson	Let's go to Annex 13, Boeing's always going to be a party if it’s a Boeing aircraft, and I say always, there's only one party to the investigation there by law it’s the FAA. Everybody else is there at the invitation of the NTSB, you become a party and you sign a party form, FAA doesn't sign the party form, we're there by law. But you sign a party form and if its International, then the country of occurrence is the lead agency, but the country of manufacturer is Boeing, of course this country takes part, and Boeing goes as technical advisors to the US accredited rep which would come out of the NTSB. Okay.
Unknown	Thank you.
Vickie Anderson	I’m just going to talk to you about the accident that I worked that had the most spectacular maintenance failure that actually brought down an MD80, so we're going to go over it, talk a little bit about the issues. I don't want to run over because everybody else has a lot of good stuff to say too. So, this was Alaska Airlines Flight 261 and probably most of you remember it was caused by a maintenance failure, so it’s one that I still use for this. MD83 was a 121 passenger flight, it was Alaska Airlines flying interim from Puerta Vallarta up to San Francisco. They diverted into Los Angeles due to a mechanical problem, they crashed into the Pacific Ocean in an uncontrollable dive, 5 crew members and 83 passengers were fatally injured, 24 of those were Alaska Airline employees. This is a picture of a jack screw. Probable cause of the accident: Loss of airplane pitch control resulting from the in-flight failure of a horizontal stabilizer, trimmed system, jack screw assembly Acme nut thread. The thread failure was caused by excessive wear resulting from Alaska Airlines insufficient lubrication of the jack screw assembly. Now at the start of this accident, if anybody had said the fact that you didn't grease something on that airplane can bring down the Transport category airplane we wouldn't have believed it. Unfortunately

Speaker	Dialogue
	it's true. In order to keep the design of the jack screw in the Acme nut threads are a such that one component is harder than the other allowing wear. It's a system that works well, it just requires maintenance and lubrication the acme nut, the threads on the acme nut are the wear portion of the two major surfaces, and so you have to change them. Now they wear at a certain rate, normally. So here's the process of lubricating the acme nut and the jack screw which travels through the nut. If you'll see, this an American or Alaska Airlines airplane sitting on the ramp in San Francisco at night, the lighting is very poor in the area, they're in a cherry picker or a whatever else we call those things, up on the tail.
Vickie Anderson	So you have to gain access to the tail to start with, you have to remove the access panel, and we see somebody in daylight removing the access panel, apply grease to the acme nut fitting with a grease gun until grease exits out of the top of the acme nut. And I don't have enough time for me to play the whole procedures for you because we do have it on video and you can go on the NTSB website and play the whole discussion of how the system works and look at the different components. Anyway you put your grease gun into the grease sert. Well the grease sert in this particular aircraft was completely clogged with old dry grease. And the other thing you do is slather grease, actually on the acme on the screw itself, and then run the nut up and down the screw which also lubricates it, those are the two different ways of doing this lubrication process, and you want to put the grease in, until the grease exits out the top of the acme nut. Well, you brush applications, a light coat of grease onto the jack screw thread, and there's your jack screw and then you operate the jack screw through the full range of travel, there's the little access panel you're going to use to get into it. It's night, the wind is blowing on the ramp in San Francisco, you're up on a cherry picker and here's where you're going to go in to lubricate this unit. Small access panel, lube of nut fitting only is not adequate, so basically trying to get the sert into the sert, get the grease gun fit into the sert is practically impossible in these conditions. Now to make you feel better, all of this has been changed. The access is much easier, the process is much easier, after this accident it was all changed, but this is before. No inspection's required. You send somebody out there to grease a component and they go out and grease the component and nobody gets up to see if it actually got greased. Okay recommendations issued and more proposed, this is one of the boards presentations, Jeff Cozetty lead the assistance group on this. So we were immediately extremely concerned with this accident because we knew we had an airplane down and we knew what we were finding. I'm going to show you the first picture. There are the threads, the thing that looks like a slinky on that screw, that's the actual threads that pulled lose when it finally failed. The airplane was flying up the coast, they had a problem on take off with the trim system, it jammed, not unusual on one of these airplanes, there are some procedures 1) you don't use the auto pilot, 2) you do some trouble shooting, it on your check list and then you land the aircraft at the next advisable place at the time. Well this happened on climb out of Porta Vallarta and they really didn't want to fly the airplane all the way up with it in that condition, so they trouble shot, they went way beyond anything that the pilot should ever have done. They called maintenance, maintenance told them to try this, try that, they reset circuit breakers numerous times. There are two ways to command the trans system, there's a pickle switch on the wheel, and then you've got the suitcase handles, well, they used both of them together, they thought that might do it. They could not break it lose, so they kept flying up but they used the auto pilot, so what's happening during the time they're flying up

Speaker	Dialogue
	the coast.
Vickie Anderson	They're constantly putting pressure on the system to move, they keep going, you can understand maybe why they don't go back to Porta Vallarta, there's very little support, there's very little arch support, meaning they don't have the kind of support they need when they have a serious mechanical problem and I don't think they really saw this as being serious at this point, system had been working for 30-40 years without any problems other than jamming at times. So they keep on coming up the coast, well the first thing that happens is they go into a semi-controlled dive and lose 7,000 feet, during the process of the semi-controlled dive is actually when the threads let lose. And it comes up against the stocks, so they they regain control of the airplane, but now they got a real handful of airplane, they are diverting into Los Angeles, the company was still putting pressure on them to go on up, this was an accident that had a million different ways to look at human factors, but anyway they're diverting into Los Angeles, the flight attendant comes up from the back and makes a comment along the lines of, hey when that happened there was a big noise in the back of the airplane, and one of the pilots say yeah we broke the tail. Okay…so do they know the structural integrity of the aircraft at this point? No. The captain decides he wants to go out one more time and try to break the system loose. He even makes the comment I'm going to become a test pilot. And he did. And of course the stocks were never designed to hold the loads. And so they failed and they lost system, they lost their control, went inverted and went into the water. So we [investigators] said, what's going on out there, do we other airplanes that are at risk? So we immediately, I mean immediately within 48 hours, came out with an AD - they required you to go out and check the system and report. We start getting the reports back and we had 9 others and we immediately found that were wearing at an excessive rate. Guess where 8 of them lived?
Vickie Anderson	Alaska Airlines. One did not, one was out on Honolulu where they have very aggressive anti-corrosion program and they were using ruby dust, in this anti-corrosion program and some of that had gotten into the grease and actually accelerated the wear rate. But the rest of them were Alaska Airlines, so then we really started looking at that. Number 1, we took a deep breath, because we didn't have to worry about the whole fleet being out there. But secondly, what was going on with Alaska Airlines airplanes, of course they were all repaired immediately, systems were replaced, things were done, they weren't doing the greasing. Bottom line, simple fact, they were not greasing the system. And so the wear rate was accelerated.
Vickie Anderson	They were signing it off. And at the time, if any of you remember all of the hoop-la, about the time the FBI was investigating them on a whistle blower complaint of falsification of maintenance records. So this one was just a mess. The FAA certainly had part of it because we were not surveying them with enough personnel to do the job at the time. They had a very small certificate management unit within a FSDO and had 5 or 6 people. and that was about it. Six weeks later they had a certificate management office staffed with 26 people so the FAA immediately moved to rectify the system, but by that time, we'd had lost an airplane.
Vickie Anderson	So we're talking about the process, you can see why you wouldn't want to do-- there again we were talking yesterday about personal responsibility, how long, fatigue, all of those things. You're a mechanic, you're signing off something you're not doing. I certainly understand, you probably don't think that the lack of not greasing it one time is going to damage an airplane, but if all of you think the same way, or if somebody else see's you doing it, new person comes in and see's an older guy doing it guess what they're going

Speaker	Dialogue
	to do? So we have a lot of personal responsibility, remember this is coming through an accident investigator who walks through bits and pieces a whole lot of the time. I have zero tolerance for personal failure if you're killing people. Other people are a lot more tolerant than I am. This is where we brought the bits and pieces in. We were at a [Unintelligible] in California, it was great, we had no press to bother us and we had good facilities while the aircraft was in the water, on the left is where you're going to check the parts in, on the right is the temporary morgue set up. This is a SUP SAL supervisor of salvage that's going to get the airplane pieces up were we need. How do you tell whether your system is operating correctly and the wear? Well there's something called an in-plate check. Lets look at the in-plate check. DC9 jack screw arrived 30,000 hours no inspection.
Unknown	None required.
Vickie Anderson	1965 sampling program premature wear found during bench checks. Changes to acme screw and wear limits. On the wing in-plate check developed in 1967, and this is the in-plate check. This is how you run the screw down, and you move the stabilizer to the one degree aircraft nose up position, you remove the bearings you install retaining fixture between the horizontal and vertical stabilizer, and now remember you're up on the top again. The in-plate check then requires the installation of a dial indicator that can affect the in-plate reading. As with a lot of tools that are used, you buy one from the manufacture and it's really expensive and then the airline does reverse engineering and builds the rest of them. Well Alaska had done that, unfortunately they hadn't done the engineering required and so the tool that they designed, the reverse engineer was not correct it didn't give correct readings. Dial indicator can be difficult to read or practically impossible, working conditions can be adverse, and that's the accident. So do we have any questions? Yes sir.
Unknown	Well this is not a question, you and I are the two people who know the most about this accident because I was the guy [unintelligible] that handled all grease questions with regard to the…
Vickie Anderson	Oh then you know all about the air shell and
Unknown	Oh yeah and then we had to develop a new end plate check list because the method you showed, the dial indicator was pointing down, so the mechanic had to read it with a mirror and when you did the process, it didn't reflect the 1 o'clock position it reflected the 11 o'clock position so they had to subtract the number from 1 into correct reading. Well, the accident aircraft, somebody had done the measurements and said it was 41,000th of an inch which is a removal.
Vickie Anderson	Do you know who that person was? The very person, and we didn't know this at the beginning, that had been the whistle blower. He started the FBI investigation, he was actually working. It was a Friday, he did the first, although I remember it a little differently, but you're right on, he did that he recommended that it be replace, he went home another crew came on, it was very easy to get different readings wasn't it?
Unknown	Right.
Vickie Anderson	So the next crew that came on got a 39 - .039.
Unknown	It was just good to go.
Vickie Anderson	Good to go.
Unknown	And failed at a hundred and fifteen the removal rate was 48000 so it was actually a pretty conservative removal.
Vickie Anderson	Yes.

Speaker	Dialogue
Unknown	[unintelligible]
Vickie Anderson	It was.
Unknown	So we had to develop an inplate check where the indicator was right in front of you at that access panel and we had to go up and prove the reliable and valid for the NTSB that's where I met Janet Price when we doing that work.
Vickie Anderson	Yeah we all learned how to slather grease with the NTSB. In the board room, as I remember.
Bill Rankin	Yes, yes
Unknown	From the outcomes of the accident how did they deal with the human factors issues associated with the test pilot mentality of the air crew?
Vickie Anderson	That's a really good question. And that's like I say we can discuss this accident for hours.
Vickie Anderson	There's so much here - there's so much in this one. And I understood everything, I mean, I understood the thought process of the pilots up to you know over shooting, over trouble shooting, they all did that. In the process of the CBR in the middle of it and you never stop a CBR and you never talk about it outside. The Alaska pilot said, stop, we have got to call our company, we have got to tell them to put something out to the pilots, tell them not to trouble shoot past what's on their check list. Because that was a common occurrence we found out. Coming out of Alaska how much did the Bush pilot mentality have to do? We can get the job done and that's what they did and they had some great pilots and this guy tried to fly that airplane upside down. I understood everything he did and why/how it happened, not necessarily agree with it, but I understood it until we got the part where they lost the first 7,000 feet and went semi-uncontrolled. They know now, they heard a big noise, they lost control of the airplane, they don't know the structure integrity of the aircraft, in structural integrity any longer and they don't know what they've got. Why would you ever and the co-pilot says when the captain what's going on here, we're going to go out here and try to unload it one more time, try to get this thing to run and he says oh I don't think so, and I'm paraphrasing, I think we just need to go on in and land this thing the captain says. Oh you think so, yeah, and the next thing you hear is the sound of the flaps moving. And the next thing you hear is the airplane going upside down. So yeah, I think they did. I'm going to let Katherine have anything to say about the human factors, I think Malcomb Brenner was our human factors person at the time.
Dr. Wilson	Exactly. That accident was long before my time although I've read the report.
Unknown	Victoria?
Vickie Anderson	Yes?
Unknown	Maybe to help answer the question about the human factors. I was teaching a course in Albuquerque in accident investigation about 2 years after this accident. A young lady came in, seemed to be fresh out of college, her degree was in human factors and she had been hired by Alaska Airlines to come in and head the human factors effort after this occurred. Now my understanding from talking to mainly ASI's is that she wasn't there very long. I don't know why that was one of the things that they tried to do was, they brought in a human factors expert.
Vickie Anderson	I think you just said something extremely important for human factors people, and I'm no professional but I've listened and what I have thought of is that there are a lot of changes made right after that accident. Human factors people came in, safety became paramount, all of that. What happened 10 years later? A lot of that's gone away. And it went away pretty quickly. Yeah?

Speaker	Dialogue
Unknown	At the time of the re-inspection did they have a replacement part on hand, did they have another jack screw?
Vickie Anderson	Oh another good question. We're not sure about that. We suspect they didn't have one, we suspect that they did not have one and it was going to be several days before they got one delivered and they needed the airplane, that what we suspect.
Unknown	We suspect.
Unknown	But the fact is that - that measurement in fact was not the cause of the accident.
Vickie Anderson	No.
Unknown	unintelligible
Vickie Anderson	Lubrication, and that's the thing to remember, is that something as small as lubrication can bring down a Transport category aircraft.
Unknown	It was actually the pilot that caused the accident?
Vickie Anderson	Well
Unknown	He went beyond his trouble shooting procedures.
Vickie Anderson	Except, yes and we don't know - we don't know that, you can certainly argue that but why did he go out and feel so compelled? Now the airplane is hard to land when you've got a full nose up or a full nose down trim and you can't move it - its like a 737 in full manual version, I've been told its, very much of a handful of airplane. But you trained it that?
Unknown	Right.
Vickie Anderson	So what was his reluctance? I don't know. That's a really good question you know why did he do the things he did? I don't know. Yes sir I'm sorry?
Unknown	Good morning ma'am. What question comes to mind is the pilot obviously went beyond his authority or ability as a test pilot and we're talking about that. But at what point did maintenance dispatch or dispatch, who ever they were talking to at the company, quit supporting that - did they get mental support to continue that from their dispatch
Vickie Anderson	Oh yes - oh yes.
Unknown	And at what point?
Vickie Anderson	From dispatch, from maintenance, from, they asked for a check pilot to come down to give them some advice and they couldn't find one. So all they were dealing with was dispatch and maintenance, and they were getting a lot of pressure to bring the airplane on. There was no discussion about go ahead and land that airplane San Diego, of course they probably wouldn't have picked San Diego, but you know some place coming up the coast.
Unknown	Well the point is you say where do they get the idea to continue this test pilot thing they probably got mental support over the radio.
Vickie Anderson	No, I can tell you for sure. Because everything was recorded - every maintenance call, every dispatch call, they recorded, so we had so information that it was pretty easy to immediately go to the part of the airplane that failed and the structure that failed. Which helped a lot. But now they didn't get any support there, they did pressure all the way up to go onto San Francisco where they had a maintenance base. But the pilot did that on his own for whatever reason. Yes Brian?
Brian Capone	What was the grease compatibility [Unintelligible]?
Vickie Anderson	We did look at that because they had just changed from Mobile 28 to Aero Shell 33 and the only information out there, was an article in a Boeing magazine that talked about it; does a good job, last a long time, cheaper. So boy, Alaska jumped right on that and any airline probably would, although the rest of them didn't. And hadn't at that point. And we thought me might have grease incompatibility. We did a lot of study, we even went

Speaker	Dialogue
	to some fantastic chemists at Pax River Naval Station. They thought that it was 95.5% mixture, which you would kind of expect to see if you put the new grease in and shoved the old grease out, that it was incompatible. But that wasn't really solid so the board put a whole lot of money in gaining a group of chemists out of Chicago I think it was. That did some very extensive testing and we found it wasn't incompatibility that caused the problem.
Vickie Anderson	Okay anybody has anymore or comments.
Unknown	The only comment I'd make is based on a conversation yesterday, on personal responsibility and fatigue - we weren't talking about not performing a maintenance, we aren't talking about knowingly skipping procedures, we were talking about
Vickie Anderson	Being on duty a long time.
Unknown	A mechanic is fatigued, that's a real world situation, and that situation is not going to go away. The ideal would be, to have procedures or measures in place to say, under these fatigue conditions we'd have a second party go out and look to assure that this was done properly?
Vickie Anderson	And sign off yeah.
Unknown	Not just skip.
Vickie Anderson	Right.
Unknown	And that's [unintelligible].
Vickie Anderson	Yeah you're right. But that's where I started talking about personal responsibility there are some areas that I think the mechanic who has the AMP has a personal responsibility to the people on those airplanes.
Unknown	But where in your research, where in the system of Alaskan Airlines did you see where this break down took place and this became a standard of practice, a norm not to [unintelligible].
Vickie Anderson	The break downs were so severe in Alaska, and not just in Alaska Airlines side on the FAA side. The first time I walked into the new office, because once an accident's over we don't stop, we support it all the way through. And I walk into the office up there - there's an empty cubicle and I was going to go in and make a telephone call and there is paper stacked on every surface this high and I went what is all of this. Well this is stuff that we haven't time to get to yet, we needed to approve it for Alaska Airlines.
Unknown	Now did you also look at other procedures that you found that weren't being followed because if you had one like this
Vickie Anderson	Yes - they looked at every single thing, in fact the FAA sent in what they call their hit squad. And they brought a bunch of people together from a lot of different offices and set them in and we were that close to be removing their authority to do maintenance. Once they finished that, they had to put 4 airplanes on the ground because they couldn't prove from looking at the paper work packages that everything had been done that needed to be. Once they got the airplanes on the ground they found that it had been done. But that was a paper work failure.
Unknown	With this and other procedure requirements.
Vickie Anderson	With all kinds of procedures. There were all sorts of problems, I think personally, this is my personal, and I'm not an expert like most of you in this room are, I think an awful lot of it came from, we can get it done, we're the bush pilots, we're going to wear our leather jackets and our white scarves and go out there and we can do this. I think part of it came from that.
Unknown	Was it true because I had heard shortly after this happened that the FAA had given extension on that?
Vickie Anderson	True.
Unknown	Procedure.

Speaker	Dialogue
Vickie Anderson	True.
Unknown	So in essence the FAA kind of played into the role of?
Vickie Anderson	We did, and that's one thing if we go out
Unknown	[unintelligible] says that this is what's required, we're going to give you an extension
Vickie Anderson	Well, now Boeing was okay with the extension too.
Unknown	The lube task was escalated via their approval liability program?
Unknown	Right.
Unknown	And they extended the in-plate check also
Vickie Anderson	Yes the same way. And it was they were
Unknown	unintelligible
Vickie Anderson	Oh yeah it was
Unknown	[unintelligible] did they put a put in something to the FAA office let's say we liked to a extend the lubrication. The FAA doesn't respond in 30 days it's the same thing as saying yes?
Unknown	No, not for a task escalation
Unknown	Well, I think maybe that might have been here they were running at that point.
Unknown	Wow.
Vickie Anderson	Because remember we had very few people, PMI had just retired, the new PMI was down here going through training. They had already had severe issues with operations. They actually had a case where the POI had found falsification of pilot training records. And she had them remove and took some action and the FAA took some action against her. She actually went to court, got her position back and the training pilot came and they had to do their time on the beach. All of that played out, there was all kinds of anomalies going on and that was amazing. Yes sir?
Unknown	Of course Boeing and Airbus held us up for about 2 years because this single system read on an airplane, we'd like to get [unintelligible].
Unknown	That's another problem [Unintelligible]
Unknown	unintelligible
Vickie Anderson	And a fail safe system was not in place.
Unknown	unintelligible
Vickie Anderson	The redundancy on this was two sets of threads.
Unknown	They give [unintelligible].
Vickie Anderson	Well the stops were never designed to hold this load stuff.
Unknown	Right.
Unknown	[unintelligible].
Unknown	You're right if stops hadn't broken off then they still could controlled the airplane [unintelligible].
Vickie Anderson	They couldn't, they couldn't land.
Unknown	[unintelligible].
Unknown	Vickie I have from personal experience I worked for an airline that had many [unintelligible] and MD80's.
Vickie Anderson	You did.
Unknown	And uh
Vickie Anderson	I think remember you many years ago.
Unknown	Yeah.
Unknown	We actually did [unintelligible] but that process really set the mechanic up for failure to begin with.
Vickie Anderson	It did. I agree.
Unknown	In a line environment that should have been a heavy maintenance or hangar [unintelligible] I did a lot of in-plate checks after that because of the

Speaker	Dialogue
	AT's I got to tell you that first, second week of February whenever it was
Vickie Anderson	January what?
Unknown	Up on a cherry picker in Pittsburgh at night
group	talking at once
Vickie Anderson	We were right here on the cherry picker and we literally with the NTSB [unintelligible] and went out there at night in San Francisco up on the cherry picker hanging off, I mean I wasn't even looking for that, I was trying to stay on the cherry picker.
Vickie Anderson	So failures - human factor failures are very interesting. They kill people. They kill a lot of people sometimes. Yes ma'am?
Vickie Anderson	I'm sorry who had their hand up?
group	talking at once
Vickie Stahlberg	Just a procedure in itself, going back and checking the pre-play, looking back at the time I was at Continental and just that simple little thing that you would look at you know thinking then you didn't even need to really look at it because it was so simple and you take a measurement and you subtract or you add it and going through records and that I wasn't focused on just that one, but going back I found so many errors just in their addition or subtraction. Or they were adding where they were suppose to subtract because of the Boeing I guess its some pre-plays subtract and some of it you add and so the mechanic
group	talking at once
Vickie Stahlberg	And they would get it switched, I couldn't believe how many simple little errors like that
Vickie Anderson	It was a system it was attached it was set up for failure from the very beginning.
Unknown	Here's an example we know an accident happened because of this. Last one Delta put the gimble nut that same nut on backward and checked it. We have 6 airplanes that had the gimble nut on back orders its an RII
Vickie Anderson	How is that working for you?
Unknown	It's an AD.
Unknown	Well it was self disclosure.
Vickie Anderson	Did it work?
Unknown	[unintelligible] but even with all these checks and balances and at the end maintain a accident they still put the gimble nut backwards.
Vickie Anderson	Well I go back to thinking and I realize the longer that I've done this 16 years you know when something happens we have 2 or 3 or 4 years where lots of good work is done and lots of things are changed, and attitudes and people are alerted and we start falling back into some of the same thought and behaviors.
Unknown	Like an RII?
Unknown	It was an RII. It still put on back orders.
Vickie Anderson	Okay well yes
Unknown	And that was really my number 1 concern was that the aircraft are not always designed with maintenance in mind. Usually designed with the flight deck crew.
Vickie Anderson	I think if you talk to anybody if you talk to flight attendants, if you talk to mechanics, if you talk to any other group they will tell you that they design airplanes for pilots they don't design them for passengers, flight attendants, mechanics or anybody else. And that's getting better but I think that's what everybody thinks.
Unknown	So I could say that you were right in the old days, now we design airplanes input a CAS system?
Vickie Anderson	Yeah.

Speaker	Dialogue
Unknown	May actually have a human model in the system and we make sure a mechanic can see all the parts, reach them all get the bin tools in to take them out.
Vickie Anderson	Yeah I'm sort of talking about the older airplanes.
Unknown	[unintelligible]
group	talking at once
Vickie Anderson	Yeah.
Vickie Anderson	Okay any more questions. Yes sir Bobby?
Bobby	Comment about your comment Mary. The FAA does have human factors folks in the certification side of the house
Vickie Anderson	They do.
Bobby	They do look at those kind of things when they are approving that stuff. But stuff does get missed I guess.
Vickie Anderson	Yeah and we got old airplanes out there that we didn't do much with and they're still flying so the newer ones I think are much more human friendly.
Unknown	Whatever happened with the human factors issue with the pressure that the principals said they were receiving from the regional office to make things happen for Alaska?
Vickie Anderson	Let’s talk about that off line. Okay.
Unknown	unintelligible
Vickie Anderson	Pardon me?
Unknown	They'd never do that.
Vickie Anderson	Well you know there's pressure, we all know there's all these pressures on our jobs, all of this pressure to get it done it, do it faster, to do it cheaper, to do something. So that's always an issue that's in there. But I will say it certainly was addressed and
Unknown	The only pressure I ever see is to do it right.
Vickie Anderson	That's the kind of pressure you need to see.
Unknown	That I would say would be more typical. If you think you have a different argument you might find be able to sway them other wise. We'll say that in general its just do it right.
Vickie Anderson	Well do it right is what we want.
Unknown	unintelligible
Vickie Anderson	That wasn't what they were getting. Their mechanics weren't getting the do it right portion. At that point. And if anybody had thought, I mean the director of maintenance came down immediately for the accident, he ended up hospitalized. And it was basically an emotional event that he just realized that maintenance had brought down a airplane and killed all those people. Every decision that was ever made was made thinking it would be a safe decision. Nobody made a decision thinking that was going to eventually...
Unknown	So you're saying that the jack screw seized. And that the pilot tried to overcome that?
Vickie Anderson	Uh hum. The motor - the motor jammed or the motor froze up.
Unknown	Seized because of the [unintelligible] screw caught.
Vickie Anderson	Yeah. I have in fact if you'd like you can go online. There is an excellent 5 or 6 minute dissertation by Jeff [Cozetty] its actually online at the board, he explains the the whole system, how to operate, shows it to you, does a cut away, shows what happened when it originally jammed, and all of the failures and when it blew out the top what happened.
Unknown	Yeah I’m familiar with it.
Vickie Anderson	Oh okay. But he explains what happened to the accident airplane and how it worked.
Vickie Anderson	Thank you

Speaker	Dialogue
Dr. Bill Johnson	Thank you very much.

Appendix J: Recent Accidents Involving Maintenance (Mr. Martin Maurino)

Recent Accidents Involving MX

AVS MxHF Leadership Workshop

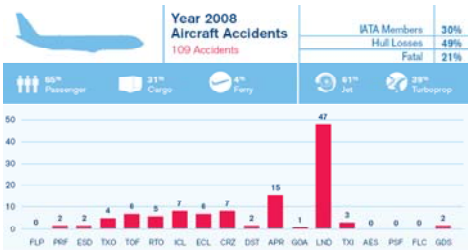
Martin Maurino M.Eng, Civil Aviation Program Manager
Standards Branch, Transport Canada

Canada

Overview

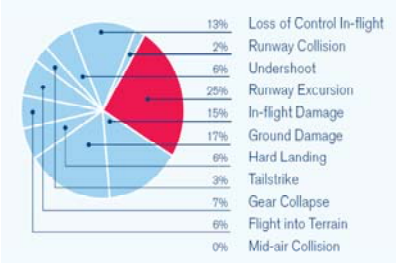
- Overall accident statistics
- MX & accident statistics
- Recent accidents involving MX (2005-2009)

Global Accident Statistics



Source: IATA Safety Report 2008

Breakdown by Accident Categories



Source: IATA Safety Report 2008

Contributing Factors

- Deficiencies in…
  - Operator's Safety Management (30%)
  - Regulatory oversight by State (27%)
  - Operator's MX: SOPs & checking (12%)
- A/C malfunction (42%)
  - Contained engine failure / power plant malfunction
  - Fire / smoke
  - Gear / tire
  - Extensive / uncontained engine failure
- MX events (15%)

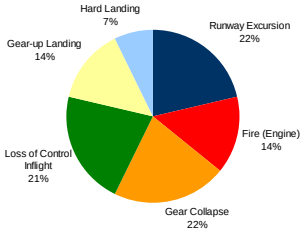
Source: IATA Safety Report 2008

Correlations of Interest

- **69%** of accidents involving SM deficiencies at Operator also involved deficient regulatory oversight by State
- **28%** of accidents involving A/C malfunctions also involved MX events
- In **57%** of accidents involving MX events, deficient MX Organization was also cited as contributing factor

Source: IATA Safety Report 2008

Accident Categories Involving MX



Source: IATA Data 2008
14 accidents

Tuninter 1153: Bari-Djerba
August 06, 2005

Tuninter 1153: Bari-Djerba
Fuel Starvation / Ditching

- ATR-72 was on flight from Italy to Tunisia
- En route, at 15:24 flight crew contacted Palermo for emergency landing
- They informed ATC they ran out of fuel
  - Fuel Quantity Indicator (FQI) showed 1800 kg of fuel
- Flight crew realized they will not make Palermo and ditched in Mediterranean sea around 15:40
- A/C broke up in 3 pieces following impact and cabin submerged
- Out of 39 pax & crew, 16 did not survive

Tuninter 1153: Bari-Djerba
Fuel Starvation / Ditching

- During MX on day prior to accident, FQI was changed
- Erroneously FQI for ATR-42 was installed
- The indication of amount of fuel on board airplane now read 3050 kg instead of 790 kg
- On August 6 A/C was prepared for flight to Bari, Italy
- 465 kg of fuel added for flight to Italy
  - *Actual total fuel: 1255 kg>>3800 kg indicated*
- Upon arrival at Bari only 305 kg were left in tanks
- Should have triggered 'LO LVL' warning but FQI read 2300 kg
- Flight crew believe they had plenty of fuel left
- In preparation for flight to Djerba, just 265 kg of fuel were added
  - Flight departed with *fuel indicated: 2700 kg>>actual amount: 570 kg*

Helios Airways 522: Larnaca-Athens
August 14, 2005

Helios Airways 522: Larnaca-Athens
Failure to Pressurize / Loss of Control In-flight

- At 09:07L, B737-300 departed for Prague with stopover in Athens
- As A/C climbed passed 10,000 feet, cabin altitude alert horn sounded
- Flight crew thought it was erroneous TOF configuration warning
- At 14,000 feet, oxygen masks automatically deployed
  - Master caution light illuminated in cockpit
- Due to lack of cooling air, alarm activated indicating temperature warning for avionics bay
- Distracted by high workload, both pilots succumb to hypoxia
- A/C continued flight on A/P and entered holding pattern over Athens
- Eventually suffered flameout and impacted terrain
- All 116 pax/5 crew fatally injured

Helios Airways 522: Larnaca-Athens
Failure to Pressurize / Loss of Control In-flight

- B737-300 underwent MX on night prior to accident
- Pressurization system was checked
- After completion of tests, Pressurization Mode Selector (PMS) left in "Manual" instead of "Auto" mode
- Outflow valves were 1/3 in open position
  - Cabin failed to pressurize after TOF
- PMS mode not noted during pre-departure checks by flight crew

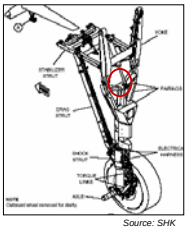
SAS Flights 1209 / 2748 / 2867
September 09, 12 & October 27, 2007

SAS Flights 1209 / 2748 / 2867
Gear Failure Accidents

- In Fall of 2007, SAS experienced series of gear failure accidents
- Commuter flights in Europe
- All 3 accidents involved Dash 8-Q400
- Gear problems prior to LND
  - Gear unsafe indication
- 1st & 2nd accidents: Gear collapsed on touch down
- 3rd accident: gear partially extended
- Emergency LND carried out
- Pax/crew evacuated >>No serious injuries

SAS 1209 / 2748
Gear Collapse on Landing

- Examination of internal threads of retraction/extension actuator piston revealed corrosion
- Led to separation of rod end from piston
- Contributed to gear collapse



Source: SHK

SAS 2867
Gear-up Landing

- Mechanical Sequence Valve (MSV) designed so impossible for O-ring to pass through MSV on its way from SSV down port to the MLG Retraction/Extension Actuator Retract Port Restrictor
  - However, MSV replaced on 22nd October 2007
- SAS MX had only NLG MSV's on stock
  - MSV supplied from stock on 22nd October 2007 was NLG MSV having Reducers installed to fit NLG
- Info given by both manufacturer and operator computerized data system was unclear and misleading to MX personnel
  - Misleading MX personnel to reconfigure delivered Authorized Release Certificate approved NLG MSV to fit the MLG MSV
- There were no procedures available for reconfiguring MSV

SAS 2867
Gear-up Landing

- For that reason by a MX action, rogue O-ring was transferred from SSV side of hydraulic line to Actuator side of hydraulic line while trapped inside Union when Unions from removed MSV Valve Body were reused on NLG MSV to fit MLG
- It was not observed that O-ring was trapped inside one of reused Unions
- Thorough inspection of Unions according to defined inspection procedure might have led to finding rogue O-ring
  - but MX personnel had no procedures available
- MLG Retraction/Extension Actuator had no protection against hydraulic fluid contamination
- At given time during retraction of MLG, O-ring was able to enter Retract Port Restrictor of Actuator
- Trapped inside restrictor, O-ring was damaged & cut into several pieces

SAS 2867
Gear-up Landing

- On accident flight during extension, right MLG extension fluid flow had enough flow to force part of damaged O-ring through small orifice hole in floating valve in Retract Port Restrictor
  - which blocked off hydraulic fluid flow
- MLG Retraction/Extension Actuator was hydraulically locked by blocked Retract Port Restrictor
  - which caused right MLG to be stuck
- In this situation, it was not possible to extend right MLG

Source: Danish AIB

United Airlines 267: Denver-Jackson
February 25, 2008

United Airlines 267: Denver-Jackson
Runway Excursion on Landing

- At 21:16 MST, UA A320 departed right side of RWY19 during LND at Jackson Hole Airport
- 119 passengers/6 crew evacuated via slides>>No serious injuries
- Both engines ingested snow & sustained internal damage
- Left MLG brake system revealed inboard & outboard wheel speed tachometer wires were cross-connected
  - Likely to cause antiskid system to use inboard wheel speed to control outboard braking, and vice versa
- In such a situation, it would be likely that when inboard tire began to skid, antiskid system would release pressure on outboard brake instead of inboard brake.
- Examination of MX records indicated that both MLG units were replaced in early February 2008

Air India 717: Mumbai-Dubai
May 16, 2008

Air India 717: Mumbai-Dubai
Inadvertent Gear Retraction

- AI B777-200ER suffered NLG collapse while parked at gate just before boarding
- No injuries
- Pax were brought to Dubai with replacement A/C
- At time of gear collapse, 4 engineers were performing inspection
  - 1 in cockpit & 3 on ground
- Gear handle was put into gear up position
- However gear pin was not inserted in nose gear strut
  - To prevent actual retraction of gear

AIRES Colombia 051: Curacao-Barranquilla
August 23, 2008

AIRES Colombia 051: Curacao-Barranquilla
Gear Collapse on Landing

- Following normal APR, A/C right MLG collapsed on LND at 17:15L
- 26 pax/5 crew>>No injuries
- Entire right MLG Drag Strut Assembly overhauled on March 3rd 2008 at premises of contractor
- Actual MX manual used by contractor did not correspond to current version of document
- AD-2006-14 was therefore not implemented by repair facility
- Detail invoice for repair does not mention replacement of top ring (which fractured) as would have been required by AD
- CAC released final report concluding probable cause :
  - *Mechanical fracture of shock absorber of right MLG which disabled gear structure to take LND load*
  - *Fracture occurred because of non-implementation of AD-2006-14 during MX of gear*

Perimeter 640: Manitoba-Winnipeg
March 03, 2009

Perimeter 640: Manitoba-Winnipeg
Gear-up Landing

- On final APR into Winnipeg, LG was selected down, but right MLG did not extend
- Flight crew carried out missed APR, declared emergency & entered holding pattern to attempt gear extension
- Gear could not be extended by either normal or emergency methods
- Crew elected to conduct gear-up LND
- A/C was evacuated
- 8 pax/2 crew onboard>>no injuries reported
- A/C sustained substantial damage to its propellers, flaps, and aft belly area

Perimeter 640: Manitoba-Winnipeg
Gear-up Landing

TSB investigation findings

- Right MLG door was incorrectly rigged, which reduced clearance between tire and gear door during gear extension
- Mis-rigged door likely went unnoticed through four separate inspections
- Combined effect of *mis-rigged gear door, installation of a new re-capped tire with large dimensions, growing free play in gear door bushings/linkage arrangement, and air loading on gear door* reduced clearances sufficiently that number 3 tire caught on ledge on inboard door skin, preventing right MLG from extending
- Note: absence of MX record for work carried out

Perimeter 640: Manitoba-Winnipeg
Gear-up Landing

Summary

- MX events contributed to 15% of accidents in 2008
- Gear-up LND/Gear Collapse main categories
- Recent accidents/incidents:
  - Mx Human Factors
  - Organizational issues (including SOPs and documentation)
  - Design

Speaker	Dialogue
Martin Maurino	When I was talking to Bill about coming down here and what Transport is going to present, I had mentioned that when I was at IATA I was in charge of our annual system report and all our accidents statistics. So we didn't honestly go to crash sites but we did work with the manufacturers, with the airlines and we did regionally trending, global trending, and looking at accidents. So what I suggested to Bill, is presenting something that I have seen at IATA that relates to maintenance because one of the critiques I had at Transport Canada when they looked at our human factors training is that a lot of the examples we use are generally old accidents from the 70's, from the 80's, you know, where its CRM where the flight engineer tells the captain and things like that which are a bit outdated. So what I want to look at today is really maintenance accident that don't go past 5 years ago. Because there's still a lot out there. What I'll do is I'll just start with a quick overview of accident statistics that I have from IATA to show you overall how maintenance related accidents are playing out world wide. And then we'll look at some recent cases. So this is from 2008 statistics, and this is just an overview. In that year there were 109 commercial air transport accidents, these are all operational at our passenger cargo or ferry flights. I have a breakdown here 65% of them are passengers, 1% cargo, 4% ferry 61% on jets, 39% on turbo, and almost 1/2 of those were hull loses and almost a quarter were fatal, and since they're operational you see the breakdown which is very typically of approach and landing or places where there's been the most accidents.
Martin Maurino	For the test that same year accidents by category of course, keep mind this is very flight OPS oriented, but we'll get to maintenance afterwards. Runway incursions are the top accident category with 25%, and then typically everybody see's about the same kind of trend, ground damage is up there as well and lost of control in flight and then you can make your way down. Notice that here, I think, gear collapsed overall was only 7% of all accidents, but we'll see in maintenance that's the next one that comes up often. So when we ask you to look and some of the contributing factors we have a taxonomy that we classify the accidents with, so this is overall all accidents we saw that in 30% of accidents we saw there was deficiencies with the air operator safety management so whether they have an SMS or not we're looking at those kind of SMS style components like a flight safety program, quality assurance and things like that.
Martin Maurino	Regulatory oversight deficiencies in all reported accidents that oversight by the state where the aircraft is registered. Another interesting thing we looked at, we looked at not just individual pilot errors, or flight attendant errors, or maintenance errors but we looked at the overall organization in terms of SOP's, training for that, flight cargo dispatch etc. So in 12% of overall accidents we found that the maintenance organization at the air operator had deficiencies with their SOP's [unintelligible]. Overall that year 42% of accidents were related to aircraft malfunction and you see the breakdown there. [unintelligible] being the main one and gears in the top three. And overall 15% of accidents that year had a contributing factor, maintenance event which usually means errors by aircraft mechanics.
Bill Rankin	So Martin that 42% and that 15% are independent numbers so none of those aircrafts malfunctioned?
Martin Maurino	No - no these can get fit into here. Yeah there all intertwining and obviously you can link maintenance errors to the maintenance organization. But in all those aircraft malfunctions we didn't necessarily pin point a maintenance error.
Martin Maurino	And so the next thing we did, which relates to your question Bill, is we

Speaker	Dialogue
	looked at correlations between those different contributing factors and how they tie together. So in almost 70% of accidents where we had safety efficiencies at the airline we also had regulatory oversight deficiencies and then you think of places this is international data so like Indonesia, places in Africa, and South America we own this so maybe get that much in North America. 28% of accidents involving aircraft malfunctions also had maintenance events maintenance errors that were attributed. And in 57% of accidents where really had mechanics making errors we also had deficiencies at the level of the maintenance organization instead of the contributing factors so there you see the two come together.
Bill Rankin	Which year is this?
Martin Maurino	2008
Martin Maurino	Its all accidents that occurred in 2008.
Martin Maurino	Now what I did for this meeting I asked IATA to send me the data where we had maintenance errors sighted in them or maintenance related factors which was 14 accidents and they did a break down like we saw for overall flight OPS the kind of accident categories that we can relate those maintenance events to and then you see the break down here. I separated gear up landing gear collapse although we tend to put them together but just to be more specific so if you put those together you see how well over 1/3 of the accidents that's the final outcome, then you'll have runway incursions, lose of control in-flight, fire which relates to engine and hard landing.
Martin Maurino	Okay I'm going to go through a couple of cases I won't go into too much detail my idea was just to give you a couple of examples. I've written out a lot more in this slides then what I'll talk to I'm not aircraft mechanic so I'll give you sort of the layman's explanation for some of these. But Joy has a power point and she'll distribute so its something that if you want you can use as examples in and I also thought in terms of human factors training it can be interesting. So the first one happened in 2005, its a Tunis Air, which is a regional feeder for Tunis Air the legacy carrier of Tunisia. And a flight from Italy to back to Tunisia. So it an ATR-72, they're flying from Palermo its sort of holiday tourists flight out to the Tunisian coast, they declared an emergency not too long after having departed Italy they informed ATC that they're actually out of fuel so they went down, both engines had stopped working however their fuel pump indicators show they have 1800 kilograms, sorry we're in metric system in Canada, and the crew realize they're not going to make it back to the mainland so they decide they are going to ditch into the Mediterranean, when they do the cabin breaks up into pieces and 16 people don't survived. This is a landmark case, because the pilots were tried in Italy. I know they made a big deal of that stuff, as well as the mechanics, but I know the captain's in prison. Yeah it was an international big thing because he started praying before the ditching. So it was a case of fuel starvation. How this played out was that the day before the accident they had undergone maintenance and they had actually taken, and yesterday we were talking about design, and sort of airplane design you can take a FQI from an HR42 to an easily fit into a 72 without realizing it. There the parts are interchangeable and that's what the guy did. So anyway you guys understand the fuel systems more than me so its gave us erroneous indication obviously because it was an HR72 that it was fit into. So they would read the 3,000 kilograms instead of 790 which is what they had. So they fuel the plane they think they have 3800 kilograms when they actually have 1,200 or so, the flight leaves for Italy,

Speaker	Dialogue
	they land at the turn around when they arrive they only have 205 kilograms left which should of triggered a low level warning but because they have the wrong FQI fitted it doesn't, the plane thinks it has a lot more fuel then it does so since the flight crew thinks they're pretty full they decide to head out anyway thinking they have 2700 kilograms of fuel which is indicated when in fact they have 507.
Unknown	Was it the wrong one or was it an inoperative one?
Martin Maurino	No they fit a ATR42 indicator into a 72 so it was the wrong piece that was fit in there.
Unknown	Okay so wrong piece of equipment was installed?
Martin Maurino	Yes correct. Yeah. So anyways this explains why they ran out of fuel. I think EASA ordered an inspection of ATR's, I don't know if American Eagle as a large ATR fleet so, I don't know if this reached you guys here in the states but I know in Europe…
Unknown	Taking notes.
Martin Maurino	The reports are in Italian but there are some translations.
Martin Maurino	Anyway so that's one. The next one maybe you'll know because that's more of an infamous one which is [Hellis Airways] also in 2005 a very bad year by the way. Yeah
Unknown	So before you go to the last one, we usually don't do criminal prosecution in the United States for this kind of thing, so what was the basis for putting the captain in prison?
Unknown	It wasn't in the United States.
Martin Maurino	No. They tell us to pick on that because I don't know if you remember in 2001 SAS had a collision in Milan where they were cleared to take off in fog and a citation was crossing them the airport director was put into prison. So was the controller.
Unknown	[unintelligible] Isn't it a Napoleonic code for law and so it's Italy, its France a lot of the European countries and they do go after you more than [unintelligible].
Martin Maurino	[unintelligible]
Unknown	I mean I understand that they go after them but I was just wondering
Martin Maurino	Yeah. I don't remember the whole story but it has to do with the fact that supposedly and during the last minutes when they were about to ditch the captain was supposedly was panic and then instead of following the ditching procedures started praying to Allah which then the Tunisians say no its just like the Egypt Air thing its just a normal thing you would say it doesn't mean that you have to stop working and so I think that was the basis of. And I think they went after the mechanics to I can't recall.
Dr. Bill Johnson	[unintelligible] have been that the relied on instrumentation without really knowing their own fuel calculations and not a lot fuel loaded, a lot of fuel burned.
Martin Maurino	You'll have the reading what they actually saw versus what was actually in the tanks.
Dr. Bill Johnson	I do know there is so much written on this report in the aviation magazine's and it’s a really good final report as well. [unintelligible]
Martin Maurino	And they made a video and I haven't seen but it may be on the Discovery Channel, I think, where they do the re-creations I think they did a video on there.
Martin Maurino	But I know it if I said this well I pushed a lot because of criminalizing the pilots.
Dr. Bill Johnson	That's correct
Martin Maurino	And in Italy I have this question when I got to Transport and they said no. Not in Canada we really don't do that kind of thing but some of the

Speaker	Dialogue
	European countries its not [unintelligible].
Unknown	And its not just European
Martin Maurino	And they were mostly I think there were mostly Italians onboard and they were going like a vacation spot they were going to so.
Unknown	Didn't do anything to the mechanic?
Martin Maurino	I can't recall I think - I think yes. I think the director of maintenance was sort of in the net as well of the people that they tried. I'm trying to remember but I think the trial is already over I think the captain's already in prison.
Martin Maurino	So the next one is Helios airways. Yeah so that was just a bit after this one, it was a pretty bad summer there's about 5 or 6 crashes we had in Toronto the Air Trans accident the same summer up in Toronto. So basically this was a low cost carrier with about 3 aircraft I think, all 73's. It was just a morning flight they were going from [Larnika] in Cypress to Czeh Republic with a stop over in Athens. Takeoff everything goes fine, they're passing 10,000 feet and they get the altitude alert horn that goes off in the cockpit, and then there's a lot of issues in terms of this airline of how they selected the crews, and their training, the captain was German and didn't speak a lot of English and the 1st officer was from Cypress because of some rule that they had to have national so there's a whole other story behind it but basically, and he had flown Soviet planes before the captain so it wasn't that good on the Western types, so anyway basically they don't realize what's going on. They think its the take off horn which of course it can't be because they're airbourne and actually its interesting that you had mentioned this and Dave [Carlisle] had mentioned is that they start trouble shooting inflight and I know that was a concern for Boeing in terms of how far do you go? They called the based in [Lernika] and was wandering what was going on at some point the captain was fed up so he got up and started pulling circuit breakers that's why he wasn't in the seat when the jets Hellinck Air Force reached them. Although its hell going on in the cabin the air jumbo comes down he really puts on the mask and there's a cabin issue as well as the flight attendants don't actually contact the cockpit to tell them what's going on. But because they continue to climb then all other bells and whistles go off in the cabin so their over worked they don't know what's going on, so there's a lot of work load issue here, and while their being distracted by everything and what not they both succumb to hypoxia, the plane's on auto pilot so it flies itself to Athens as its suppose to do, it enters a holding pattern, and eventually, obviously, because they had plan, it was about a 45 minute plan, at this point that had been going for awhile, both engines run out of fuel and they crash so there's 121 fatalities, it was the worst accident in Greek history.
Martin Maurino	And the airlines since then has gone bankrupt. So the night before the accident the aircraft had undergone maintenance and they had pressurization system checks there was a history of the plane having pressurization problems, flight attendants had complained I think just a couple of days earlier they heard hissing from R2 or L2, so I think maybe what this is about, so the mechanic completed the test but left the PMS and manual instead of auto. So the out flow value was 1/3 in opened position which explains why they actually didn't lose cabin pressure they never pressurized to begin with, and this wasn't captured by the flight crew.
Unknown	Isn't that on the [unintelligible]
Unknown	Yes. Two or three times.
Dr. Bill Johnson	Yeah.
Unknown	Well they didn't check it.

Speaker	Dialogue
Unknown	Yeah.
Unknown	Thought it was [unintelligible].
Martin Maurino	And actually Bill we're talking about this Boeing accident yet then he made interesting point that when you're looking at the report that Greek NTSB put out, that's as far as you're going to get in terms of the maintenance problem, there's a lot more focus in terms of the flight crew and the cabin crew. Well yes how do you shoot some recommendations because they continue to climb and the cabin crew never called them. Its called the flight plan
Unknown	You call it the yellow jumbo or the orange jumbo?
Unknown	I haven't heard that [unintelligible].
Martin Maurino	The yellow.
Unknown	Yellow jumbo?
Martin Maurino	Yeah.
Unknown	Okay.
Unknown	The orange jumbo over here [unintelligible].
Martin Maurino	unintelligible
Martin Maurino	So that takes for that one.
Unknown	Can I ask a question?
Martin Maurino	Yeah go ahead.
Unknown	Just to clarify - what's the role of the US FAA or NTSB when it's a international accident with the American product. Vickie Anderson answers: Under annex 13 of ICAO's that's the annex that builds an accident investigation internationally the country of occurrence is only agency. So the country incurred is going to leave the investigation the country of manufacturers, certification, and you get down into engine manufacturer and amount of citizens are asked to take place. There were 4 in the US or appointed US accredited rep who will be a NTSB investigator in turn he will take people from Boeing say Pratt-Whitney engines and one of us will travel with him as the FAA technical advisor, we'll all travel as technical advisors to the US accredited rep. And because it's on US manufactured aircraft we have continued air worthiness responsibility.
Vickie Anderson	Under annex 13 of ICAO's, that's the annex that builds an accident investigation internationally, the country of occurrence is the lead agency. So the country occurrence is going to leave the investigation, the country of manufacturer, certification, and you get down into engine manufacturer and amount of citizens are asked to take place. They will appoint a US accredited rep who will be an NTSB investigator, in turn he will take people from Boeing, say Pratt-Whitney engines and one of us will travel with him as the FAA technical advisor, we'll all travel as technical advisors to the US accredited rep. And because it's our US manufactured aircraft we have continued air worthiness responsibility.
Unknown	And both [unintelligible] was part of this.
Unknown	Pardon me?
Dr. Bill Johnson	unintelligible
Unknown	Yeah.
Martin Maurino	Okay our next ones a little more technical so I actually written it down in full but I'll just give you a quick overview and you guys can keep it. It's a series of accidents and Transport was involved in this because they are Bombardier aircraft some Canadian aircraft. Scandonavian Airlines in [Nepaul] had a series of accidents and actually very close in September 9, 12 and October 27 so its the pictures. You can see that they're all sort of identical with the right gear collapsed on landing. These are all commuter

Speaker	Dialogue
	flights for SAS so going around the Scandonavian countries all three were dash 8 Q-400 aircraft all three had a similar scenario in the sense that park landing they got a gear unsafe indication in the cockpit. In the first and second accidents the gear collapsed on touchdown we'll see after there actually copy cat accidents of one another. And then the third accident the gear partially extended and so they couldn't go any further they had to go gear up landing. So all three had emergency landing, and there was no serious injuries in any of them although they were lucky in the first one the flight attendants moved passengers and the blade actually went into the cabin. So
Unknown	This was the same carrier, same malfunction how short a timeframe?
Martin Maurino	Within it started September 9 those are like really three days apart and the last one was October 27.
Unknown	Wow I would blame their oversight authority on that one.
Martin Maurino	Yeah.
Martin Maurino	[Unintelligible] Bombardier and Bombardier at them. So the first two accidents were actually like I said they were copy cat accidents of one another. And basically had to do with corrosion. So you see here that they examined the internal threats and there was corrosion which led to a separation of the rod and from the piston that's how the gear collapsed. So it had to with the fact that they weren't doing checks for corrosion so these were both identical accidents. The one that I'll go into a little more into detail that's interesting is the third one is actually different from the first two. Now what happened is after the first two accidents they grounded the entire fleet, when they realized it was corrosion they started doing checks and ironically this was one of I think six aircrafts that was actually put back into service because it didn't have a corrosion problem and then it had the accident. Now what happened in Europe you have the whole text I want to try explain those systems cause I don't understand myself. But basically what they did, they had a problem with having parts in stock at SAS so they were doing a maintenance on the main gear and they didn't have the part they needed to they figured we have parts of the nose gear we can just modify them and put them in the main gear. Which they weren't doing as a violation it was sort of understood within the company because they misunderstood Bombardier communication and all that this was actually okay that they can just sort of modify it and stick it in there and it would be good to go. Which is what they did and then you guys can have this to go over you have some other [unintelligible]. No this wasn't something Bomardier agreed with on paper they didn't know it was going on. Then it came out after that the company had a history of [unintelligible] misunderstanding documentation. So by doing so an O ring that was inside the piece that they modified actually migrated, this had to do with tighten the gears so the aircraft kept flying, the O ring migrate up to there and basically lodged itself blocking hydraulic fluid which explains why the gear wouldn't come down. So this is actually the real explanation. Had they done inspections they could have found the O ring but they didn't have inspections in place so that also explains why it wasn't detected. And then so basically they have the accident as the gear extended the fluid flow was restricted by the O ring and this is why they couldn't unlock the gear. So here you have the O ring and you can see it shredded as it came off and how it actually jammed. Interesting enough it wasn't the only aircraft they did this to so after this accident they then grounded the entire fleet and found that two other aircraft had - had the same procedure done so they would have actually encountered the same accidents two other times. It was a big deal for the company, you know if there's a lot of press in terms

Speaker	Dialogue
	of their maintenance was precisely a Swedish authorities and as a result they have actually withdrawn which was a big thing at the time. When the third accident happened they withdrew the entire fleet. And they sold them all out. So they no longer operate that aircraft type. But then Bomardier gave them a couple of CRJ's and now there all good.
group	laughter
Martin Maurino	This is the only American one that I think which you guys quite know is in United accident that I've been at Jackson Hole in 2008.
Unknown	unintelligible
Martin Maurino	It was NTSB investigated so I'm sure you guys know about more than me. On a domestic flight they landed at Jackson Hole which from what I understand is a ski resort. 119 passengers, 6 crew they landed they couldn't come to a stop, they went off the runway, everybody went out via slides no real injury, the aircraft was substantially damaged in just the snow. And basically what happened here is that the tachometers had been inversed. The aircraft had undergone maintenance earlier that month and the mechanics actually did [inverse] which I think [unintelligible]. And I think this had to do also with documentation and how clear the actual documents are but you can very easily inverse this. I don't know if you guys have some in terms of this one. And that's how United explained it to us.
Unknown	Yeah.
Martin Maurino	And - now this one I think the picture kind of tells the story but I put in there because I would actually see come up every couple of years before and Lufthanza had a similar one a couple of years before. This was an Air India Triple 7200 that was going from India to the UAE. They were parked at the gate before boarding, and basically what happened is there was 4 mechanics performing inspection, 1 in the cockpit, 3 on the ground, gear handle was put into gear up position however, then put the pin into the nose gear strut, so the gear retracted itself.
Martin Maurino	I mean its typical omission. The next one, another dash 8 from the Arias Columbia which is a small company they fly to the US now in Florida. They were on a trip from the Caribbean into Columbia. Normal approach they touched down and then at that point the right landing gear collapses, nobody gets injured they just deplane. The entire struts and we have in overhaul just a couple of months before it was actually outsourced maintenance that was done by a contractor in Miami and the company's based in Columbia. There was an [AD] that had been issued but was actually not in the maintenance manual used by the contractor, they didn't have the current version so the AD wasn't implemented. So when the Colombian authorities determined as the cause was that there's a mechanical fracture of shock absorber of the right main landing gear, which disabled the gear structure and to take the landing load and this occurred because of the non implementation of the AD during a maintenance of the gear. And what I find interesting in this case and what I put in there and I would see this often in IATA is that especially when you're outsourced maintenance, airlines tend to kind of do that, and there's no real follow-up. Because this was outsourced to an American company and the airlines here as well. I guess they know what their doing. And a lot of times when we speak also in large carriers you know the safety side will say we don't we have no clue what's going on in the maintenance inside of that company.
Unknown	Not in this country.
Martin Maurino	Hmm?

Speaker	Dialogue
Unknown	Not in this country.
Martin Maurino	I've been told that by US experience as well.
Unknown	This is like that attitude.
Unknown	You got data to support that because I'll have to repute that one [unintelligible] that they said we say we sent people down there, providing considerable oversight of the MRO's and Delta puts onsite people so I don't know where you got your stats but
Martin Maurino	I was told that by a common accident in the US air I was told that they don't investigate on the safety side of the house they don't need.
Unknown	Their responsible for everything they send out.
Unknown	Yeah.
Martin Maurino	Yeah. Yeah exactly, But yeah not always good. [unintelligible].
Martin Maurino	And the last one is actually a Canadian I figured I'll give you one from Canada which happened early last year. Perimeter Airlines and a domestic flight. They were on final to Winnipeg landing gear was lifted down but the main gear didn't extend, they go around, they declare an emergency, they try to get the gear down, it doesn't happen so finally they have an emergency landing, evacuate there's no real injuries but the aircraft is pretty banged up. Our [TFV] findings basically the right main landing gear door was incorrectly rigged and this made the clearance between the tire and gear door wasn't sufficient from the extension and you have sort of more detail there. And one problem we had with this company is that there was a lot of unrecorded maintenance so it was hard to back track.
Unknown	What type of airplane was that?
Martin Maurino	Its uh
Unknown	Lear Jet?
Martin Maurino	No. It's Metro Liner
Unknown	unintelligible
Martin Maurino	So just as a summary in terms of statistics and we usually see about the same amount about 13, 14, 15% every year when we're looking at operational accidents will see a maintenance - maintenance errors in there. In terms of maintenance and you saw - I tried to cover pretty much all the categories we had a runway incursion, we had a lose of control in-flight, stuff like that, but you saw gear up and gear collapse seems to be the main category that pop-up where we can link operational accidents to maintenance problems and you saw that in these recent accidents we have human factors in terms of maintenance that have come into play. Like the slips and errors, like the Air India, organizational issues including SOP documentation like this Perimeter Airline and design like the ATR. So you have the full presentation so you can actually get the full stories and they're all published reports so you can look these up if you want all of the details. Thank you.

Appendix K: The Technical Community Requirements Group (TCRG) Process (Dr. Bill Johnson)

Technical Community Requirements Group (TCRG)

Dr. William B. Johnson
Chief Scientific & Technical Advisor for Human Factors in A/C Maintenance Systems

AVS Mx Human Factors Leaders' Workshop
Civil Aerospace Medical institu

AVS Mx Human Factors Leaders' Workshop
Civil Aerospace Medical Institute
August 4 - 5, 2010

Presentation Goals Today

- Overview FAA R&D Process
- Describe example HF R&D Topics
- Funding and Success Criteria for Mx HF R&D
- Discussion

FAA Lines of Business Define FAA R&D

- Air Traffic Organization (ATO)
- Aviation Safety (AVS)
- Airports (ARP)
- Aviation Policy, Planning and Environment (AEP)
- Commercial Space Transportation (AST)

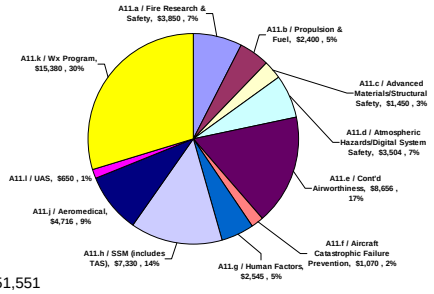
AVS FY12 Process Summary

95 requirements submitted

Cost estimates requested for 62 requirements

50 requirements in funding plan

FY12 Aviation Safety RE&D Contracts



Total - $51,551

Example Continued Airworthiness R&D

FY 2012 Requirement	Proposed FY2012 Budget
Health Monitoring of Composite Structures and Complex Flight Critical Systems	1,000
Stall Departure Identification, Recognition and Recovery	500
Flight Critical Systems Design Assurance: Phase 2	206
General Aviation - Automation & Envelope Protection	200
Envelope Awareness and Protection Legacy Transport Airplanes	150
Advanced NDI Methods for Composite Structures	2,000
NDE for Critical Engine Components	900
Health and Usage Monitoring System (HUMS)	1000
Advanced Control Systems	150
Risk Assessment and Risk Management Methods for Small and Transport Airplane COS	1,200
MMPDS	100
Damage Tolerance and Durability Issues for Emerging Technologies	950
Emerging Technology - Probabilistic Loads, Strength, Flutter and Aeroservoelastic Predictions	300
	8,656

Example Flight Deck / Maintenance Human Factors

FY 2012 Requirement	Proposed FY2012 Budget
Flight Training Methods for Jet Upset Prevention, Detection and Recovery	200
ADS-B Human Factors – AIR & AFS Equipment Design, Evaluation, and Operational Approval Guidance	400
Avionics: EFB, moving maps, & multi-function display issues	720
Unmanned Aircraft System (UAS) – Control Station Human Factors Considerations	360
Pilot System Interface and Human Factors Issues, and Guidance for the Certification of Advanced Autopilots & Related Automation Technologies in General Aviation Airplanes	425
Head Up & Head-mounted Displays: certification requirements and operational approval criteria	440
	2,545

Example Mx HF Activities

- Fatigue Risk Management
- Maintenance and Ramp Line Operations Safety Assurance
- Extensive Training for FAA Aviation Safety Inspectors
- Recurrent for Inspection Authorization Certificates
- HF Ops Manuals for Maintenance, Ramps, Airports
- The Maintenance Human Factors Training System
- Support of Aviation Safety Action Program
- Looking to the Future of Aviation Maintenance/Engineering

On-Going and Future R&D

- Fatigue Risk Management
- LOSA
- Future of Maintenance/Engineering (including Next Gen)
- Addressing Technical Documentation
- Knowledge Capture of Senior Personnel
- Cost-Effectiveness of Mx HF Programs

Successful Flight Standards R&D must:

- Be aligned with FAA organizational objectives
- Capitalize on existing basic scientific research
- Deliver applied useable products/processes
- Cooperate with aviation/airline industry committees
- Strive to demonstrate the safety and cost payback

Simplified Version of How R&D is Allocated (According to the written process)

- Requirements are generated by field personnel
- TCRG committee members take field ideas to TCRG for prioritization (You will use the process in the small group activity)
- The Research and Engineering Management Team (REDMT) selects which projects will be funded
- All projects must be defended on an annual basis

Questions - Discussion

Three Small Group Activities

1. Define Evolving MxHF Challenges & Solution Approaches (Immediate, Mid and Long Range)

2. Create an Example R&D Justification for TCRG

3. Initiatives to Extend MxHF beyond Training

Activity 1: HF Challenges & Solution Approaches

Identify three challenges related to Mx HF for the immediate (present to 3 years), (mid-term 4-6years) and (long-term beyond 6 years. For each challenge suggest a program to address the challenge.

The solutions are as important as the challenges.

Your Activity 1 Flip Chart Might look like this

Present Term (now to 3 years)	1. Challenge 1 2. Challenge 2 3. Challenge 3	1. Solution Set 1 2. Solution Set 2 3. Solution Set 3
Mid-term (4 to 6 years)	1. Challenge 1 2. Challenge 2 3. Challenge 3	1. Solution Set 1 2. Solution Set 2 3. Solution Set 3
Long Range (beyond 6 years)	1. Challenge 1 2. Challenge 2 3. Challenge 3	1. Solution Set 1 2. Solution Set 2 3. Solution Set 3

Activity 2: TCRG Research Proposal

The AVS Technical Community Requirements Group (TCRG) is a structured approach to identify the high value targets for research and development. The TCRG activity plans about 3 years in advance but also addresses on-going research and "pop-up" requirements.

For each TCRG proposal there is a set of questions that must be answered.

Select one of your activities from any of the Activity 1 exercises and answer the following questions:

Your Activity 2 Flip Chart might Look like this:

1. Title of R&D Requirement (Word so it will attract proper attention)
2. Briefly describe the requirement (Short description of the requirement)
3. Is this related to NextGen? (It could mean more $$$)
4. What are the steps necessary to do the R&D? (How to approach the challenge)
5. Background on this or related activity (A chance to build the case)
6. Regulatory Link (Related to existing or upcoming regulations?)
7. What we would have at the end of 1-2-3 years (Concrete deliverables are nice)

Rate Your Activity on 1 to 9 scale

1. Potential to prevent or mitigate fatalities and injuries
2. Will identify and analyze emerging threats
3. Will enhance existing safety regulations and standards
4. Will prepare for new technologies, etc.
5. Answers public, congress, NTSB, or FAA drivers
6. Additional justification if you want to.

Ratings:
1 Essential
3 Very Important
5 Important
7 Useful
9 None

Activity 3: Initiatives to Extend MxHF beyond Training

You are visiting a maintenance organization that tells you they have a world-class Mx human factors program.

1. List at least 5 programs initiatives that extend beyond training.
2. Suggest the measures that the MRO, or you, could use to determine if these initiatives have value. How are they making a difference?
3. Be prepared to describe one of these initiatives to the workshop.

Your Activity 3 Flip Chart Might look like this

Initiative 1	Ways to measure the impact of this initiative
Initiative 2	
Initiative 2	
Initiative 4	
Initiative 5	

Speaker	Dialogue
Dr. Bill Johnson	Good Morning. The presentations, thus far, have been excellent. I hope to be clear and concise as I describe the AVS R&D requirements process named the Technical Community Requirements group or TCRG. Please ask questions throughout the presentation. The TCRG is the group that defines the research requirements for AVS and, in fact, all of FAA. I'm going to talk about that process. I had some flow charts that were so complex even though I've been working in the process for 6 years I still don't understand them. The reason for that, I think is that the real meat and potatoes of how you get the money still aren't in the documented part of the system. Does that make sense? There is a lot of behind the scenes sales and marketing beyond the formal process. So, let me just tell you a little bit about how the system works. I will provide an overview the R&D process and I'll keep that pretty quickly. People learn best by example so I just want to show some of the examples that other groups are doing, and then the things that AFS 300 and I've helped accomplish with the help of CAMI and with other contractors. I hope to show you the past direction for the past 6 years and where we hope that's going to go. Then the last thing I'm going to do is ask you if you had to show up next week with a TCRG plan, for any given task, how you might complete the form. I promise you that, if you come up with some really strong ideas we could get them into this year's TCRG process. We'll leave it open for discussion. Now, we can take a quick look at the lines of business that are competing for the FAA research dollars. As you know, ATO, of course, is the biggest. Then there is aviation safety, airports, the policy planning, the environment, and the commercial space transportation. I'm just going to concentrate mostly on AVS but just show you a little bit of what's going on in the others. At the moment I can only tell you the 2012 plan. The plan for 2013 is going on as we speak. In fact, aircraft certification which of course is under AVS, had to submit their requirements about 2 weeks ago. AFS has to submit theirs sometime between now and the end of August. So, it's going to go through the process. Last year AVS submitted 95 requirements. Sixty-two of the 95 made the first cut and then submitted detailed budgets. From those, about 50 were funded. So about maybe a half of the research proposals make it to being funded at least at some level. Human factors gets about 25 million dollars of the total FAA R&D budget. This is 5% of the total pie. However, ladies and gentleman, we don't have to feel bad about the number. We certainly don't have to feel "oh shucks we only get 25 million and these guys get a 150 million in the weather program". Well those are the facts, those are the size of the projects that FAA's attacking. We can get our hands around getting the high priorities with the money available. And we've been doing it. Do we want more? Yeah – yeah, always, sure. But we're pretty proud of the things that have been going on thus far.

Speaker	Dialogue
	Now, what are doing to maintenance? Over the last couple of years we have been spending the largest portion of money that we have available on fatigue risk management and we're proud to say. We could be doing it with anyone in the world. What we decided to do is do it with the best possible people in the United States, which is here at CAMI. So we're really delighted that we're working with CAMI on that work. Katrina presented the fatigue projects real well yesterday and doesn't need to be repeated here. Maintenance and ramp, line operation safety audit – LOSA is the next presentation right after mine, right? Dr. Kevin Gildea will describe that activity.
Dr. Bill Johnson	We have helped guide the extensive training activity for aviation maintenance inspectors. Now, that doesn't get the human research factors funding. That's funded out of operations money more than out of the human factors money. However, we feel quite proud to include that on a list of human factors things that are going on in maintenance. We thank you guys from the FAA Safety Team for inviting us to participate so much with you as you do so many Inspection Authorization training classes. For those of you that aren't real familiar with inspection authorization, it permits the general aviation personnel to return all the GA aircraft to airworthiness. IAs tend to be the most experienced and the wisest of the GA aviation maintenance technicians. Every time I get among that crowd, especially during break, you just see how darn smart they are in terms of not only their knowledge of aviation, but also their general knowledge of everything. So, please let us keep working with you on these IA renewals. Another example of applied output is the Operator's Manual for maintenance Human Factors and the Operator's manual for Airport Services. I'm going to talk to you on during the "return on investment" presentation about one of the chapters in the book. Both manuals are short, with about 30 pages, 27 pages with pictures. As with many of our projects, we worked very closely with the Air Transport Association and industry committees. We spent a lot of time supporting the aviation safety action program, also known as ASAP. The reason I even got a little fired up when Keith Frable started talking about ASAP and voluntary reporting, is I believe in the importance of just think in terms of its importance on identifying problems before they become serious. The ASAP program is so critical and the just culture part of the ASAP is so critical, FAA has to continue to subscribe to that just culture philosophy. When a person comes into work under the influence drugs or alcohol or commits any of the four other "major sins" there may be no forgiveness. However, for the normal mistakes human makes, and that they honestly report, ASAP cuts them some slack. That might not be the exact way to say it. But ASAP is a powerful way to correct small problems before they grow larger. We started a large research project to look at the future of aviation maintenance and engineering. Unfortunately, after about 9 months it just simply was not going down a path that we felt we could defend to our management or to the industry. We took the very unusual step to stop the work. We hope that important work will be invigorated in the future.

Speaker	Dialogue
Dr. Bill Johnson	What do we look towards to the future? Well, first of all, we're going to look to some of the successes we have right now. The first thing is that we are dedicating our largest funding to fatigue risk management. We have proposed to continue the LOSA work, research on technical publications, and also on a way to capture the knowledge of retiring Aviation Safety Inspectors.
Bobbie Reid	I have a question, Bill. Sometime ago I worked with SASO on one of them. A maintenance organization accident/causal factor analysis it was under RPD 767 or 676 it was a - it was basically theoretical analysis of a maintenance organization and how it supports accidents and incidents. Have you ever heard anything about that? Do you guys working with SASO at all?
Dr. Bill Johnson	No sir - no.
Mr. Reid	Well they do a whole bunch - they fund a whole lot of analysis through there because there a line item on the budget.
Dr. Bill Johnson	So they're doing it - is that operational kind of money then is that what you mean?
Mr. Reid	Well yes its OPS money yeah but they've got line items so they're planning for it way down the road and you might want to get with this fellow or actually Rich Abbott is the maintenance guy that coordinates these but there's a lot of human factors stuff being done through SASO right now.
Dr. Bill Johnson	Well I think we need to make a point of being sure that we do talk to them. We want to avoid redundancy and get things moving in complimentary way. I hope we can pursue that avenue.
Mr. Reid	I'll send you a copy of the study.
unknown	What is LOSA - SASO?
Mr. Reid	Safety - systems approach to safety oversight. Dennis Niemeyer at AFS30 is the coordinator he works directly for John.
Dr. Bill Johnson	Each year you, by the way, you have to re-justify the work you are doing. This year we must re-justify what we're doing in fatigue to the committee and we have to re-justify what we're doing in maintenance, ramp LOSA. Again we want to get a fresh start again on looking at the future of the aviation maintenance technician including what impact - we don't, I don't pretend to know the answer to any of these but what impact does NextGen play on what our aviation maintenance technicians are going to need to know, and know how to do, say in the next 5, 10, 25 years. Someone needs to really get that answer in the way that it makes sense.
Mr. Reid	They're working on that as well SASO
Dr. Bill Johnson	There's a number of initiative's going on - addressing technical documentation. And we've got a TCRG request related to that topic as well.
Dr. Bill Johnson	We have one of these prepared right now in the area of addressing technical documentation. But sometimes, again this is not a complaint but merely an on-going challenge, much of the direction that research is going to go gets defined at the AVS-1 level and seldom do you see something as specific as worrying about maintenance documentation. So, when AFS 300 and I submit a proposal to address the challenges associated with technical documentation it’s difficult for somebody from the flight deck or other aspects of AVS to say I don't see that in the strategic plan for why is that important? Well I think three accident investigators just told us why it is important. Every one of the many accidents were related to some failure in the whole technical documentation issue. That's the argument that we've been

Speaker	Dialogue
	making, and we add to that, of course. We also emphasize that we must keep asking why, why, why was the documentation not used? One of things of course that's going on and we have a TCRG request. That address knowledge capture. We want to find ways to capture the knowledge that's out there? How do we capture some of that wisdom that's at this table or out there with those inspection authorizations and other senior mechanics. There's an increasing amount of commercial software out there that addresses this challenge. For example, telephone companies and other kind of help desk kind of places that really captures all the knowledge about a particular product or piece of information. We think we need to capitalize on that in aviation maintenance human factors as well. In fact, Victoria Frazier, in the Chief Scientist Program, wants to capture some of that knowledge before the people retire. Yes, old guys like me eventually retire.
group	laughter
Dr. Bill Johnson	I think there's at least 4 or 5 of them older than me. That's why I like hanging out with those guys. I feel younger.
group	laughter
Dr. Bill Johnson	Anyway how are we in the chief scientist program not only just going to capture some knowledge that a Chief Scientist, named Al Broz, might have about non destructive inspection. When Al walks away, man where's his list, where's his phone contacts, something as simple as that. What's the address to all of these labs in the Netherlands and everywhere else and who is the key contacts there. This may sound trivial but when they are gone all the information should not leave with them. I recall a cartoon with the guy standing with the grieving widow and saying to her I'm sorry about Joe, I but did he ever mention the words source code?
group	laughter
Dr. Bill Johnson	We must be sure that we have that source code! Another topic requirement that we have submitted to the ACS HF TCRG is one to study the effectiveness of human factors programs. In fact, I have submitted this 3 or 4 years in a row to the committee. It never receives enough votes to be funded. So the TCRG does not want to fund such a study, yet senior FAA management are always asking for proof that the R&D activity has value. Our management at flight standards has said that our R&D should do the following things. First of all it has to be aligned with FAA organizational objectives. FAA management, for the most part, wants applied R&D with useable deliverables. The good basic scientific things that are going on at the universities, and the labs around the world, must feed the applications-oriented R&D that we can perform. No bonuses, no big prizes for big words that don't make any sense to our end users.
group	laughter
Dr. Bill Johnson	Cooperating - one of the things that we are doing is cooperating to the best of our ability with industry. Every project that we have done relies on the important industry component. Dr. Avers described yesterday that our committee that is comprised of industry participation, both management and labor. Dr. Kevin Gildea is going to talk about LOSA and the extensive industry involvement. On that work FAA is out-numbered by ATA and organized labor committee members.

Speaker	Dialogue
	Ideally, TCRG requirements should be field-generated. That would imply that ASI's call headquarters or maybe I get lucky and they call me and say Bill, we need to be doing this particular kind of project. Often we have a pretty good idea of the requirements because we get out in the field a lot. So we think we are getting there, but more field input is needed. So, the TCR committee members in the area of maintenance human factors are me and someone from AFS 330. That is the Airline Maintenance Division at headquarters. The official TCRG customer is AFS-300 position.
Dr. Bill Johnson	The research and the engineering management team which is called the RED Team ultimately selects the projects that will be funded. So, here's what happens. About 25 TCRG members, mostly flight deck personnel, vote on the project to pass up to the RE&D Management team.
Dr. Bill Johnson	Yeah and then about - and about maybe a 1/4 of them are in Washington DC and they're just scattered. So all those meetings are just really long telecons. So, we don't get together as one group very often. I guess it would be a little bit more scientific-oriented researching kind of people that are on that group. And agree among themselves sort of - you know if I agree your project's great - I'm at risk that you're going to get all the money and I'm not. So there's a little bit of that going on but its really - you're laughing - it's a little bit of it going on its subtle, its polite but there is that undercurrent. If we get 2 million for fatigue - flight deck's not getting that 2 million for one of their projects. And the same token every time they come up with a new 10-million dollar idea it’s 10 million we can't get. So, you know some of that does go on. So what is our job? To sell it. We've got to sell it. Promote it - and I'm going to talk about that just a little bit more. And so then as I said all projects have to be defended annually. Although they're talking about changing that process because it really eats up a lot of time and effort defending every project every year. I mean we have a good research program going in fatigue, as an example. Everyone in management knows we need it, all the scientists know we need it, outside agencies know we need it. Why in the heck do we have to defend it every single year so they're trying to pump this to a three-year cycle. Yet each year we must submit the on-going project as if it is new. So what we defended in 2010 is solid money and by the way when we put in the money for 2013 we tell them what the plan would be for 3 to 5 years and about what kind of funding it would need for 3 to 5 years but if it gets funded for 2013 we have to re-defend it in 2014 again. So that's just the way it gets its part of the system, and its okay
Dr. Bill Johnson	So that is the structured approach to identify high value targets for research. And also there is an ability to have some pop-up ideas. I'm just humoring Dr. Wilson (NTSB) here but, for example, say we were doing nothing on fatigue which is not true. But say we weren't and suddenly Randy Babbit says you know what Johnson, we've been getting this NTSB letter 25 years why don't we do something? Money pops up faster than you can possibly believe it from places you didn't even know it came from, without doing any paperwork whatsoever. That does happen but you know you don't want to count on your whole research program being pop-ups Bill, how come everything you want to do is so important? As everyone learned from Nick Sabatini his famous line was "if everything's important,

Speaker	Dialogue
	nothing's important".
Dr. Bill Johnson	The TCRG proposal has seven questions that must be answered. I'm going to show them to you and I was going to ask you to take all the activities that are on the list like fatigue, and the one's that we defined the day when the class started yesterday morning and pick out one of those and perhaps build one. But that's too long. Here are the questions that must be answered in order to present your plan to the first committee. First of all, what's the R&D requirement and those parentheses are my own that says first of all word it in a way that might get their attention. We'll just do it real time. Anybody want to just throw an idea out - Brian like technical documentation or something like that?
	That's actually what I had on my mind today when you brought that up earlier I had a number of questions.
Dr. Bill Johnson	Okay well let's do that one.
Dr. Bill Johnson	For maintenance technical documentation briefly describe the requirement in about 2 paragraphs maybe 3. You have to capture the requirement. What do you mean technical documentation maintenance?
unknown	Well it has to have some writing standards for example. In other words for people to understand it.
Dr. Bill Johnson	Okay.
unknown	Bill can you start within the background?
Dr. Bill Johnson	Well actually that's why I stood back and had to remind us, strangely enough, that background is question number five and whether its related to the regulatory link is down here so all of those questions are eventually addressed. I'm not saying you pick a number but you would say 8 out of 10 accidents have some component related to failure to use documentation properly? And there's a number of reasons that might be happening. You know what they are? And how might we approach that? And would issues like usability of documentation be an important issue?
unknown	[unintelligible] it really wasn't a problem
Dr. Bill Johnson	Pardon?
unknown	You were describing the result or a problem not necessarily
Dr. Bill Johnson	the requirement
unknown	a requirement
Dr. Bill Johnson	So the requirement
unknown	Normally there would be a requirement for technical documentation I understood that
Dr. Bill Johnson	Yes that's a better way to look at it - just what it says
Jim Hein	You could even try to say you're looking at writing standards. You have to say cross cultural or cross demographics [Unintelligible] of the United States I mean what's the appeal to the mechanics or even the demographics of the work force you go to one part of the country and another part of the country where is the responsibility for the air carrier if they're going to re-write standards for their culture?
Katrina Avers	The bottom line question that we would ask as a researcher probably is identify what the causes are of technical documentation failures. Because you're already identifying those as far as cross cultural issues or writing standards and those might be some of the answers. So we need to identify what are the most critical causes of technical documentation failure's and then develop solutions directed toward those causes? But Bill you're right on
Dr. Bill Johnson	Yeah but I agree with you completely, both of you completely, but I'm just

Speaker	Dialogue
	standing here trying to act like a TCRG member that does not understand the requirement.
unknown	Well the question maybe stopped here then.
Dr. Bill Johnson	Well this is the question - we can't debate the question – it's not an essay test on final exam. We must answer all of the questions. Everyone must follow the same rules of engagement
unknown	What is the requirement for technical documentation then it's got to apply it - this has to be information.
unknown	Standardized format?
group	Chattering
unknown	I don't understand why people don't use technical documents or why they have training because people didn't follow the documents.
unknown	That's what my point would be--more of the effects of technical documentation utilize and following procedures. Because that's what it is and then part of that you would hear. I think it's a good research for mechanics is yes it is documentation provided to me and I'm suppose to use it but that technical documentation lacks this, or doesn't fit this format.
unknown	Uh huh.
Dr. Bill Johnson	And by the way I'm standing back - one of the things that a lot of the people on the TCRG have voiced some concern about is the whole process asks a lot of wants, a lot of detail on the steps necessary to do the R&D. We must list the steps and milestones along the way. And a number of the people that submit to the TCRG system wait a minute you want me to say what the problem is? How you solve it? And what other milestones will be at month 1, month 2, month 5 and I just did the research project I don't know the answer if I knew all of that stuff I would be putting it in there. But you do have to give it your best in about 3 or 4 paragraphs
unknown	Well lets go to the next question?
Dr. Bill Johnson	Well lets try on sure. Thank you sir.
unknown	Briefly is this related to NextGen?
Dr. Bill Johnson	There's a reason for that one. That's a yes or no answer.
unknown	That's a yes.
Dr. Bill Johnson	Of course it is! Technical documentation seems to be related to nearly everything. But if you check yes then there's a little loop in the flow chart and it says go to a different committee you're in the wrong place.
group	laughter
Dr. Bill Johnson	Yeah. So you want to stay in with the human factors people because they're at least on everybody around the table while they all want the same pot of money or at least on your side. So there's some reasons strangely enough that you don't want to say maintenance technician is that related to NextGen? But then it is not an HF project.
unknown	Almost everything is.
Dr. Bill Johnson	No - no we said yes in the beginning and then we realized that Dr. Abbott, she is one of the Chief Scientist for Human factors in Flight deck, she runs this particular committee and does a great job. But if we say yes then Dr Abbott says "okay if it is a yes, Bill, then take it to Nextgen.
unknown	It could just be a subcommittee of NextGen.
Dr. Bill Johnson	I should have put that one in there. Okay let's do this one what are the steps necessary to do the R&D – Brian, I think you started you said what the first step was.
Brian Capone	Need to go out and talk to our mechanics on you know using the documentation and procedures and then I think one of my top concerns is the change in the automation in the way that documents, you could even change it - there's a lot of stuff out there that manufacturers are going to

Speaker	Dialogue
	that the automobile industry is doing where its all pictures. You click on it and the real cut is 3D and then you know everything just comes off, you look at it
Dr. Bill Johnson	He's talking about BMW movie. Did you see that BMW movie? There's a BMW advertisement where all technical documentation for the car is on wearable 3-D headset.
Brian Capone	No I didn't see that one - but there's a lot of people that have approached me. A lot of the IA's seminar companies that do that want to get into aviation but when you start telling them you can't just do it, you're going to have the manufacturers buy off that's where you need to go talk to it and the FAA will look at it and I don't know if it scares them off or what, but they kind of pull away.
Dr. Bill Johnson	Well to give you some idea I wasn't even planning on saying this but to give you some idea of this TCRG process and why it's so tedious. In order to complete the TCRG request you must have a sophisticated R&D plan in mind. The first thing I did was to call Bill Rankin and schedule a meeting with Boeing and other experts. We arranged a phone call with the Boeing vice president, two senior vice president's from MROs and many Boeing technical people. They were all aware of a recent very large maintenance related incident related to documentation.
unknown	Kind of like a manager in charge of the maintenance [unintelligible]
Dr. Bill Johnson	We talked for nearly two hours. We tried to get our hands around the issue. Then I called a general aviation aircraft technical publisher to talk about their spin on new technologies. I talked to Gulfstream to get a GA manufacturer's perspective. I am convinced that this is one of the most significant problem in all of aviation maintenance.
unknown	Do you at some point check with to see if somebody else has already done the research?
Dr. Bill Johnson	To the best of our ability we must do that when we submit that kind of requirement. But there is not time and money to plan and conduct the R&D in order to make the case that is required.
unknown	Other than the background section so
Dr. Bill Johnson	Yeah, you will say where things have gone on and we're certainly real careful on answers. In fact, if you go to the human factors website, the flight standards human factors website and search for documentation you will find past projects. FAA had Wichita State University conduct a 3-year study where they really did some nice stuff on maintenance documentation. Collin Drury at University New York at Buffalo did a bunch of research on it. Was it good stuff? Yeah. Clemson University did a bunch of research on how you write documentation, how you avoid making mistakes while writing documentation, how do you do readabilities studies, how do you know and all that kind of stuff. Okay. We did all of that. Is the problem fixed? No. So we need more!
unknown	When you were implementing
unknown	Was it the right research?
Dr. Bill Johnson	We never implemented - it was applied research for the most part but we never fully implemented it. Perhaps we needed a few more years of funding in every example. I think the key is maybe characteristics for all 3 of those projects as we probably needed more industry involvement. In those projects. Were they out in the industry? Absolutely. Was what they

Speaker	Dialogue
	did good? I believe it was. And people still use some of it. But I think this I'm hoping this project will start - if its not this year its going to be next year, its going to be sometime. It's got to be in conjunction with the Air Transport Association and General Aviation Manufacturers' Association.
Dr. Bill Johnson	And as you can see that's why we decided not to make this a group activity because again this is not a 15 minute job where we're going to solve this and complete it. But it gives you some sense of the challenge that's there but I think more importantly it gives you a sense that AVS truly does have a process that they follow that seems to work to define the R&D. But I will say like any organization in the world that I've ever been involved with, you've got the formal process, and then you got to do the sales and marketing for your ideas and everybody does it. Everybody does it, some better than others.
Mary	Just a question about the process at what point would you identify who you would like to research to be done, or by or do you?
Dr. Bill Johnson	Well technically you don't.
Mary	Okay.
Dr. Bill Johnson	Technically you don't - technically you sell this whole package this whole idea and then you specify what the requirements for the research - this is a very good question. You specify what the requirements for the research would be and what you want, capabilities the researchers must be and that's not part of the TCRG. By the time they're asking those questions you've got it made.
Mary	Okay.
Dr. Bill Johnson	But then what happens as with everything else it goes out on a contract bid and then you find the very best value and you know gosh Rick I don't mean to embarrass you but that's how Rick became the people that are delivering the current training to inspectors and it was extremely that's a very nice contract and I think that most of us would recognize that but it was extremely competitive and who had the capability and proved it in writing that they're the ones to get it done. And that's the ideal. That's what happens and in this incident it worked perfectly. Sometimes I'll be real honest with you except I'm sorry this isn't all 100% FAA people but the reality of it is that sometimes contracts, expedite things and selects from what's the easiest way to get that work accomplished, rather than who's the best person to get it done. And that happens sometimes too often. Yes ma'am
unknown	Is it ever the people at the Tech Center or CAMI that do the work?
Dr. Bill Johnson	Absolutely. Absolutely.
unknown	So it's not always a contract?
Dr. Bill Johnson	In fact, even when CAMI is doing this work in fatigue and in Maintenance & Ramp LOSA that is a contractual arrangement. But we definitely have a preferred provider in CAMI. I'm going to look first to see to the extent to which our own internal FAA people can get that job done and it's a great and lucky day when you're looking at your own family and they're the ones that you think that can do the very best job. And I always say if your brother-in-laws a plumber you're going to go to him right? Well if he's the plumber he better do the best job for you that he does for anybody else in the world or suddenly you're going to start looking for a different plumber no matter what.
Dr. Bill Johnson	Does that answer your question now? Yeah. Okay so - so they're one of many that can provide. Okay. So anyway you answer all these questions and by the way unfortunately you don't get to just answer them.
unknown	It's alright if you use all odd numbers too.

Speaker	Dialogue
Dr. Bill Johnson	Oh no - its not [unintelligible]. You can put two. You could put 1.1, 2.3. 3.6 whatever you can do that. But then after you do that, the fun isn't over - why now justify why you said it's essential and there's a section in the form to do that as well. So I think I got the idea across. It's a good process, it's 90% of the time it's a fair process, and but it's also a process that it's really true that if you have a good idea and you get it somehow to this committee it will get proper consideration. But be warned that if you have a really good idea you still have do all due diligence to be sure that you sell the idea at all levels. The TCRG is a bit cumbersome but it works! Thank you.

Appendix L: Proactive Safety Management: Maintenance and Ramp Line Operations Safety Audit (LOSA) (Dr. Kevin Gildea)

Proactive Safety Management: Maintenance and Ramp Line Operations Safety Audit (LOSA)

Federal Aviation Administration

Presented by Kevin Gildea, PhD

Date: August 4-5, 2010

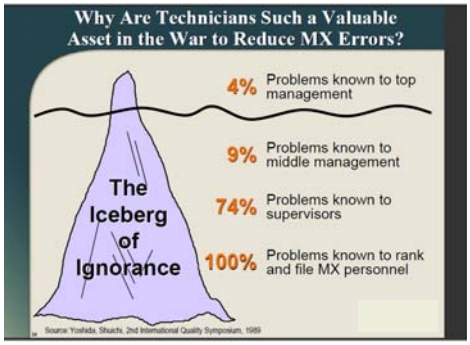
Background

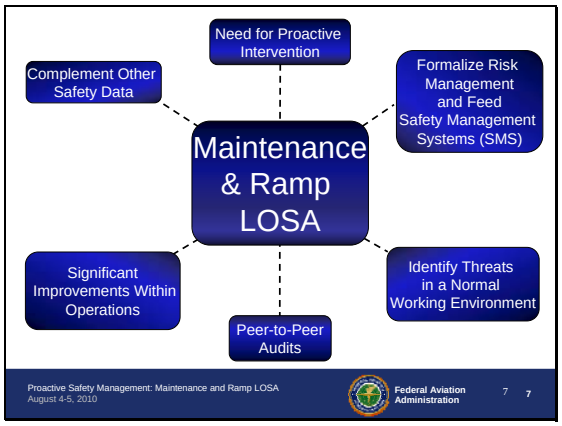
Industry Background

- **Managing risks has become critical for modern organizations**
- **Trend of proactive interventions**
- **Capitalize on the successes of flight deck Line Operations Safety Audit (LOSA)**
  - *Identify the early signs of emerging risks through normal operations audits*

ATA Mx and Ramp Human Factors Task Force

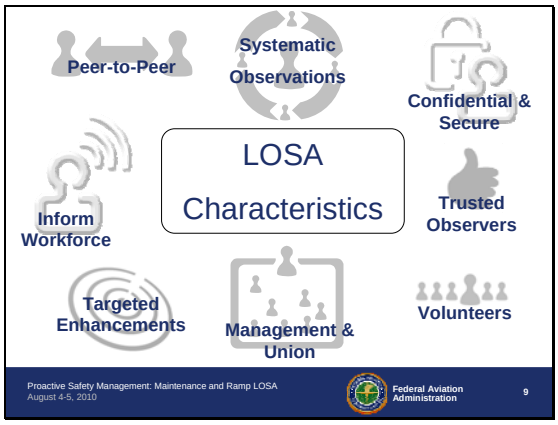
Relevance & Importance





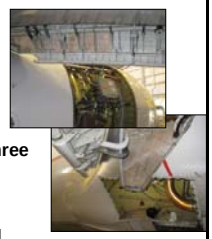
Customizing for Mx, Ramp, & MROs

- **Domains**
  - Maintenance
  - Ramp Ops
  - MROs
- **Lessons learned from existing Mx and Ramp LOSA and similar programs**

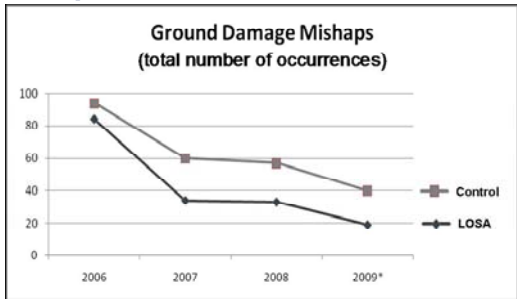


Maintenance Success Stories

- **M-LOSA findings help to make deactivation procedures more workable, efficient, and safer.**
- ***Before:*** **Leading edge device de/reactivation procedures took three hours to properly tag out without individual sign-offs.**
- ***After:*** **With sign-offs, this modified process takes between thirty and forty-five minutes to complete.**



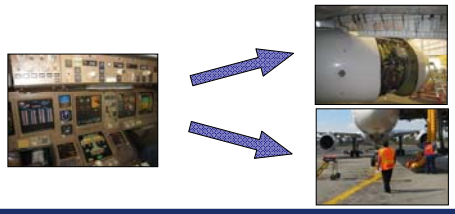
Ramp Success Stories

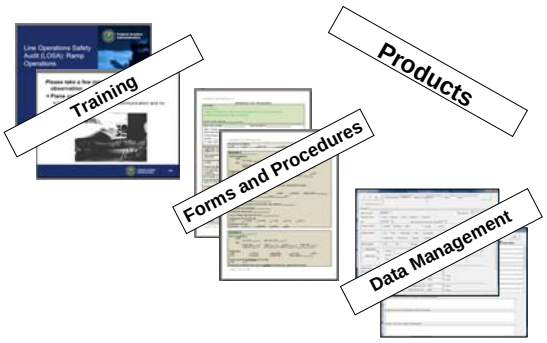


Accomplishments

FAA Tech Report

"A brief history of LOSA programs – from flight operations to maintenance and ramp operations"





LOSA Training

- Threat and Error Management (TEM)
- LOSA Procedures
- Scenario-based Practice

LOSA Forms

- Developed by reviewing and aggregating audit forms of Maintenance and Ramp LOSA (or similar programs) and related references
- Refined during beta testing
- Beta Testing of the forms
  - Maintenance – August 2009
  - Ramp – October 2009
  - Cargo – March 2010
  - International – TBD

LOSA Database Software

- Basic information about the observation
- Supports all information from forms
- Analysis and report generation
- Data exportable to Excel and other statistical software
- Data will contain no identifying information on the auditor or those being observed
- Forms in MSWord and PDF format

Questions?

Speaker	Dialogue
Kevin Gildea	My background is in training development for the Air Force as a contractor. I've only be with the FAA for a year but I've become a convert to the LOSA process. It makes sense from both a scientific and operational perspective. I hope to convey those concepts in this presentation.
Kevin Gildea	As we have discussed over the last two days, managing risks proactively has become very important. The shift to a proactive approach is an effect of the progression of aviation. The first 50 years of aviation presented many engineering and operational challenges as is common in a young field. The problems were often staring everybody right in the face. The problems were often very difficult to fix but they were often a bit easier to find because they were more prevalent. As incidents and accidents have become more rare finding the remaining problems has become a more difficult task. Fixing the root causes has also become more challenging in some regards. When we walked into LOSA development for maintenance we had a really good leg up from the previous 10 years of experience with flight deck line operation safety audits. There had also been some early implementation of LOSA for ramp and maintenance. We were able to invite some of the experts into the project to provide input. As Bill mentioned, we have a big team working on this and it keeps getting bigger. It has been very effective collaboration with St. Louis University, the FAA, plus numerous airlines and service providers. The team has provided tremendous support. For the LOSA project the members from the FAA have not been operating as regulators. We have been operating as colleagues and researchers with the other ATA Human Factors committee members. [While presenting the iceberg image] The people at the top of an organization do not see many of the problems that exist on the shop floor or on the line. If we want to understand what is wrong in the system and where the problems reside we need to go to the maintainers. I would argue that there's actually a level below what even the maintainers see - I think we have a set of latent problems that nobody knows about. Its like your Dash 8's with the o-rings. Did anybody really realize that it was a problem? It seemed like a very viable approach. It is easy to spot the problem after it occurs but it is very difficult to predict. Even with the American Airlines DC-10 that crashed in Chicago back in '79. Using a forklift to hold the engines in place during removal and replace was considered an acceptable approach. The question then becomes, ”how do we get at those types of problems?” How can we take a step back and reevaluate our procedures? LOSA is designed to help uncover those hidden problems and to tap into the maintainers understanding of the challenges. In addition to building on the LOSA flight deck experience we also looked to the META process and checklists for additional insight. The structure of the LOSA checklists is familiar to those who know META. Unlike META the LOSA observers watch normal operations from a “fly-on-the-wall” perspective. LOSA is also a peer-to-peer process. The observer should be another maintainer and someone the team respects and trusts. It should not be an FAA person or a manager. A key aspect to building trust in the LOSA process is a solid understanding of what LOSA is. The maintainers should understand that the information will remain anonymous and that the information will be used non-punitively. To protect those being observed

Speaker	Dialogue
	and the integrity of the process we are setting up reporting mechanisms that will preserve anonymity. It is important that those being observed engage in their normal daily activities. When maintainers take shortcuts or change standard operating procedures on their own there is usually a very good reason in their minds. It is not malicious. These actions are often taken because there are problems with the system in some way, whether it is regulatory, procedural, or an engineering challenge.
Unknown	I have a question.
Kevin Gildea	Yes.
Unknown	Do you have a size for your MRO I mean MRO does that mean small, medium, large?
Unknown	i. e., work they do, essential maintenance versus [unintelligible].
Kevin Gildea	Initially we're looking at the large companies. We took the same approach with the airlines. It is much easier to conduct a LOSA with the resources of a large company. The smaller companies are not going to have the fiscal resources, time, or personnel to do a successful LOSA. Therefore, LOSA will generally be employed with these larger companies. We have had some discussions about how can we make this accessible to the smaller companies but that is a problem for future research.
Kevin Gildea	Systematic observation. The goal was to develop forms that reflect the structure of the tasks in such a way that the maintainer can pick up the form and say, “Yes, this is what I do every day.” Although there will always be differences from one shop to the next, beta testing with the forms indicated that the current forms are workable for many companies.
Dr. Bill Johnson	You make that sound real easy but I was there. Bill was there. It was huge.
Unknown	Yeah.
Dr. Bill Johnson	It was so many meetings and so much discussion with so many people. I feel that you underplayed oh yeah we ask them what we do. A lot more [unintelligible].
Unknown	Yeah that one place did a great job.
Kevin Gildea	A lot of that happened before I came onboard.
Unknown	We could base it on the way the maintenance documentation [unintelligible].
Dr. Bill Johnson	Yeah.
Unknown	Followed structure on remove and replace.
Dr. Bill Johnson	That's true.
Unknown	And then we added some things to that.
Kevin Gildea	Okay.
Dr. Bill Johnson	Yeah we didn't re-invent maintenance
Kevin Gildea	Okay.
Dr. Bill Johnson	Maybe we should have.
group	laughter
Unknown	That's next.
Kevin Gildea	Not only should the observers be trusted but they should also be volunteers. Additionally, before a LOSA observation takes place the LOSA observer should approach the technicians and obtain their approval. If the technicians do not wish to be observed their desires should be respected.
	Construction noise on tape can't hear what Kevin is saying.
Kevin Gildea	Over the last ten years very few flight crews have declined a LOSA observer. Once the maintenance community becomes familiar with the LOSA process and realizes they will not be reprimanded the anticipation is

Speaker	Dialogue
	they will also accept the presence of LOSA observers. It is also important to have management and labor onboard. It is important to management that they see an increase in safety and efficiency. There is some initial Return on Investment (ROI) data is compelling.
Unknown	What is the union doing that you, if they find something? You're looking at LOSA, you've got implications there, how is the union taking it [unintelligible] say this peer finds something on this peer and what's the union how does the union handle this? Is this. I have another issue on the union as well what it brought up. I brought it up to Keith a minute ago. Because it deals with having no senior help late at night. But how does the union how are they handling this? Because this is an issue on their structure. How is that working?
Kevin Gildea	We do not have a lot of data points yet other than the beta tests. However, there have not been any major issues yet. It is very much an open question in regards to other companies. One airline's maintenance team was a very hard sell. Management said yes, maintenance management said yes, the union said yes. However, when we went in there to do the actual training with the maintainers there was a lot of pushback. And I think it was the way it was initially presented to the maintainers themselves. They did not have an understanding of how the LOSA observations worked. Taking a little more time and introducing the LOSA concept in advance of the LOSA observer training that generally takes place a few days before the observations begin.
Unknown	[unintelligible] with the brother on brother [unintelligible]
Kevin Gildea	Yeah.
Kevin Gildea	When the maintainers start to see that the data is truly secure and they will remain anonymous that concern tends to fade.
Unknown	Is part of the problem scale ability? The fact that you kind of need a union for this to work?
Kevin Gildea	To make the LOSA process work? Yeah. I think its
Unknown	unintelligible
Unknown	I think the scale ability, if you have 20 people in the shop and one is the LOSA observer - observing the other 4 people. But does it have the same? I don't think it works as well as if you've got 10,000 mechanics and you've got 5 people who make LOSA observations.
group	talking at once
Unknown	Well yeah, if you've only got 3 or 4 people, they ought to be able to watch each other work anyway.
Unknown	Right and they come to agree on what they ought to be doing.
Kevin Gildea	[unintelligible] On one of our first beta tests one of the observers was from another base. The people in that shop were very comfortable with people from their own hangar. However, it took some time for them to feel comfortable around the new guy. So you may actually have better luck with the people they actually know. Somebody they're drinking beer with.
Unknown	With Continental when they were part of a BETA and I don't know if it's the same BETA that you were discussing now. Some of the things that they shared with me was that just what is going on fully understanding what's going on? And whose who? And is this going to hurt me kind of thing? And once the mechanics understood then they were comfortable and then they were sharing information so my understanding it was more in-house help looking at a procedure what's really going on? This is what our manual procedures say, we're doing this. Now what are we really doing

Speaker	Dialogue
	and is it working? And you know that kind of stuff like the self analysis is like an audit more advanced in trying to help themselves with the fatigue that's in their environment?
Kevin Gildea	Yes that's exactly right. And actually I have that example in a couple of slides. I'll hold that discussion until that point if that's okay. Comments - questions at that point?
Unknown	No that's fine.
Unknown	However, if it’s a regulatory non compliance that’s not a protected program.
Kevin Gildea	Exactly. Yeah. If you have a regulatory non compliance you know sometimes
Unknown	Well and were talking about this because I've actually trained a couple airlines in maintenance LOSA because it’s suppose to be non invasive so you're like in pilot LOSA you only get intervened if you're going to die.
Unknown	Right.
Unknown	The maintenance LOSA if you see somebody doing something incorrect like torquing without a calibrated tool or using the wrong grease or doing something wrong when they think they passed the aircraft is technically [unintelligible] and so at some point is maintenance LOSA there's probably got to be an intervention to say wait a minute you didn't do the test correctly. When do you intervene?
Unknown	unintelligible
Kevin Gildea	Which yeah there's been a lot of discussion on that and you know it’s a discussion people technical non compliance but your own guy's doing a LOSA to catch that they can request that it be fixed and then you have an air worthy bird and you don't [unintelligible].
Unknown	You have to release the aircraft.
Unknown	Yeah.
Kevin Gildea	So you know that isn't regulatory non compliance you have a maintainer that needs to be trained and you fix your bird before you sent it out. There's a lot of discussion back and forth.
Unknown	It’s routine. I mean, mechanics make mistakes, at least in the hangar, where they're doing heavy maintenance quite often, drill the wrong hole is that a non compliance? No, because they haven't proven the aircraft to return to service so they haven't made an airworthy determination and so they have opportunity to correct their error.
Unknown	Yeah.
Kevin Gildea	That's what should happen with a LOSA to if its something that's air worthy
	Construction noise on tape can't hear what Kevin is saying.

Appendix M: Demonstrating Safety or Financial Return-on-Investment from HF Programs (Dr. Bill Johnson)

Demonstrating Safety and Financial Return on Investment

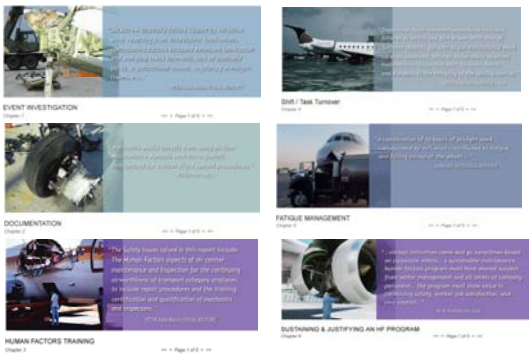
Dr. William B. Johnson
Chief Scientific & Technical Advisor for
Human Factors in A/C Maintenance Systems

AVS Mx Human Factors Leaders' Workshop
Civil Aerospace Medical Institute
August 4 - 5, 2010

Presentation Topics

- Operator's Manual for HF in Aviation Maintenance (4)
- ROI Discussion and Examples (12)
- Discussion as Time Permits

www.hf.faa.gov/opsmanual



"...various initiatives come and go sometimes based on corporate whims... 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.B. JOHNSON, FAA

SUSTAINING & JUSTIFYING AN HF PROGRAM
Chapter 6
<< < Page 1 of 5 > >>

The Reality of Sustainment and Justification

- As a EASA-required or Transport Canada-required HF program is a regulation with no specific need for cost justification.
- ROI can protect certain HF program attributes like amount of training, promotional materials, conference participation.

ROI Challenges - What is it difficult?

- **Assigning cost to a particular challenge/event**
- **Establishing cost of intervention**
- **Matching HF intervention to performance change**
- **Assigning value to what did not happen**
- **Add your reasons here……**

Here are Example $$ ROI Approaches

- **Cost vs. Lost Product Production**
- **Costs of R&D and Returns – FAA Style**
- **Justification from Improved Work Performance**
- **"Trust Me": A Non-Analytic Approach**

Five steps to calculate $$ ROI RATIO

1. Estimate annual cost of a specific event: **COST**
2. Estimate cost to address the contributing factors: **COST TO FIX**
3. Estimate the probability the COST TO FIX will be successful: **PROBABILITY OF SUCCESS**
4. Multiply COST times PROBABILITY OF SUCCESS and then subtract COST TO FIX: **RETURN**
5. Divide RETURN by COST TO FIX: **ROI RATIO**

Example : Ground damage during towing

- 16 significant towing incidents at one hangar during 1999. (Average Year)
- **Cost** is $260K/year
- The organization conducted focus groups and event analysis to understand the contributing factors.

Ground damage during towing: Prevention Measures

- **Paint Centerlines, Clear zones, tail zones, etc.**
- **Standardize lights on hangar doors**
- **Modify work platforms**
- **Train personnel**
- **Audit performance and deliver feedback**
- **Total Cost to Fix: $52K**

ROI on Fixes for ground damage

1.	COST	$260K
2.	COST TO FIX	$52K
3.	PROBABILITY OF SUCCESS	75% (.75)
4.	RETURN	((.75x$260K)-$52) = $143K
5.	RETURN ON INVESTMENT RATIO	($143K/$52K) = 2.75

Some Johnson papers have other examples

- **Ground Damage During Towing ROI = 2.75**
- **Damage in the Paint Hangar ROI = 5.5**
- **Technical Documentation ROI = .52**

Observations about ROI

- **ROI calculation is not high enough priority.**
- **Organizations often don't count the cost of error.**
- **Organizations don't count error costs very well.**
- **Workers are not sensitive enough to the cost of error.**

Observations about ROI (Con't.)

- **When something breaks you fix it and don't calculate it.**
- **When something is not safe you fix it and don't calculate it.**
- **When work conditions are not safe you fix it and don't calculate.**
- **You just don't calculate it!**

Observations (Con't.)

- **Most interventions are seemingly intuitive and cost justifiable.**
- **But the times are changing…**
- **ROI for HF interventions is in infancy.**
- **It does not have to be complicated to make the case!**
- **Numerous small justifications make a big point!**

But, ROI on Safety is a different challenge

- "Safety" is an intangible numerator
- We can estimate costs to try and be safe but it is harder to estimate the cost benefits of "being safe."
- So, what are reasonable metrics to show that a safety investment has safety returns.
- Try and estimate the safety payback on this workshop

Workshop ROI

- Cost is easy
- Expenses approx $50K USD
- Labor
- Planning: 30 person/day @ $800/day = $24K
- Delegates 30x4dayx800 = $96K
- Total Cost = $170,000
- What is the safety return? HELP?

Processes that could measure Mx safety

- Aviation Safety Action Program reports
- NASA Aviation Safety Reporting System reports
- MEDA-like investigations
- LOSA reports
- Alertness measurements

What are the Safety ROI Measures?

- Reduced Accident Rate (Extremely difficult/impossible)
- Reduced events in maintenance?
  - Reworks
  - Mx-caused delays
  - No fault found on components
  - Warranty claims
  - Personnel lost-time injury
- Level of voluntary reporting report activity?
- # of "Near Misses" in Mx
-

Action Items

- Strive to identify safety payback on MxHF investments
- Create a database of measures
-
-
-

Questions - Discussion

Speaker	Dialogue
Dr. Bill Johnson	Well we are at a circadian low point so why not talk about Return on Investment, also called ROI! I want to begin by mentioning the *Operator's Manual for Human Factors in Aviation Maintenance*, a book that we completed in 2006. The Op's Manual is significant because it has a chapter about ROI. I'm going to show you that chapter and then talk about ROI. I have a couple of examples that may be helpful. I encourage discussion along the way. That's my presentation plan.
group	laughter
Dr. Bill Johnson	The book, by the way, was called the *Operator's Manual for Human Factors in Aviation Maintenance* Anyway the book has six chapters. The committee identified the 5 or 6 key things that any organization needs to do in terms about human factors. The chapters are: Event Investigation, Technical Documentation, HF Training, Fatigue, Shift/Task Turnover, and Sustaining and Justifying an HF Program. ROI is in Chapter 6. I had the responsibility to write that chapter.
Dr. Bill Johnson	Chapter 6 addresses the question: If you did all the first 5 chapters, then how would you sustain the program? The way you sustain that is hopefully do a little bit of cost justification with your management. That is what this chapter is about. So, we're going to talk about this sustaining and justifying the human factors program.
Dr. Bill Johnson	Alright. Reading from the Op's Manual, "Safety initiatives come and go, sometimes based on corporate whims. Human factors program must have shared support from senior managers and all levels kind of personnel. Human Factors programs can demonstrate value in continuing safety, worker job satisfaction, and cost control." That was my quote for the start of the chapter. Now let's see my quote from reality. In reality, many of the Part 145 repair stations in the US have HF programs. There are about 6,000 repair stations in the US. Is that the number close enough? Help me someone, if you have a different number.
Dr. Bill Johnson	About 1200-1300 of those have the EASA certification. Let's just use the number 6,000 but 1300 have EASA certification. Guess who of the 6,000 have an EASA certification? It is the larger repair stations. Therefore it probably represents about 80 or 90% of the people in the repair station business or in those first 1300 that have certification, EASA certification!. Therefore we've got the lion's share of our approved MRO 's actually delivering human factors training. They don't have to cost justify it because you have to do it, by regulation. You don't really have to talk anybody into it. Whereas you start talking Greg about one of the regional's or you talk about 135's or even an airline maintenance organization. If you're not an EASA 145 you don't have to do it. So again if you're going to do it it's because someone's wise enough to realize hey maybe this is going to minimize error, maybe its going to save us some money but they might say let's try to figure out how much that is? And I've got some examples on how to do that. But practically you might say hey we got to do it, so you do

Speaker	Dialogue
	it. Richard [Kaminarski] is a Canadian that runs aviation consulting company. He is a pretty well known consultant in human factors area training in particular. Richard made a big point to us regarding the demand for HF consulting after it became a regulation in Canada. Before the, rule the very good companies were implementing HF to help sustain efficiency and safety. As soon as it became a rule the phone start ringing, but too often it was people trying to figure out what the minimum was to meet that rule? He said our human factors training went downhill and that's why he is in the "other" North America (US) so much, because there's not a rule and the people that are asking for human factors training want it because they indeed truly want it. They want to do a good job therefore he can deliver them a much better product. So if you think about that once it became a rule people seemingly want to check the box. My other comment was ROI can really protect human factors programs, protect training, it could protect the way you develop promotional materials within your organization. You must demonstrate the value. You know that ROI is important. You identified as being important when you came to this workshop yesterday morning. You ranked it #2 of the list of the 10 most important challenges. Why is ROI difficult? Well first of all, it's really difficult to assign cost to a particular events. Airlines and MRO's, regardless of what you say AAR – Mr. Huntley, sometimes you're not real good at saying what that mistake cost. Airlines are even worse. MROs are more sensitive because they can do the math and its coming out of the bottom line immediately based on that product delivery.
unknown	Well a lot of times they don't want to give up that information either. There's a lot well it didn't cost us that much for his insurance or you know we can bury it in other areas.
Dr. Bill Johnson	Okay. Good you said it better than I could've. I think airlines are even worse because they damage something they get on with fixing it and getting it back in the air and sometimes they don't do all the real economics to figure out the cost of the event. Some of the airlines have a cost of losing a customer because you cancelled a flight on them the third time and they said to hell with this airline, I will choose another brand. One manufacturer of airliners has a list that shows the average delay cost, based on A/C size. For example the delay cost of a modern narrow body 140 passenger aircraft is about $6,000 each hour.
unknown	They catch that sort of damage - the damage they don't catch is someone taking a new engine out, or a new component out of the airplane dropping it and breaking before they install it and putting that back in, they don't capture those errors. They don't capture the cost of that.
Dr. Bill Johnson	Or taking that component off line and sending it off for maintenance that it didn't need. "No fault found" – They don't capture the cost.
unknown	[unintelligible] would capture that.
Dr. Bill Johnson	Keep going. Sometimes we're not even very good at establishing the costs of an intervention. Like what does this workshop costs? I can show you how I calculated that. It was pretty easy, once you do it a few times. Matching the human factors intervention, that is what we do at the

Speaker	Dialogue
	workshop, compared to the FAA or industry impact---that's the tough part! There's not enough time left in the day to get that complete answer by the way. Unless there's somebody in here much wiser than I am. And then the classic one, these aren't, again these aren't excuses, these are just what makes it hard, assigning a value to what didn't happen. We can add to that list, if anyone would want to make other comments about costing, challenging, speak now or forever hold your peace. Okay. Alright so now let's keep going. I'm going to do some math don't worry. So here are some examples that sometimes are typically taken and these are just sort of big picture examples. First you might look at the cost of an intervention versus a cost of lost production. If we do this, we're not going to lose production in this area. And you could put some numbers on that. Let's go with another one. This is an FAA approach where we compare the costs of R&D versus the cost of return. Now this is an honest to gosh true story. I can tell this, it was planned I'm not just making it up as I go here. This is my true story. I was with Galaxy Scientific and we were building a system that some of you remember. I'll take a chance and say it the online aviation safety information system OASIS and a lot of the ASI's carried that system around with you, right? Guilty as charged. I worked with the FAA to get the money to put that program in place, we did bid on it, we did happen to win it, and we worked with so many people to, for a whole lot of money to build that OASIS system. We had a young man in an organization who was doing his Ph.D work at the University of Houston it was a combination of industrial engineering and economics. He was blending those two disciplines together which is unbelievably interesting and excellent. So he was doing it and he did his dissertation on creating a cost benefit analysis on FAA making the investment in OASIS the R&D investment, buying all those computers and what impact it had on what was the return on that investment? And I am telling you we were so diligent, we were so scientifically diligent on that, step by step working with an advisory committee from University of Houston his Ph.D committee to be sure that we weren't going to make up any stories. Because there was a lot of room for error and trying to do that. We did the analysis, I'm not going to get into the details of exactly how we did, but we were able to show that the investment would permit FAA inspectors to save about 20% of their time. FAA completely bought off on the whole cost benefit analysis and it made Aviation Week and it was the things that FAA managers were holding up bragging about while some of you guys out in the field were cursing OASIS and whoever that damned contractor that built his thing. Does that sound familiar Brian or what are you smiling at?
Brian Capone	Well you have seen the last study they put out on and how much time we sit behind that thing versus going to the field and conducting real inspections!
Dr. Bill Johnson	The estimated time savings was 20%. Everybody bought off on it. I remember a senior FAA manager called me saying "Bill we're going public

Speaker	Dialogue
	with this - we're taking this to the administrator. Are you absolutely positively sure that you did this in a diligent way that cannot be debated, this is good science it's done. I told the manager this is really good work. The young man is bright. We worked with the committee and I stand behind the accuracy of the work. Well and they bragged it up for a year. It was about 13 months later that manager called me in a huff . She said Bill you have to discredit all that work you did, you have to prove it was wrong because OMB is now saying that we're trying to hire all these new inspectors and we just proved them last year we saved 20% of the time of inspectors. Now they're saying we don't need to hire anybody else because you picked up 20% of the work force by efficiency. You got to prove that you're wrong. That's where I finally had a problem, even as a contractor, where you'll do whatever the government asks you. I told the manager that we worked hard to be diligent on that. Our data are correct as I said in the beginning. We cannot disprove the truth. So be careful what you prove because it could come back and getcha. Anyway justification for improved work performance. So if you do this you're going to improve work accordingly, I'm going to show you some examples of that. Now I've talked I've had the pleasure of talking about cost benefit a lot. I don't have all the right answers but I've talked about ROI and written a lot of papers about it.
group	laughter
Dr. Bill Johnson	When you have your child first wanting to ride a bicycle when their about 3 or 4 years old. You walk behind with the bicycle, right? You walk behind him with a bicycle and you try to hold him up and then finally you let them go and then they go around the block and I promise you when they get around the block they come back and ask you for car keys. So get ready for that.
group	laughter
Dr. Bill Johnson	But what I want to say is do the same thing with cost benefit analysis. I'm going to show you how - how we can take the same repeated short bicycle ride with ROI. Some may suggest that I have over-simplified ROI. Okay we're doing baby steps. Estimate the cost of a specific event. And we're just going to call that cost. BY the way, if we fix the cause of the event that Cost becomes the Return And this is in our manual. The next thing we do is estimate the cost to address the factors that contributed to that cost. So the guy tripped over this wire, what's it going to cost to get that wire buried into the floor. So now we have the cost to fix. Right? Those are pretty straight forward and then these really work. I'm not ashamed to show this is off. Now I've got to also estimate if I this wire of yours that I tripped over, if it's gone, what's the probability that I'm going to trip over it? Well its pretty obvious if its gone. It's 100%. Burying the wire will fix the problem, I can't trip over something that's not there. But one of the things you must do in an ROI is estimate the probability that the intervention will really work. My old FAA boss called it fuzzy math, but fuzzy math is really something different. You can call it a probability estimate or

Speaker	Dialogue
	even a SWAG. That is up to you.
Dr. Bill Johnson	Instead of burying the wire we could put duct tape over it. Tape - if I taped over it there's still probably that I can still trip, so give it a 15% so I have to estimate that the probability that the cost to fix it will really solve the problem. Let's review: 1) what it costs to trip, I fell, I busted my nose, I lost xx many days of lost job injury etc. etc. And okay so we've got those three let's keep moving. Alright so all you have to do to get your Return is multiply the cost times the probability of success. Actually you have to then subtract the cost to fix from the multiple of the event cost and the probability of success. That is your true return.. Please let me just put that in the little equation. You put that together, then you do the division you divide the return that gives you the return so let me do this. You've got the cost, the cost is $1,000 what's the probability that I fix it? 50% so now you got the cost, $1,000 times probability of success some I'm going to save $500 and then I subtract, the cost to fix. Say it was $200 to bury the wire. 1000 time .5 is 500, then subtract 200 to have the return of 300. Divide 300 by 200 to have an immediate ROI of 150 percent. Compare that to your IRA! Here's one that was done during 1999. It is a real story, it really happened. We had the airline had a significant towing event where the aircraft damage cost was pretty minor really. Heck if you scratch the paint on a couple of aircraft anymore its $260K, isn't it Bill?
Bill Huntley	Uh huh, maybe less, depending
Dr. Bill Johnson	This was in 1999 now. So anyway the cost of the damage was about $260,000 that particular year. So the organization, a focus group, determined the contributing factors of aircraft damage while towing. They found out that if they were to just paint the centerlines, more clearly, mark the clear zones where the tail zones are, that would help. They also standardized the lighting on the hangar doors, so they would know when the door was fully opened.. They also did a little modification to work platforms so work platforms were not banging against the airplanes. And also, as usual, when everything's screwed up they trained the humans. They also spent a little bit of money trying to audit whether or not they really repaired the problem. Here is the math. They estimated the fixes it to be about $52,000. They predicted a 75% chance of eliminating some of that damage. Alright so we multiply the point .75 times the damage, subtracted the cost of fix of $52K, which gives you $143,000 and divide that $143,000 which in a way its like your profit or your return by what you invested the $52,000 to give you a return on investment of 2.75. So that is an example of a return on investment of 2.75. Before I came here to talk more about ROI I actually typed in ROI, return on investment, I might have put the word "maintenance" in Google, figuring I'd get some information for you. Very quickly I got four Johnson papers. If you really want to look at the other papers honest to gosh if you type the letters "ROI and maintenance" on Google you'll find these papers right

Speaker	Dialogue
	away and the good news is some of them are on the FAA website. We did one another ROI where there was some damage in the paint hangar. All they had to do was fix the lifts, and fix the brakes to get the stickiness out of the lift controls. The airline got 5 to 1 investment.
unknown	Hey Bill
Dr. Bill Johnson	Yes.
unknown	On that particular one, that's because I saw that years ago what you did with Delta Airlines
Dr. Bill Johnson	Yeah that's right.
unknown	I applied that across the runway's over here
Dr. Bill Johnson	Yeah
unknown	About 3 years ago. We virtually eliminated our aircraft damage with [unintelligible].
Dr. Bill Johnson	Just by doing
unknown	But they forgot they, you know its one of those - we don't have that problem anymore its something else. But the savings we have just from that they've justified.
Dr. Bill Johnson	Now the point
Dr. Bill Johnson	I'm glad that you had said this Bill because I want to go back to the bicycle and your child. These small fixes and ROI demonstrations can be used to justify other Human factors interventions.
unknown	She's already got her keys, by the way.
Dr. Bill Johnson	I know she just turned 16 this year didn't she?
unknown	Yes just a few days ago.
Dr. Bill Johnson	Anyway these are just small examples of three, four, or five thousand dollar savings. In fact I did some cost benefit years ago in the nuclear industry and I went to a training manager and they had just bought a $17M simulator. And I said you know we're doing a study on return on investment and how did you do the cost benefit analysis to determine if you need a simulator? He said, well all I do is, I just tell my management that by having that simulator would prevent one full day shut down per year. I asked if he could substantiate that claim? He said no but that's the number I use one day and one day is return on investment to turn off a nuclear plant was high enough that he was able to justify the cost of buying that simulator. This nuclear plant ROI is not taking a baby step. The example was shortly after the Three Mile Island event. The industry was in a panic. Don't wish for such a purchasing environment in our industry. We cannot justify our human factors by saying they will prevent an accident. Accidents are few and many many interventions contribute to accident prevention. This workshop is an example of one such intervention.
Dr. Bill Johnson	Really what happens in the industry is that something breaks and then we hurry up and get it fixed so we can get back on track or get that flight out. Managers are not standing around doing basic ROI math problems….they are worried about the next push Let's try and cost justify this workshop, in case someone at AVS asks. How do you do math on an intangible object like safety? There are, of course, some answers we'll try to arrive at them. We can estimate cost and try to be safe but its really harder to estimate the costs of being safe. I

Speaker	Dialogue
	was going to ask the question so what are reasonable metrics that show that the safety investment has returns? So like the price of this work shop. Well here's my quick math of the cost of this work shop. What do you think it costs? Give me a number quick? Keith how much does this work shop costs?
Keith Frable	It probably costs near about $100,000.
unknown	No.
unknown	$18,000
Dr. Bill Johnson	18 you say?
unknown	More like 40
Dr. Bill Johnson	Keith, you cheated? Did you look ahead at my slides?
unknown	Does that include [unintelligible].
Dr. Bill Johnson	Cost is easy. The expenses - the expenses of this, this and a few other odds and ends, this is a little bit steep we know all bills aren't in.
unknown	[unintelligible]
Dr. Bill Johnson	Thank you sir. That's why you got the wrong answer by the way. Then you got the labor cost. Now what I did on the labor cost is, please don't debate this too much, but I just said $800 a day as you're saying come on man give me my 800. Well guess what, if you take whatever your salary is let's just say I think I figured 800 at a $100/hr obviously 8 times 100 is 800.
group	laughter
Dr. Bill Johnson	But if you're making $35-40 lets make it $35/hr I don't know if the math works out on that but I do know as spending a bunch of years in the industry as a consultant. I know how to figure total employee costs and overhead. Typically the multiplier is 2+ times the employee's salary It is even higher in government. I just chose to 1.2 to come out with about $24,000 for 30 people to be here about $24k for your time. I did not put in time for a replacement worker to do your job while you were gone.
Bobby Reed	Right.
Dr. Bill Johnson	Nobody right? But if you were fixing airplanes at AAR somebody's you got to pay that guy while the other guys are in a workshop or training.
unknown	Well I have to leave an actor back there to do my stuff.
Dr. Bill Johnson	Yeah. Well I didn't try to inflate the price it was already high enough and there was no need.
unknown	Bill do you want me to send my bill's in I'll increase that amount for you.
group	laughter
Dr. Bill Johnson	The delegates then would be 30 times I called it four days because you spent time travelling both ways. That would be $96,000 so we keep going here so really Keith I forgot its not 100 its $170,000 and that's really without any exaggeration does anyone think I'm crazy with that number?
unknown	No.
Dr. Bill Johnson	The mathematics are easy. In fact I think Keith demonstrated and Bobby you did too - you left an actor if you took the price on that person this number is even higher.
unknown	Right.
Katrina Avers	Or the amount of money in preparation because everybody did some planning.
Dr. Bill Johnson	On the accounting code. Yes. Alright so but $200,000 now Victoria probably went to you and asked for $200k I would have been out of luck.
unknown	Yeah.
Victoria	Yeah.
Dr. Bill Johnson	Okay alright so now that part was easy like I said figuring up the costs was easy. Give me the return number. I left that blank for the purpose of discussion.

Speaker	Dialogue
Jim Hein	5.5 to 1, trust me.
group	laughter
Dr. Bill Johnson	Jim, you're a quick learner.
Dr. Bill Johnson	There is a lot of safety value in the 2 days of networking and discussion. The final report will also help others.
unknown	Perhaps if you weren't looking at the cost of the accident but instead of
unknown	And what if we were to have grade as a group that human factors is the last variable in accident prevention. And if we were to say then that if we agree that human factors is the last variable we have to say what is the value of an accident and if we agree that no accident is acceptable no matter what the costs, human life has a value that is intangible, then based on the energy invested to date which we do know if we were to say we're half there we could calculate how much more energy we have to put it to get to the solution. So instead of working dollars we calculate time. And then we put the resources to meet the time to come up with a solution.
Dr. Bill Johnson	So you would say that the numerator would be time?
unknown	The numerator is time. That's correct.
Dr. Bill Johnson	Well you can put money time?
unknown	You can. But my focus if you try to make a dollar value, which you have to, then of course, you just then, you do. But I think you know how much energy has been put there, I mean it doesn't take much to figure out how many people have been working and what they produced. And then you have to trust me on how - how much, how close we think we are. And you know what you think you need to come up with, human factors solutions, so you come up with those - those deliverables calculate how much time it takes to produce those deliverables and then work it back.
Dr. Bill Johnson	I respect what you're proposing - they have a proposal because its hard to have any kind of proposal because this is so complex but the thing that worries me is, okay it concerns me about just trying to think about one thing like time is okay while we're doing this, ATC is doing that, and another organization is doing this, how do we attribute the cost in the cause and effect?
Keith Frable	Could you pull up a cost on our inaction whether than action?
unknown	No it’s the other way.
Keith Frable	Rather than accidents is attributed to human factors or to fatigue and so what those costs and man and lives and property damage, and by our inaction to continuing rate of those happening?
unknown	Uh um.
unknown	As opposed to not having this?
Dr. Bill Johnson	Let's do a sampling - take the accidents you showed us, 4 or 5, I think Katherine and I think everyone of those had a human factors component?
Keith Frable	Right and what the costs of those were? Or inaction of not having it would perpetuate or continue to -
Dr. Bill Johnson	Alright, so all we have to do is take those 5 accidents, we could put numbers on those, we know - we know what number you use for a life, and equipment. And then we, so we've got that
Katrina Avers	And investigation time, I mean all the time that it takes for personnel responding to it.
Dr. Bill Johnson	Alright but then what we would have to do is take the human factors specifically that you outlined right in the documentation etc. etc.
unknown	The ones we have in our 10 [unintelligible]
Dr. Bill Johnson	Oh actually if we use these 10 to approach this
unknown	Correct. And then by not coming up with this it would by not doing anything, see our job is innocuous if we don't do anything, you see the

Speaker	Dialogue
	results of our inaction. If we are doing our job you don't see the results of our action. On either accident rate stays the way it is.
Dr. Bill Johnson	In fact even you asked me yesterday about the reason. I don't have regulatory actions but we do have a lot of voluntary reports.
unknown	Correct.
Dr. Bill Johnson	And you're going to get one or the other.
Keith Frable	That's right. And so if we don't do anything you're going to get this as your result. By doing this we may eliminate the accident rate [unintelligible].
unknown	At the very beginning of the way you just read that I would avoid saying that human factors is the last step I would say it's the next step because there could be something further on you know I have every effort as we go down this road you know what I mean? You're first [unintelligible]
unknown	The reason I mentioned - I say that is because I - and I forget the reasons model I added one to that and what I said was you know the Swiss cheese model?
Dr. Bill Johnson	Sure.
unknown	That the last piece is human factors. That can prevent an accident. We have all the things that line up that create an accident in the chain but the last thing is the person that says whoa you know the human factors associated with the person making a decision that stops an accident so in reality if you have your human factors in tact every accident should be preventable.
Dr. Bill Johnson	And while you were saying that I was thinking of Reason's final book - well I think its fair to say it's his last book because Professor Reason is pretty sick, he is such a brilliant guy but his last book that came out 2 1/2 years ago was the *Human Intervention.* He spent his whole life writing about human error and he spent his last book writing about how the human prevents error and it's called the Human Intervention. It is an interesting read. Plus it also really is a good chronicle of all the other books that he wrote and then shows about how the human steps in.
unknown	You're following his job, you're not judged on what you do well. We're always judged on what we don't do well.
Dr. Bill Johnson	I'm glad we are having this discussion.
Guy Minor	I was just going to say Bobby in that book he does have another layer and its cheddar.
group	laughter
unknown	For what?
Guy Minor	There's a last layer just as you said
unknown	Oh.
Guy Minor	Reason put another layer up and its cheddar because there's no holes. The what he does mention that mice like cheddar and they eat away at the cheddar and the mouse is recoverable mistakes or errors that are not dealt with [unintelligible].
Dr. Bill Johnson	That would be technical documentation
Dr. Bill Johnson	Very good point.
Dr. Bill Johnson	Yes sir Jay?
Jay	I think you should consider the networking aspect of this. And one reason I say that is maybe you're probably familiar with the Pell program. I've been accepted into it - in it right now. They really, really promote networking they think it's very important to network so I think that's a return on investment.
unknown	That's kind of where I was going to, is take trying to put a dollar, even just like on education that you receive period, and then there's so many benefits that are not measureable you can do your tasks quicker, or with

Speaker	Dialogue
	more analytical observations or something like that - you can't really measure that enhancing your performances as each individual when we go back to our jobs so this trying to look for a dollar figure would be very difficult I think that listing the benefits that are provided in this type of work and I maybe looking at it too basic but identifying the benefits to something like this maybe more measureable?
Dr. Bill Johnson	So what we really would need to do in that equation there, why I'm asking this question, what's a safety return initially, to heck whether or not we can put a number on it, we don't have to do it now, but write those intangibles down and I mean, really I'm just making this up that AVS-2 would say give me the ROI on that - there's been no request for such thing. But if they're - I'm just looking for someone to blame someone to attribute the accountability to. You nevertheless you enlist that and Jay what you just said about networking any executive that would question the value of networking is kidding him or herself. Because they know darn well that it's their network that has them in the position to make the kind of brilliant decisions they do make.
unknown	This room touches some many organizations it's just unbelievable.
unknown	Uh huh.
unknown	Yeah
Katrina Avers	And I think for myself I think some of things that we've talked and learned is going to help me do my job more efficiently, which as a safety professional as many of us are, then I have a percent in - if I'm saving 20% of my time and night on who to contact and I know this resource is available and I can get it done more quickly, it's not that there isn't another 20% of work to do, there's more work to be done than I have time in the day so that is enabling additional safety related functions that otherwise would not even be possible.
Dr. Bill Johnson	By the way that answer is ultimately what FAA management used with OMB on the answer about the 20%. It was they weren't - they still needed that additional time to be efficient at what they were doing anyway. And we still need the help.
unknown	I think to Katrina I think having these contacts and knowing what everyone is working on in the different organizations will allow us to do a better, quality job I know some of the best input that I get for NTSB responses are from multi organizational answers and it shows that we're actually dealing with the issue from a more global perspective and [unintelligible] perspective. So knowing the resources [unintelligible].
Dr. Bill Johnson	Absolutely
unknown	Of who to talk to.
Dr. Bill Johnson	Absolutely
unknown	I think helps [unintelligible] way. In the quality of product. I mean we can throw out an answer but it won't necessarily speak to the issue quickly.
Dr. Bill Johnson	And yeah I'm sort of still trying to go back to this list and what you just said would go on that list. I really have spend a long time looking real hard to see how successfully people have put values on the safety numbers. And it's extremely difficult to find a document that does that. So the fact that its a challenge is not a problem, but its still a challenge that you want to give it your best shot and come up with an answer that you can sort of apply some logic to. So when you take this - does anyone want to make any last statement when you take this break think about anything you want to get on the record and maybe with your name on it because maybe this stuff that we do in that last 20 minutes or half an hour will be stuff we'll try to get in the executive summary on what advice we would give to AVS on what

Speaker	Dialogue
	came out of this work shop and what kind of things ought to continue to come in AVS like this workshop or continuation there of.
Dr. Bill Johnson	Yes sir and then we'll take a break?
unknown	Back to cost. It seems to be, as I realize but Keith said to, but it is hard to measure a failure to act. But I had mentioned to you earlier about the repair station
Dr. Bill Johnson	Yes sir.
unknown	And what they do is track the cost of errors and I imagine AAR does too. They have a cost charge every time the mechanic makes an error. So if you wanted to say how much of that is related to human factors we could say almost all of it because somebody made a mistake in trying to complete his task. So I think there are models out there or data out there based on cost of errors that have been captured and corrected. Like for example, they can't charge the customer.
Dr. Bill Johnson	Well you more than once have said, Bill get out here and let's go over there and ask them for that. Maybe we could trigger this meeting for us to go do that.
unknown	[unintelligible] cost code the R22 is what they call it and they do a lot of corrective action assessment on their own processes relative to those figures because those are errors that the mechanic makes that they can't charge the customer. Wasn't I reading something somewhere or somebody mentioned about multi million dollar mistakes down in a different air carrier that was just due to the mechanic and they're not billable. I mean I know I've made a few in my time. You know expensive errors but it sometimes is the Swiss cheese event. So there are places that you can get some cost accounting and that's one of the first things I mentioned, how could you but value on this on maintenance human factors errors?
Dr. Bill Johnson	So if we had that cost we know what some of the interventions costs. That was easy math.
unknown	Yeah at least from that staff on that population.
Dr. Bill Johnson	Okay. And we're going let's promise our self something you and I will get that done but it's that intangible thing called safety that we figure and I think the approach of lack of action might be easier to put money some action
unknown	Exactly. They say now, and that's a good point they are capturing the safety costs and preventing that safety issue by benchmarking those errors, so what's the value for safety there? Well they're fixing it because it has to be fixed for name safety but is there a cost of escape? Well there are things that do escape can get detected while the aircraft is in operation - hopefully not through a terrible event. So a lot of things aren't just fix them later. I mean once it's discovered.
Dr. Bill Johnson	And I think - so that's one action item. And another action item is to use Katherine's examples. Nothing against Martins. We'll use your accidents and so when we have to answer the question to ourselves why - why those accidents, but tell you what we had this workshop and we had to pick something out so let's pick that one out and let's run with your stuff. And maybe it will have interest to your organization as well when we get finished. I will do that, I personally must do that anyway so I look forward to doing that so.
unknown	If you want to set
unknown	Excuse me.
Dr. Bill Johnson	Yes sir.
unknown	One thing I've been - whether it applies or not. One thing I've been trying to build is all those examples that you were going through showing [unintelligible]

Speaker	Dialogue
Dr. Bill Johnson	Yeah.
unknown	Probability and all that
Dr. Bill Johnson	It's easy.
unknown	I'm trying to tie it with the traditional risk models that SMS is wearing and tie those two things together. Now for senior executives and other people that want to see what's this is costing me, they have a color, and they have a cost on return on investment, I think three pieces there, they might need so I'm getting there but
Dr. Bill Johnson	Yeah well you know costs and costs effects are interesting but if you really do the math that number on what you get back for what you do is really an even more interesting number.
unknown	[unintelligible] you know that's what their interested in.
Dr. Bill Johnson	Thank you for your attention to this sort of unsolved problem and I look forward to working with a lot of you to continue to come up with the answer even if we have to well we'll make the list.

Appendix N: Workshop Summary Slides and MX HF Concerns Discussion Transcript

Workshop Summary

2 Days of Presentation with extensive discussion

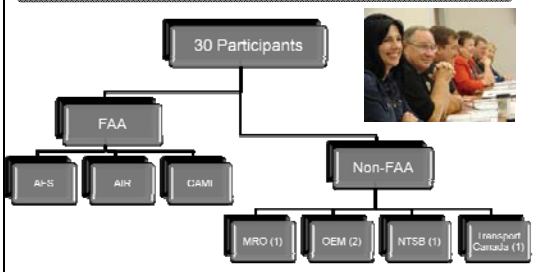
AVS Mx Human Factors Leadership Workshop
Civil Aerospace Medical Institute

CAMI
Oklahoma City, OK
August 4-5, 2010

Workshop Objectives

- Assemble AVS/AFS maintenance HF leaders
- Identify critical Mx HF challenges and solutions
- Set direction for HF programs and curricula
- Identify R&D priorities
- Contribute to uniformity of FAA Mx HF message
- Document proceedings with FAA tech report

Workshop Participation*



*Conclusions not necessarily endorsed by organizations

The "Top 8" Mx HF Challenges*

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

*Based on Rank Order

Workshop Action Items

- Address "Top 8 Mx HF Challenges"
- Work to combine Mx and Flight Crew fatigue rules
- Promote ↑ voluntary reporting and data analysis
- Address HF issues with use of technical docs
- ↑ situation awareness regarding RIIs
- Update advisory Circular 120-72 (on Mx HF)

Workshop Action Items (cont.)

- Continue/expand LOSA R&D
- Create system to audit Mx HF
- Expand/revise Mx HF Presentation System
- Consider rebranding "Mx Human Factors"
- Consider another annual FAA Mx HF Workshop

Workshop Photos

Thank You Workshop Participants

Anderson, Victoria	AVP-100	Johnson, Bill	AIR-100
Anglemyer, Richard (Rick)	SCSI	Keesey, Carl (Steve)	ASW-OKC-FSDO-15
Avers, Katrina	AAM-510	Kleiser, Terry	AGL-IND-FSDO-11
Banks, Joy	AAM-510	Larcher, Ken	AAM-600
Brock, Mark	ANM-SEA-FSDO-01	Maurino, Martin	Transport Canada
Capone, Brian T.	ASW-BTR-FSDO-03	Minor, Guy	AWP-204
Carroll, Greg	ASO-ATL-DELTA-CMO	Pittsenbarger, Dwayne	ASO-204
Ciaccio, Jennifer	AFS-310	Rankin, Bill	Boeing
Etheridge, Fred	Gulfstream	Reed, Bobby	ACE-204
Frable, Keith A.	ASO-ATL-DELTA-CMO-27	Schooley, Mary	ANM-117
Frazier, Victoria	AIR-103 CSTA	Sims, John	AAL-FAI-FSDO-01
Gileda, Kevin	AAM-510	Stahlberg, Vickie A	AWP-HNL-CMO-35
Hein, Jim R	AWP-204	Wallentine, Michele	ANM-RKM-CMO-21
Hiles, John	AFS-330	Wilson, Katherine	NTSB
Huntley, Bill	AAR CORP	Yeager, Nadine	ACE-200

Speaker	Dialogue
Dr. Bill Johnson	What I want to do is use this opportunity for you to say any other action items that you think we might have. I think we could run with a lot of things that were discussed, but is there something that you want to make sure we get on record?
Brian Capone	We have to attack that documents problem.
Dr. Bill Johnson	Brian comments like that are ammunition that we take to the TCRG. We just ran a two day workshop and documents emerges as the number two, number three problem.
Bobby Reed	Bill, I don't know when the next opportunity or workgroup is going to meet, but, I know that there are a lot of other national meetings taking place; the POI meeting's coming up, I know the PMI's are talking about getting together again, we have the FAST Team National meeting. I think it would be an oversight if we didn't somehow incorporate a chunk of training in each one of those on Human Factors so that all the other ASI's that don't have the benefit of sitting here know where we are at and where we can go.
Dr. Bill Johnson	Alright, so I think the next item from that would be a briefing package that anyone here could take that briefs what went on here, in maybe 10 to 20 slides, what's important and why, and what the recommendations from this group would be. One thing I am going to spare you and me the trouble of, is asking everyone to read it [report] and agree that that's what we want to say in the report. Trust me.
group	[laughter]
Dr. Bill Johnson	You probably like the idea that you don't have to read it.
Vickie	Just something that I thought about talking about procedures again, like why the mechanics are not following procedures; one of them being documentation with these several other issues, and a BDRP may be one avenue of gathering that data of seeing that a lot of the time someone [Unintelligible] the BDRP's, either not following procedures and just the current EIR's, another medium for gathering data on these events that are going out that are known for not following procedures.
Dr. Bill Johnson	So you're saying we should be looking at the voluntary reporting systems to see how often procedures is an issue?
Vickie	Yes.
Keith	I already have data for you on my ATOPS surveillance, so my quote of 55% of the data of my 'no findings' were in mechanics not following procedures.
Dr. Bill Johnson	Contact Keith for some specifics. Cause we're gonna also ask you the cost of not doing something too.
Keith	We have a chart of every no that we have and this last quarter we went over the no's that were found by the inspectors in the field; 55% of those no's of all the no's that were found last quarter were in the realm of not following procedures.
Greg Carroll	I'll be honest with you Bill, I didn't say anything about it when our list of favorites came out came out yesterday afternoon, but from my little corner of the world, that runs a close second behind fatigue as being an issue that we needed to address.
Dr. Bill Johnson	Alright, that list from our comments, I think that ended up being Second, didn't it? Lack of knowledge and training came in second. Oh no! It's tied with procedures. Oh my gosh!
Greg Carroll	Well. I mean specifically what I'm talking about, unless you can kind of file it under complacency, it's not on the list.
Dr. Bill Johnson	How could that not have been…
Greg Carroll	I filed mine under complacency.

unknown	A lack of knowledge is not knowing your GMA policies and procedures.
Dr. Bill Johnson	Okay, could we make the comment of complacency on our list is matched with documentation issues? Is that fair to say?
Guy Minor	I'd like to see some leadership training first. Maintainers, we teach them to be good mechanics, but we don't teach them to manage, so things like well leadership, assertiveness, communication, writing, public speaking and stuff like that. Non-technical stuff.
Dr. Bill Johnson	Believe it or not, even with the job title that I have, I would ask myself, does, should that be the responsibility of a human factors program, or does that fall into the area of management training?
Guy Minor	Well it is manager training?
Dr. Bill Johnson	I think that's a short coming, in terms of performance that needs to be addressed, we should document that whether it's human factors training or whatever kind it is.
Katrina Avers	Although we talked about some of those things when we were talking about generational gaps and I think that is probably where it's going to come far as assertiveness, and knowledge sharing, or knowledge gaps between our senior personnel and our junior personnel; and failure to be assertive in situations when you should, as a junior personnel.
Dr. Bill Johnson	Or one thing that did come up as part professionalism is being able to be a good mentor and maybe that ends up on the list too, but-
Bill Rankin	That use to be MRM, everything you just said was what we used to use. We even had a CD on an MRM 15 years ago that dealt with all those issues.
Bill Johnson	That's true - that's true.
Guy Minor	We have to say professionalism. We want our people to be professional what does that mean? Well it means that they communicate well and they are assertive and they're good leaders.
unknown	Well trained, well treated.
Dr. Bill Johnson	And so you want human factors programs to teach engineers to write?
unknown	Yeah
Dr. Bill Johnson	Please! I'd rather work on documents or fatigue. [Laughter]
unknown	[Unintelligible
unknown	Didn't you in Galaxy make a procedure writing tool?
Dr. Bill Johnson	Yeah, well we were the prime contractor Professor [Collinjury] and also the Clemson University contributed to that. It was steps for writing procedures and how to be sure that the language was clear. I forgot all about that. We need to go back and look at that thing.
unknown	Let's trot that thing out.
Dr. Bill Johnson	It's the good news is years ago Dr. Bill Sheppard and Gene Watson made a commitment that as much as we possible could put on the web, we would do. Now we now we started actually before we had web; well before FAA was putting all their stuff on the web with CD's where we had years of CD's, and then when we did finally start using the web our website goes back to the research that started in 1988 so that's pretty significant that we're able to keep that, that legacy data and thank God to FAA commitment. Many times, they had to go back and change a whole lot of formats to keep reports that we did in '88 up-to-date and compliant with putting it on the current FAA web. But we've been able to fight that battle and win it consistently. But if it goes away from the web for the most part a lot of that stuff is just gone. It's out of the literature, and a lot of it conceptually is still correct, you know, it's got 1990 publication dates but it's not ready to be thrown away.
Bill Rankin	Still got one of your old MRM CD's?
Dr. Bill Johnson	Oh absolutely. Yeah, but it's framed on my wall and the glue is on the

	outside where it's got the tracks, so I'll have to peel it off and scrap it with a screwdriver.
unknown	[Laughter] Bill?
Dr. Bill Johnson	Yes, sir.
Bill Huntley	Sometimes that I think would help us in the industry, is possibly PMI's PAIs whomever, when they're out during surveillance audits, and I mentioned it in that choppy briefing I had with you, if a company's violated by whatever means whatever it is, ask for the response instead of just technical information that is going to be put in for the response, force out of the businesses what human behaviors or elements or human factors were identified in your investigation? What do you do to correct it? I think it's going to force people to start even digging deeper into human factors in their businesses where it becomes an organizational norm and unfortunately my tact has been with because there was no regulation there was no FAA, to get a human factors program even started, I started asking friends of mine that worked for our customers, "Can you help me out, come into our organization, say you want to see a human factors program". So that kind of started the ball rolling, so it's the same concept I guess I'm asking from the FAA is-
Dr. Bill Johnson	Is not that a form? Like Keith, I keep going to you, but is that a form that a PMI would?
unknown	[Unintelligible]
Keith	What he is asking is when we send a letter of investigation over he would like us to include that you get down to the root cause of the human factors elements that caused the accident.
Dr. Bill Johnson	Do you force the company to do that?
Keith	However, we won't be able to do that without regulatory guidance.
unknown	Or guidance.
Vickie	The best that I know, what I did was when on voluntary disclosures knowing that Continental was utilizing their MEDA form is, I would put recommendations on the corrective action to ensure that they completed the MEDA and they've but that data into their system. But has far as forcing, them I couldn't do it.
Bill Huntley	Or asking?
Keith	On voluntary disclosure we can't ask for you to get down to the root cause and identify what human elements are.
Vickie	We can make recommendations
Keith	On an EIR you cannot because it's facts. Just the facts..
unknown	That's thinking, Kevin.
Bill Huntley	I think it's a gap, I think we're missing one because the business is going to give you what you're asking for.
Vickie	What is the business doing? Why isn't the business coming to us and saying, "You know we've got this human factors program and this is how we're analyzing our root cause of the problem and this is how we're fixing it".
unknown	Because it's the same thing you just said they don't have any [Unintelligible]
unknown	Yeah, but I mean if they [Unintelligible].
unknown	Well where I work, if it's needed, they always put it in there anyway. They've all [unintelligible]
Bill Huntley	There are a couple that do and they try to identify some of those factors, but I think if it became a norm where it was, I know it's harder to require that information within that but I think there's got to be a way.
Vickie	Maybe he wants the human factors requirement as long as you can.
unknown	Well just consider the human factors element part of your argument.

	That's how we do it. We just take the argument and consider it…
unknown	Well, I've identified things to Delta already in their SMS program, identifying the hazards and I've gotten them to react to that hazard so that's another way.
Jim	[Unintelligible].
Dr. Bill Johnson	Jim, yes sir this is great.
Jim	Is to begin to address other than all these little individual human factors, I mean we've been kind of wearing out the idea of human factors, and there's an overarching view that we can take and that's to change the safety culture of the organization. Not just the organization, but change the safety culture thinking of the individual. I think that if we do a movement to change the thinking about what safety culture is and to move toward a just culture, and knowledge culture and all the different types of culture that make up what we consider to be a safe culture.
Dr. Bill Johnson	From Reasons' book mostly.
Jim	Yeah well kind of well that's, that's the stimulus.
Dr. Bill Johnson	Yes.
Jim	We probably go, you know, even further than that if we really put our mind to it. But to you know we're kind of wearing out the human factor idea you know, people when they say human factors yeah we do have human factors we already have this human factor program but they haven't changed the culture, that drives those human factors so we need to get people and organizations to think about the culture that they work in. And whether or not this is a safe culture that I feel comfortable working in. And if I don't, to move on, and if I'm an owner you know, are my employees coming to work with a safety culture mindset?
Dr. Bill Johnson	Jim Hines.
Jim Hines	And they also need to understand particularly over the long terms there's no penalty to production for having a robust safety culture, and that's what you run into. Well I don't want to tie the guys hand because he still has to move the airplanes they stop short of what we would really like to see in terms of a good robust safety culture cause they're so afraid it's going to impact production; and over time, doing right doesn't have to come with a penalty in production. It doesn't.
Dr. Bill Johnson	I want to say one thing to Jim. I agree with what you're saying, but I have two 'sort of' responses not to be argumentative, but to be concerned. One is, while I agree with you full whole heartedly. If at the end of the day if we need to get money to do different things we have to break it down into the baby steps of fatigue, documentation, LOSA, and while all of those things comprise that culture you can get money in bits and pieces where as you said give me the money to change the culture it's like saying if we have if we have this workshop we won't cause an accident, it's like such a big thing, but we're gonna get the right words in there.
Jim Hines	I understand your reasoning on that and my response to that is if you've got a sickness, an illness that if I fix this place here, this place over here isn't getting fixed, but if I take a systemic medicine, everything gets fixed at once. By doing the safety culture then we can do the one shot instead of a hundred small shots. We can take one shot and fix it.
Dr. Bill Johnson	So documented, and we'll try to get those words in there and so elegantly stated we'll be sure you get your name next to it.
Katrina Avers	If you look down on your note pad and what we have so far, documentation, fatigue, you know kind of our final. We have our initial list that we came in with, and if we could write down kind of what we're coming up with right here.

Dr. Bill Johnson	Well we're writing everything people are saying here making a list of bullets.
Katrina Avers	Okay, well what I thought is that if we had that list up there we could then rank them and we could have again a hierarchy based on the whole group so instead of just
Dr. Bill Johnson	Would you be the writer?
Katrina Avers	Yeah.
Dr. Bill Johnson	Another thing about Human Factors, every now and then, I typically I don't know the last time I taught the dirty dozen, but anytime I say the word, I feel a pull back, my only comment on that, and with the word human factors, is I tell you okay, I tell you what, if everyone in here could tell me that they've cured all those 12 mistakes that Gordon Dupount identified I will never say the word again I promise. And I tell you what, if we think we've fixed all the human factors problems in the world, I'll never say the word again, I'll get my titled changed, email address at the FAA changed and that's nearly impossible, but I think I'd get the title changed. So you know, I think I'm still ready to beat up that word a little bit more but point well taken. You think Bill you need a new package for that word?
Bill	Yeah. I'm just you know people are tired of hearing runway incursions you know
Dr. Bill Johnson	But there down.
Bill	If you walk into a meeting and you say today and tonight we're gonna talk for about runway incursions for the next hour people get up and leave.
Dr. Bill Johnson	Yes
Bill	And that's kind of the way human factors is going to become if it isn't already. Is now we're going to talk about human factors. We go in and say let's talk about safety culture. What's that?
unknown	I don't use the word HF anymore.
Dr. Bill Johnson	You don't.
Bill	I call it delimitation of human performance
Dr. Bill Johnson	Well, Transport Canada did that quiet sometime ago.
unknown	When you say the word human factors everybody's like, oh no not again.
unknown	And what mindset is it that's going to effect things like failure to follow procedures and for mechanics to think about whether they needed RII inspection and you know whether their willing to gloss over a procedure or not do it because they think that the next guy is going to do it. It's the safety culture. The organization sets people up, sets mechanics up to do not do things or to do things that aren't safe.
Dr. Bill Johnson	So re-packaging of that term is one of the things you are suggesting?
unknown	Yes.
unknown	Re-packaging what, sir?
Dr. Bill Johnson	Human factors.
unknown	Human factors for the maintenance end.
unknown	Re-branding.
Dr. Bill Johnson	Thank you.
unknown	Great wording.
Dr. Bill Johnson	Yeah. There you go.
unknown	You know I think it's similar to CRM for pilots. I can't tell you how many airlines I ask about their CRM training and they go, oh yeah we do that, so what's trained? Nobody can tell you. Very few pilots can tell you what's trained in the part of their CRM program. So I think it's important to make sure that the mechanics are saying look maintenance was an

	understanding age but what's being taught, it's not the term that's used to package it, but I think that however that we're teaching it, is engaging to them so that they remember it, they fly it.
Dr. Bill Johnson	Do you think that the word fatigue is also getting, even though it's the problem is not even close to be solved, but the words got a problem as well. I mean Mark calls it alertness.
unknown	The popular thing about fatigue right now is Congress has it in their mind about aviation and fatigue and the Collegan accident and the NTSB talking about fatigue and the FAA has to do something about it, that makes fatigue really popular thing to talk about right now, particularly where there asking for money. But the thing that's going to solve fatigue is a change in the culture.
unknown	True but once again it's all about the pilots. And I'm wondering if we didn't just miss the boat on all that, we could have piggy backed onto that thing in maintenance, and had we miss that?
Dr. Bill Johnson	Well AFS-1 early on was saying that this was the opportunity to capitalize on that but I'm not sure that we have.
unknown	Well that was going to be one of my questions we talked a lot about [unintelligible] change it takes forever and that but you gotta start somewhere you know is that one of those we're going to put up there, an effort to put time limitations under the fatigue while everybody's talking about it now in Part 43 we talked about or something. And also to piggy back with teaching the safety culture I think we had mentioned, uh we're going to make sure it gets in the Part 147 schools so that the next generation grow up with it. And that's regulatory. If you don't make it somewhat in a regulatory you can talk all you want the big company's yeah you know, they may do it but anything below 121, unless you're a very large 135 and you've got other stimulus making you do it - forget it. It's not going to happen unless it's regulatory.
unknown	Absolutely.
Dr. Bill Johnson	That whole concept of safety culture I won't believe Jay was on that list in case they changed 147, would that be one of the topics covered in a 147 program. Was safety culture in that list?
Jay	I don't recall.
unknown	FAAST Team has been told to stand down from SMS. We could still talk about safety culture.
Dr. Bill Johnson	Well if you're told to stand down that worries me that the compartmentalization of SMS and the fact that silo said, "don't you touch it. It's ours."
unknown	It wasn't really brought about it in that way Bill, what was happening was, some FAAST team folks were out talking to repair stations and others about the SMS coming down the pipe and their wanting to know how soon and when. Then the FSDO's were saying we haven't even heard about it yet, and so we were just asked to stop briefing it.
unknown	Oh.
unknown	All of the FAAST Team was brought here to OKC, given a two week course about SMS, and on the last day they said don't talk to people about this.
Dr. Bill Johnson	It's a secret, is that it?
unknown	Well because AFS-900 took over the SMS and..
unknown	And they developed regional force of contact.
Dr. Bill Johnson	Right but that was because different messages were coming out about SMS and what we were going to do and it really is appropriate to say what we're gonna do when we know exactly what we're gonna do. We made the same mistake with talking about regulations. The FSDO were

	in their area talking regulations and somebody asks a question, we give them advice, they do something, and we really don't have regulatory advice authority.
unknown	But that's not what he's talking about. He's talking about the SMS team working with the AFS-900 were told by John Allen his words were stand down.
unknown	Right I understand.
unknown	We since past if we can present SMS with general aviation [Unintelligible] and we were told not to use those words.
unknown	Until everyone knows what it is we're going say and how we're going to deliver I think it is appropriate to say the right thing at the right time.
unknown	Well apparently the AC-120-92 is what we're delivering and that's all these people were given that information out.
unknown	And 120A is done just waiting to get reviewed to put out.
John	Well and the only change there is the framework.
Dr. Bill Johnson	Speak up. You're too shy John you're gonna have to speak up.
John	Well I was waiting, everybody's talking, but I do have something on the other side of this safety culture issue. It's probably a taboo subject, but in the 3 the 4 tragic accidents, what came out was not so much the documentation but these people didn't know what they were doing. They were young mechanics, young technicians who weren't trained. Their training wasn't complete. Now what shift were they working? A lot of this came out on the grave yard shift. I had a guy who said this is probably a taboo subject.
Dr. Bill Johnson	No. Nothings taboo.
John	But the thing here is how do we address laborer and the company's and say okay guys I realize you senior guys don't want to work at night but you have nobody working at night that understands the system. You have nobody here but young guys who are returning these aircraft to service who have no idea what their doing. And I thought that just sitting here listening to those presentations.
Dr. Bill Johnson	Well first of all, notice that is was #2, lack of knowledge so [unintelligible].
John	But I'm not talking intern, I'm not talking FAA safety culture, I'm talking getting out there and changing the company and the labor forces culture because that needs to change as well. We need to have the senior guys on that midnight shift to help you young guys who don't know what their doing.
unknown	[unintelligible]
Dr. Bill Johnson	The only way you'll get them there is if they're on overtime and they're 18th hour.
Dr. Bill Johnson	We got a real world answer here on this scheduling issue is that what you are going to talk about?
unknown	No. Actually, I was going to get away from here because I wanted to get back to this uh what do we have up there re-branding and that human factors term.
Dr. Bill Johnson	Yeah.
unknown	Kind of a precautionary note on that - is there's already regulations being developed using the term human factors if we change it now again it's no different than TQM, MRM I mean all these past programs are basically the same thing. So re-branding and re-naming it might not be a good idea.
Dr. Bill Johnson	Well, clearly this will be in the report as things that were discussed. That might not get the same level of attention as addressing the fatigue and documentation issues. I'm not sure. You know, we need to get this thing figured out. It's going to be fun.

unknown	Safety culture I'm not taking that away cause that is the home-run there. I mean to develop that, we're struggling with that daily.
Mark	Well I've been listening to everybody and I'm still stuck on my need for a model.
Mark Brock	But I'm going to put it together with some of the comments so far. So for example, if you're trying to ascertain the safety culture of any entity you need a baseline. And what would you establish the baseline around? Well I think the top 10 list here so if you went in and tried to look at values relative to shiftwork or schedules. So you say do you have an acceptable level of error or with the fatigue was real good example six tens when aren't you getting enough sleep? You go to a different entity and you might find that they need more or less sleep and it would be a baseline established on that culture. So, I keep thinking if you can capture the baseline in a model, determine what the parameters are, and then identify the risks when you are working inside the envelope or start to work outside the envelope, then you can start to put risk assessment to it, put barriers in place and let the culture know when they're at risk. Well for example, the young mechanic working at night. They would be identified from their model but that's a risk, so they may come up with a correction or a barrier or solution to that by giving them more training in the day time with the older guy or finding someone that wants to work at night but where do you develop these models from. I was looking at the LOSA up there the LOSA is a database that's trying to collect a trend. And a trend starts to establish at least a baseline and then from the baseline you can decide how much risk you want to use and you start to work outside the envelope or when are you well within the envelope. Because there are so many factors, you pick the top ten if you can model those top ten you might be able to change the priority cause this is somewhat subjective too.
Dr. Bill Johnson	Well but I don't think that top ten has changed much until the last two days based on the things that have been discussed.
Mark	No. Because it’s subjective I mean you have where's the dates to substantiate that well you probably have some for fatigue that is very high up on your list and you're getting a lot of input there. But or you may even validate your list based on the models that you developed based on the data that you can collect and LOSA would be an example. For me, that's one way to implement change if I could show people a model, a norm, if you will and where they're at risk. And how they can change that. So it’s, I think, it’s a little ahead of my idea cause my visions a little bit ahead of where you're actually at but if I had a model or something that I can point to and say well here is where you should be but you're over here, you're in a risk area. You need to do something to change the safety culture to bring it back into acceptable risk area.
Dr. Bill Johnson	Well I mean you're aware the FAA did spend a lot of money for a project that did that kind of thing through the University of ___ and had a web-based way of accessing the culture in an organization and identify
unknown	Could it be adapted to a maintenance environment?
Dr. Bill Johnson	Well it was used in maintenance environments, but I don't know where that stands because I don't think it crossed the bearer from a University project that required University hand holding to a real project that you give to a real company and say here it is, here's how it works have a nice day we'll support you if you need it, but you don't need us and that's the goal we have with our LOSA project as Kevin said so well you know we want to be sure that if it leaves CAMI, well it works for awhile but eventually, by design, that's for the real world to just use you don't have

	to call us as a anybody as a consultant to support it.
unknown	If you propose by regulation, a program, you can give them goals in that program to establish a baseline entity if you will to establish your risk assessment [unintelligible] any of these dirty dozen or top ten come up. I mean that would be part of a program goal whether it fits into SMS or not but I'm still looking for a model. When is fatigue becoming an issue? I mean.
Dr. Bill Johnson	Yeah. That's on our list and Victoria made a note to talk with Mark and ATS.
Dr. Bill Johnson	Yeah. That's for the cost stuff, yeah.
unknown	You get at least the cost of maintenance errors
Dr. Bill Johnson	Yeah.
unknown	Which should be relevant.
Dr. Bill Johnson	Which was about 3rd on the list as I recall.
Dr. Bill Johnson	Yeah.
unknown	Probably just due to a large degree human factors you can call it re-work the cost of re-work.
Dr. Bill Johnson	Yeah, there a whole ROI issue.
unknown	But the other ideas just trying to determine when any of these dirty dozen or these ten factors are really problems. I mean a measureable problem where you can say there is a risk and you can take an action to prevent it. I don't know how you do that.
unknown	If you change the safety culture but you have to have something to base it on, don't you?
Dr. Bill Johnson	Well, we do I mean we heard time and time again in the three presentations about some of the contributing factors or primary cause of an accident and they were some of those very things.
unknown	Yes.
Dr. Bill Johnson	That's very quantifiable.
unknown	Yeah, but those were like after the fact.
Dr. Bill Johnson	Yeah, indeed.
unknown	I know I'm not suppose to preach SMS.
unknown	That's something else the safety risk management part of an SMS sets up, allows an organization to analysis themselves and to set up the safety culture issue that will figure out when these different human factors are hazards and risks and what the levels of risk are and to build controls that will reduce the risks to acceptable levels. The LOSA is like part the safety assurance part of the SMS program where you test regularly to see if those controls that you put in place are working to achieve the reduced level of risk that you were shooting for.
Dr. Bill Johnson	You really got this down well, sir. You do.
Terry	No. I would just like to add, to that following procedures and technical documentation, that it does include also the general maintenance manual policy and procedures because what we run into a lot, or I've seen a lot, is although they'll make no mistakes early or mis-steps doing the task, they also and I'm stuck on the ROI stuff, they don't realize that there is policy within their own company that they have to look at when they are accomplishing that task as far as ROI. For instance if they are working on structural repair and they cut out the damage, the [Unintelligible] is not telling them what some things the [Unintelligible] is telling them, verify the materials or the [Unintelligible] contain so on and so on. [Unintelligible] ay attention to your maintenance manual [Unintelligible]
Dr. Bill Johnson	Okay.
unknown	I tell them that what some of things the GM are telling them, verify that

	the materials part of the [unintelligible] so on and so on. Just saying pay attention to maintenance policy procedures also it says they work in conjunction a lot of times and they made a mistake on [unintelligible] missing things that knowledgeable of their formal policy and procedures.
Dr. Bill Johnson	So you get the GMM right and it might over come some of the technical documentation issues.
unknown	Mine's real quick.
Dr. Bill Johnson	Yes, sir.
unknown	If we continue to look at how we capture a human factors data.
unknown	Yeah?
unknown	Cause it’s all over the board.
unknown	Objective assessment.
unknown	There's plenty of places when act on investigation. And the second thing is the advisory circular we have isn't, it's never been updated? Isn't it like
Dr. Bill Johnson	That is a very good point.
unknown	They really need to update that advisory circular because that's what we take to the smaller company's
Dr. Bill Johnson	It’s one on training more than anything else. The Human Factors Advisory Circular. That's what you're talking about right?
unknown	It’s 120-72
unknown	72. That's good.
Bobby	Okay, I'll be dunce. I wanted to piggy back on the comments about getting on this fatigue issue that Mr. Babbitt just addressed for the pilots and put a lot of energy there. I think the irons hot right now and I don't know if anyone else is familiar with the MET Towering issue associated with wind generators they go up in less than 20 minutes, they go at a 199 feet so they don't light them and they don't pay them. And they're a real hazard for ames operators this issue was raised; the Central region became the vocal point we put together a white paper, and sent it to Babbitt for influence use, for him to influence industry to take action in the absence of regulation. And I think that getting a white paper out of the findings and the thoughts of this group and of course yourself Bill, in getting that up to Mr. Babbit for influence in his communications with industry would be helpful.
Dr. Bill Johnson	Yeah. The comment I made at Victoria's we wanted an executive summary that would get to AVS-1 and-
unknown	Perfect.
Dr. Bill Johnson	Therefore, hopefully to the administrator. Very good point.
Dr. Bill Johnson	Alright. Bobby moves that we vote. I move we write down on a piece of paper our top concerns.
Katrina Avers	Okay. Put it on a piece of paper and give a ranking.

Appendix O: AVS MX HF Leadership Workshop Evaluation Form

AVS Mx Human Factors (HF) Leadership Workshop Evaluation Form

Please indicate your agreement with the following statements about the Maintenance (Mx) Human Factors (HF) Leadership Workshop. If you do not have an opinion about an item, skip it and go to the next item.

Workshop Content

	Strongly Disagree	Disagree	Agree	Strongly Agree
The workshop covered useful material	☐	☐	☐	☐
The workshop was well organized	☐	☐	☐	☐
Workshop activities were constructive	☐	☐	☐	☐
Workshop information was practical for my needs and interests	☐	☐	☐	☐
The visual aids and handouts were useful	☐	☐	☐	☐
The workshop format encouraged active involvement of participants	☐	☐	☐	☐
Workshop pace was appropriate	☐	☐	☐	☐
Presentations contained the appropriate level of detail	☐	☐	☐	☐

Participation Benefits

	Strongly Disagree	Disagree	Agree	Strongly Agree
The workshop helped to focus my thoughts about Mx HF	☐	☐	☐	☐
I gained new insights into Mx HF	☐	☐	☐	☐
I learned new information to help with Mx HF presentations	☐	☐	☐	☐
I learned new information to help me do my job better	☐	☐	☐	☐

The recommendations resulting from the workshop can benefit...

	Strongly Disagree	Disagree	Agree	Strongly Agree
Mx HF research and development	☐	☐	☐	☐
FAA senior management	☐	☐	☐	☐
FAA Mx HF operations	☐	☐	☐	☐
U.S. domestic aviation maintenance organizations	☐	☐	☐	☐

Overall Evaluation

	Poor	Fair	Good	Excellent
How would you evaluate the workshop training session overall?	☐	☐	☐	☐

How could the workshop be improved?

Any other comments or suggestions?

Appendix P: AVS MX HF Leadership Workshop Evaluation Item Report and Suggestions for Improvement

Summary Results for:

AVS Maintenance Human Factors Leadership Workshop Evaluation

August 2010 Workshop

Federal Aviation Administration
Civil Aerospace Medical Institute
Aerospace Human Factors Research Division
Oklahoma City, Oklahoma

And

Xyant Technology, Incorporated
Oklahoma City, Oklahoma

Explanation of Report Content

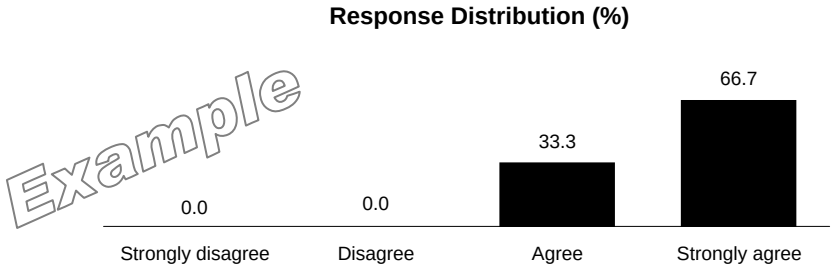
The Federal Aviation Administration's (FAA) Civil Aerospace Medical Institute conducted a Maintenance (Mx) Human Factors (HF) Leadership Workshop on behalf of the Office of Aviation Safety (AVS). Participants were asked to complete an evaluation following the workshop. The evaluation offered respondents the opportunity to provide suggestions for improvements and general comments about the workshop.

The evaluation form was distributed to all workshop delegates who attended the course (N=30). An invitation to complete the evaluation form was sent via e-mail and included a hyperlink to the survey. Completion of the evaluation form was both voluntary and anonymous. This report includes the evaluations, and comments and suggestions for improvement provided by all respondents (N=27).

Example of Report Format

3. Workshop activities were constructive.

n	m	sd
27	3.67	0.48



Descriptive Statistics

Number of Respondents (n). The number of people that provided a usable (i.e., valid) response for an item.

Mean (m). The mean is the arithmetic average, or the sum of all scores for an item divided by the number of people who answered that item. Means are provided for items answered on interval scales (e.g., Agreement). Each response option in the scale is assigned a number from 1 (low) to 4 (high). For example, on the Agreement scale, the first response option (Strongly disagree) would be assigned a score of 1, and the last response option (Strongly agree) would be assigned a score of 4.

Standard Deviation (sd). The standard deviation is a measure of dispersion, or spread, of scores around the mean. Smaller standard deviation values indicate higher levels of agreement among respondents.

Response Distributions (%). Distributions can show where perceptions are negative or positive by looking at the percentage of the respondents choosing low (1 and 2) or high (3 and 4) response options. Items are written so that a response of 3 or 4 is positive.

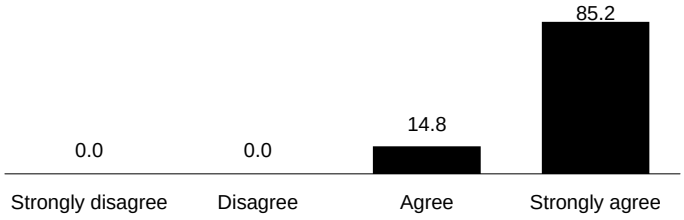
AVS Maintenance (Mx) Human Factors (HF) Leadership Workshop Evaluation

Workshop Content

Response Distribution (%)

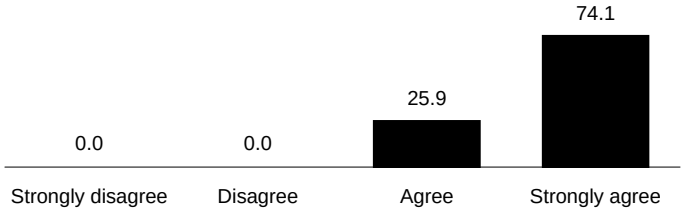
1. The workshop covered useful material.

n	m	sd
27	3.85	0.36



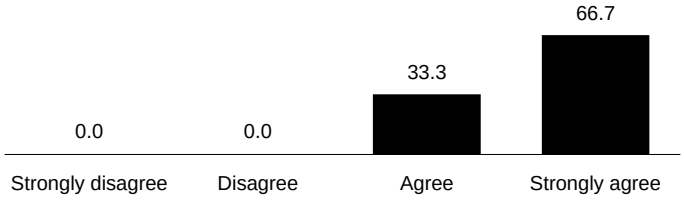
2. The workshop was well organized.

n	m	sd
27	3.74	0.45



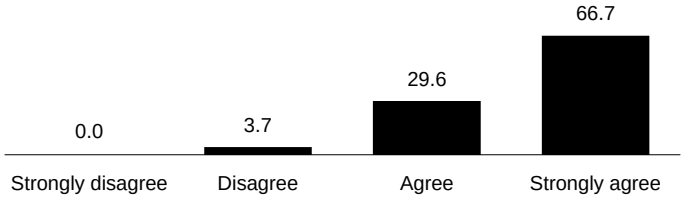
3. Workshop activities were constructive.

n	m	sd
27	3.67	0.48



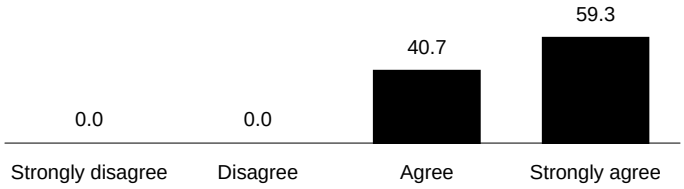
4. Workshop information was practical for my needs and interests.

n	m	sd
27	3.63	0.56



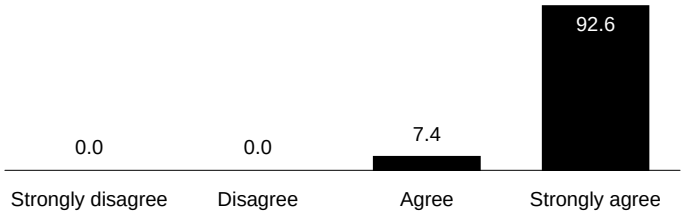
5. The visual aids and handouts were useful.

n	m	sd
27	3.59	0.50



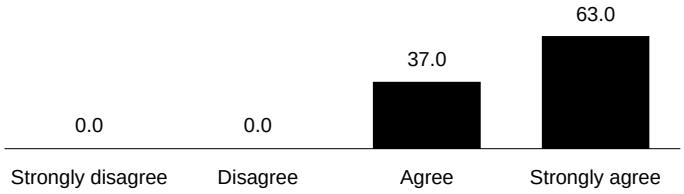
6. The workshop format encouraged active involvement of participants.

n	m	sd
27	3.93	0.27



7. Workshop pace was appropriate.

n	m	sd
27	3.63	0.49



Response distribution percentages may not sum to 100% due to rounding.

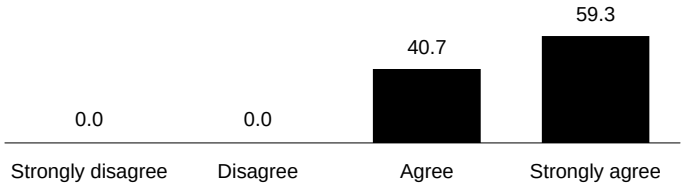
AVS Maintenance (Mx) Human Factors (HF) Leadership Workshop Evaluation

Workshop Content

Response Distribution (%)

8. Presentations contained the appropriate level of detail.

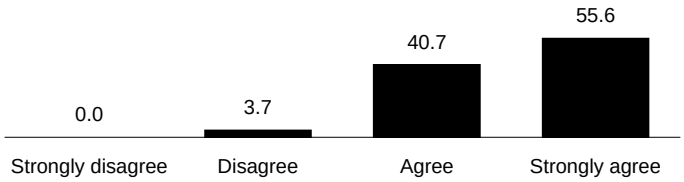
n	m	sd
27	3.59	0.50



Participation Benefits

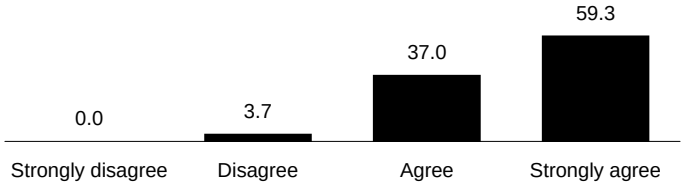
9. The workshop helped to focus my thoughts about Mx HF.

n	m	sd
27	3.52	0.58



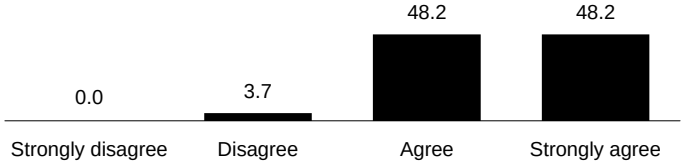
10. I gained new insights into Mx HF.

n	m	sd
27	3.56	0.58



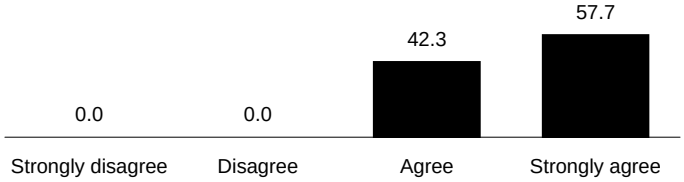
11. I learned new information to help with Mx HF presentations.

n	m	sd
27	3.44	0.58



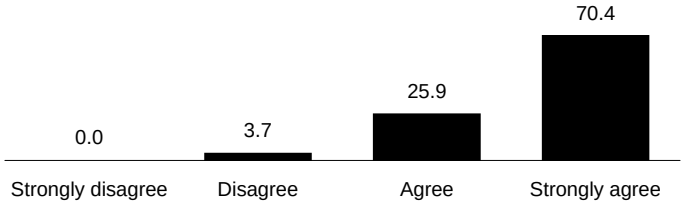
12. I learned new information to help me do my job better.

n	m	sd
26	3.58	0.50



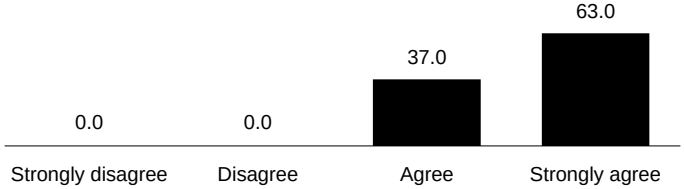
13. The recommendations resulting from the workshop can benefit Mx HF research and development.

n	m	sd
27	3.67	0.55



14. The recommendations resulting from the workshop can benefit FAA senior management.

n	m	sd
27	3.63	0.49



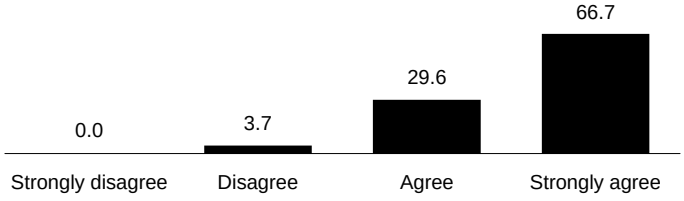
Response distribution percentages may not sum to 100% due to rounding.

Participation Benefits

Response Distribution (%)

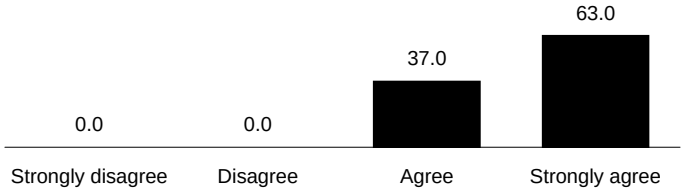
15. The recommendations resulting from the workshop can benefit FAA Mx HF operations.

n	m	sd
27	3.63	0.56



16. The recommendations resulting from the workshop can benefit U.S. domestic aviation maintenance organizations.

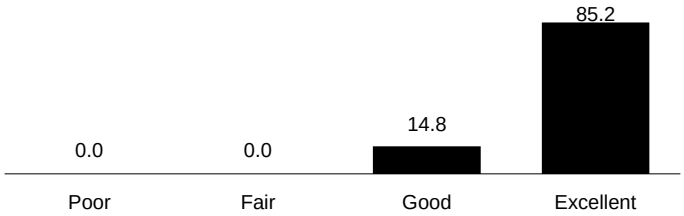
n	m	sd
27	3.63	0.49



Overall Evaluation

17. How would you evaluate the workshop training session overall?

n	m	sd
27	3.85	0.36



Response distribution percentages may not sum to 100% due to rounding.

Recommendations and Comments

How could the workshop be improved?

** "1. Remove time constraints. This workshop could easily use 3 days assessing this topic 2. Remember the majority of the work force is NOT large air carrier. This work shop focus highlighted the Legacy carriers when, in fact, we have a larger issue with the general, 91, 91K and 135 work force. Granted these Legacy carriers garner the majority of the limelight, but we need to address the rest of the aviation community as well."

** "1) Spend less time on introductions. Have each participant prepare a one (or less) biography with contact information that can be handed out to the group on the first day. 2) Have each participant prepare a two-page position paper about the human factor they see as most important; giving examples and suggesting possible solutions. Break into small groups of participants with similar interests and have them present their paper to the small group. Small group discuss and report back to the large group with results/findings/suggestions. Make copies of everyone's position paper available to all participants. Recommend written feedback to the authors of the papers where appropriate."

** "A half a day longer with breakout sessions."

** "A little better arrangement for the speakers to stand out of the way of the materials they were presenting. Better if the computer was on the podium."

** "Another day would have been nice. There was so much excellent information and participation, toward the end of the second day we were a little rushed."

** "Don't change a thing ... top notch meeting! Would love to see the momentum continue and new topics discussed within this group for future sessions. I see great organizational and research value in continuing this interaction. I appreciate the invitation to be involved. Thanks!"

** "I think it would be important to maintain the momentum by organizing follow up meetings."

** "I think that if we would have remained with the original plan to break up into smaller groups and brainstorm ideas, using a facilitator that we could have developed a more organized list of ideas. The agenda was probably a little too aggressive, in that the schedule was very full."

***Indicates next comment.*

How could the workshop be improved? *(Continued)*

** "It could be a regular event. Perhaps an annual one."
** "Make it a recurring event."
** "Polycom in more people to expand our base group. Facilitation."
** "Probably need one more day to continue the great conversations and sharing of info and experiences."
** "Second workshop addressing MX lack of knowledge issues."
** "Size was right. Content was right. Format was right. No changes."
** "The only improvement I would recommend would be extending it one more day. The discussions and issues were so dynamic and had many diverse factors, I would have liked to have spent more time exploring some of the more controversial subjects."

Any other comments or suggestions?

** "Excellent workshop. Info will be very valuable for Transport Canada."
** "Great job organizing. Food was a very nice touch -- thank you. The presenters and presentations were good -- and all presented different information. I appreciated being able to take part in the workshop and got a lot out of it. Thanks to all."
** "Great job. Very professional. Suggestions above might not make the workshop better; just thoughts about different approach."
** "I enjoyed the workshop and I appreciate being included with this group of highly talented and skilled group of people."
** "In this evaluation form, my opinion is that a neutral should be a selection between agree and disagree."
** "It was great to meet others who are working human factors projects. For instance, I had not met Kevin Gildea or heard very much about maintenance LOSA."
** "Joy, you did a great job hosting this workshop."
** "Make this an annual event with different participants."
** "Recognizing that this was a very good first meeting to get everyone acclimated to the format, the people, and the free flow of ideas with respect to HF, perhaps it would be advantageous to define some specific goals and deliverables for the next workshop, and maybe even assign some follow-up tasks. Global cultural change in aviation maintenance is going to require a lot of work by a number of impassioned people."
** "Thank you."
** "This workshop was one of the best I have attended in my 15 year career with FAA. Ms. Joy Banks provided outstanding support, again the best I've seen in my career. She provided detailed information, responded quickly to any questions, and kept us abreast with updates and reminders."
** "Workshop should happen annually."

***Indicates next comment.*