Vol 2 I Issue 3

FEATURED ARTICLES

Written by maintenance human factors professionals dedicated to identifying and optimizing the factors that affect human performance in maintenance and inspection. Past newsletters @ humanfactorsinfo.com

A Revisit of Top Modern Maintenance Human Factors Challenges

Dr. Bill Johnson

About the Author: *Dr. William Johnson is the FAA Chief Scientific and Technical Advisor for Human Factors in Aircraft Maintenance Systems. His comments are based on nearly 50 years of combined experience as a pilot/ mechanic, airline engineering and MRO consultant, professor, and FAA scientific executive.*

In 2010 we dedicated a Chief Scientist/Civil Aerospace Medical Institute Workshop to identifying the top maintenance human factors challenges in North America. The European Human Factors Advisory Group also ranked the challenges in 2010. We conducted the same ranking in North America and Europe (EU) in May of 2014. There were no large changes in the rankings. This paper compares the studies and describes the European and North American approaches to address the top maintenance human factors challenges.

The 2010 List of Challenges

The 2010 list is based on similar, but separate, studies. In 2010 the North American and European ranking of the maintenance challenges had a 60% agreement/overlap in the top 5 challenges, as shown in Table1. The matching challenges were Worker Fatigue, Safety Culture, and Measuring Impact of MxHF Programs. This ranking reinforces the fact that humans are humans and have the same maintenance challenges no matter where they are working. One significant difference is that Europeans have the challenge of 28 national regulatory authorities and many others, including North America, with whom they have bilateral agreements (meaning that local FAA and other non -EASA National Aviation Safety Inspectors enforce the EASA regulations).

Table 1. Top 5 NORTH AMERICA EU Maintenance Human Factors Challenges in 2010

North America	Europe
• Using Technical Publications	• **Measuring Impact of MxHF Programs***
• **Worker Fatigue***	• Expanding MxHF across all European Countries
• **Safety Culture***	• **Worker Fatigue***
• Voluntary Reporting	• **Safety Culture***
• **Measuring Impact of MxHF Programs***	• Standardizing Regulatory Oversight

Note: (*) Agreement between North America and EU

The 2014 International Rankings

In the 2014 study the European and North America Study were combined. A single web-based questionnaire provided the data in 2014. It was sent to a selected sample of the maintenance industry in North America, most of who were involved in the 2010 ranking activity. Twenty-five percent were from Europe, the rest from the North America. Seventy five percent of the Europeans and 60% of the North America sample responded within the allotted time frame. The end result was that 75% of the responses were from the North America. It has a larger aviation industry so this representation is acceptable. The questionnaire was open-ended. The respondents did not pick from a list but merely wrote their own short description of the challenges.

Sixty three percent (51 responses) returned answers. That is a very respectable response rate to an open-ended survey with a short response

window. Some respondents later told that they queried their workforce and managers before responding. We are certain that this sample size and number of responses yielded valid and reliable information.

The top five challenges represented 67% of the combined EU and North America responses. Table 2 shows the list of the top challenges that combines all respondents. The combination of Culture/

Table 2: Top 5 Combined EU-NORTH AMERICA Maintenance Human Factors Challenges in 2014

- Culture/leadership
- Technical Publications
- Worker Fatigue
- Voluntary Reporting
- Measuring Impact of HF Programs (tied with "HF Training")

Leadership, Using Technical Publications, and Fatigue represented 50% and 54% of the votes in EU and North America, respectively. The Europeans included "Oversight and Regulations" in their top five. In North America there was a four-way tie for 4th place to include "HF Training," "Pressure/ Stress," "Measuring Impact," and "Voluntary Reporting." In other words, again there was general agreement between EU and North America.

The open-ended responses were high value. The author and Ms. Joy Banks, a Psychology Technician from the FAA Civil Aerospace Medical Institute, deliberated on the interpretation and categorization of the responses. The work was tedious but interesting. Table 3 shows examples of the information rich free-form challenge statements that were coded into one of 21 categories.

Table 3. Example Challenges from Respondent's Comments

- Leadership managing to outcomes rather than process - workforces tend to receive this message as "our procedures aren't important enough to adhere to"
- Safety Culture - Maintenance issues that cause accidents or perpetuate poor maintenances begin with management making a conscious decision to lower the bar
- Application of *Just Policy* to lead a *Just Culture* for improved reporting
- Failure to follow procedures/processes policies
- Fatigue/alertness - Company needs to develop and enforce a max duty time for AMT's
- Complacency: Doing things on a routine basis and by-passing the maintenance manual. e.g. tire change
- Integration of Human Factors principles into day to day operations

Comparing the Two Surveys

The results between 2010 and 2014 are consistent, with a 75-80% overlap in identified challenges. Since it was extremely difficult to separate comments about culture vs. comments about leadership those categories were combined. The result was that "Culture/Leadership" moved to the top of the list. The EU continues its struggle with consistent member states so that challenge remains in the EU top five. North America identifies "HF Training" and "Pressure/Stress," which are not in Europe's top five. The fact that there are more similarities than differences is significant. It means that EU and North America can share approaches to address the challenges.

There similarities from 2010 to 2014 should not be too alarming. The challenges are complex and ingrained in aviation maintenance. The challenges are part of the culture and "Culture" takes a long time to build and a long time to change. The good news is that FAA and EASA have been actively addressing the challenges with applied research programs and proposed or enacted regulatory changes. Enactment and additional proposed Safety Management System (SMS) regulations in the EU are a step in the right direction. FAA also has pending SMS rules that will begin with the

airlines. While SMS was not addressed in the top five it is certainly an important corrective action to address many of the challenges. FAA SMS regulations, especially for airlines, are proceeding toward adoption. FAA Administrator Huerta has also placed highest strategic priority on "Risk-Based Decision Making." This process uses data-driven tools to make smarter, risk-based decisions about safety. Since human performance and human factors are among the highest risks in aviation one might expect increased attention to this high risk area.

Products and Regulations to Address the MxHF Challenges

It is one thing for research to identify challenges. That is the easy part. It is more important that the R&D finds and tests practical solutions to the challenges. That is happening and there are plenty of examples.

FAA and EASA have been addressing the top five challenges, even before the 2010 list was identified. Many of those efforts have been described in this FAA Maintenance Human Factors Newsletter and also AMT Magazine, Ground Support Worldwide, and other publications. EASA has created regulations for human factors training, over 10 years ago. New EASA proposals (See EASA NPA 2013-1 and 2013-19) are suggesting new content for HF training, stricter HF knowledge requirements for HF trainers and ASI inspectors, and requirements for a Fatigue Risk Management System for maintenance organizations. Those regulations will impact the 1,500+ North American EASA Part 145 certificate holders.

FAA's robust MxHF program has created a variety of solutions for topics like Fatigue Risk Management, Measuring Impact of HF Programs, HF training, and more. That information is available on the convenient website address www.humanfactorsinfo.com. Table 4 shows a partial listing of products that are on the website.

What You Should Do

Responding to the survey and reading this article is helpful but is a mere start or continuation of your quest to tackle the challenges. The top five challenges are not new and many of the solutions are available. Your job, in industry, is to convince your managers to commit to enacting the solutions and to dedicate the necessary resources. You must be proactive when you see something that is a likely hazard that contributes to overall safety risk. Your job, as a manager, is to take a leadership role in addressing these known challenges that are contributing to risk. You must encourage all workers to voluntarily report potential hazards. Tell everyone about such reports. Strive to alter the reporting culture. Your job, as a regulatory inspector is to ask your airlines and repair stations what they are doing to address the top five MxHF challenges in their organization. You may not be enforcing a specific regulation but you will be fostering a positive safety culture. In the meantime FAA, EASA, and other regulators must evolve and support the products that they created with their industry partners. Expect to see me, Bill Johnson, doing that!

Table 4. Sample information on FAA MxHF Website (www.humanfactorsinfo.com)

- Maintenance Fatigue Web-based Training System
- Fatigue Video entitled "Grounded"
- Calculate Return on Investment – Procedures and Software
- Workshop reports on: Fatigue; Using Technical Documentation; Collecting Voluntary Data
- Line Operations Safety Assessment for Maintenance – Procedures and Software
- The Operator's Manual for Human Factors in Maintenance
- The Maintenance Human Factors Training Program – 150 PowerPoint Slides with 11 Videos

Comments – Send comments to **bill-dr.johnson@faa.gov.** Let's start an industry dialogue.

Dr. Bill Johnson is the FAA Chief Scientific and Technical Advisor for Human Factors in Aircraft Maintenance Systems. Johnson is a member of the Human Factors Advisory Group to the European Aviation Safety Agency (EASA). Johnson is a pilot and an A&P for close to 50 years.

Presbyopia: Why Near Vision is Important to the Safety Management System

Dr. James W. Allen, M.D.

About the author: Dr. Allen is a retired navy physician specializing in the prevention of health effects due to workplace exposures. He works on a consulting basis primarily to human relations and safety departments for government and corporations. Results of his clinical and environmental findings save companies lost work time, make them safer, comply with health laws, and improve workers' health. He can be reached through his web site www.WorkingHealthyAlways.com or email at jallen@workinghealthyalways.com.

Physical Limitations Experienced by AMTs

Latent Medical and Environmental Conditions (LMEC) refers to physiologic limitations experienced by the AMT that originates from disease, normal aging, and occupational exposures. They are a link, identified as the red link in the chain of events that leads to a maintenance

Figure 1: The red link is a LMEC in an accident chain

incident (figure 1). While LMEC have always existed, they have been invisible to the Safety Management Systems (SMS). With the aging of the workforce, public health officials have highlighted common age related conditions. A major signpost in the aging process starts at about age 35 years when most individuals first notice difficulty reading fine print. For mechanics, their loss of near vision impacts their job performance. A SMS can no longer ignore the latent effect of this age related condition. Understanding this LMEC, called presbyopia, is the first step toward breaking the red link.

Aging Eyes

Accommodation is the subconscious process that allows the lens of the eye to focus light on the retina. This process changes in a predictable pattern with age. Prior to age 35 years focusing between near and far object presents no problem. Starting at that age, objects held further away are easier to see. Presbyopia, meaning old eyes, is the medical term for this loss of accommodation. A review of the anatomy of the eye and an understanding of refraction, bending of light, provide an explanation for presbyopia.

The lens focuses light images onto the retina, the structure with the visually active rod and cone cells. Light from far object, generally considered more than 20 feet away, requires less refraction than light from near object (1). For far vision, the lens is in the relaxed condition. Refracting of light by the relaxed lens places a sharp image on the retina (figure 2)

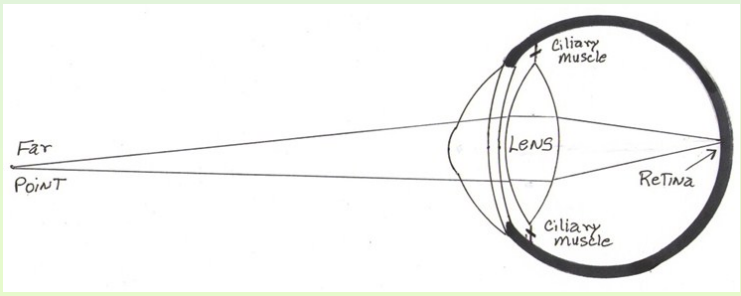

Figure 2: Anatomy of eye for Far vision. (used with permission of the author)

Near vision requires more refraction of light than far vision. Contraction of the ciliary muscles changes the shape of the lens providing the additional refractive power (figure 3, next page).

Starting in the teenage years the lens loses it elasticity but the effect is not noticeable until the early forties. With this loss of elasticity, the ciliary muscles become less effective in changing the shape of the lens . The refractive capability of the lens declines (2). Diopter (D) is the unit of

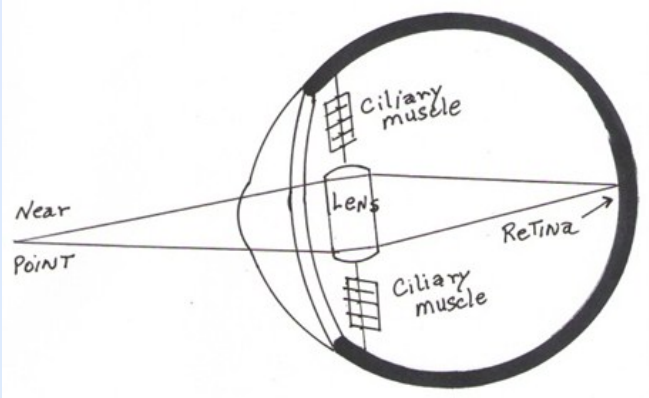

Figure 3: Anatomy of eye in near vision. (used with permission of the author)

measure related to the near point of focus.

Accommodation, measured in D as integers and decimals, shows a linear decline until about age 52 years when all accommodation is lost, figure 4.

Aging Eyes Symptoms

Clinical symptoms of presbyopia usually start with a complaint of difficulty seeing fine print. Over-the-counter reading glasses starting at +1.0 D help for a short time. These lenses bend the light coming from near objects to supplement the lens' refractive power. As presbyopia worsens near vision requires more refractive power so readers with +3.25 D or sometimes higher are commonly available. Eventually, everything inside of 20 feet looks blurred with the unaided eye. Prescriptions recommended by optometrists include spectacles that contain bifocal, trifocal or progressive lens designs and corrections for other defects in the aging lens. Other common symptoms are complaints of discomfort during attempted reading and a noticeable delay in focusing when changing fixation between distance and near objects. Individuals older than 52 years are completely dependent on prescription lenses for near vision.

Why is presbyopia a red link in an accident chain? Consider visual inspection of the aircraft, a major duty for most AMT. Advisory Circular (AC) 43-204 details the visual inspection process. For good inspection this AC assumes a trained inspector with binocular vision and good visual acuity (emphasis added) (3). The AC's assumption of good visual acuity may be incorrect considering the aging of the

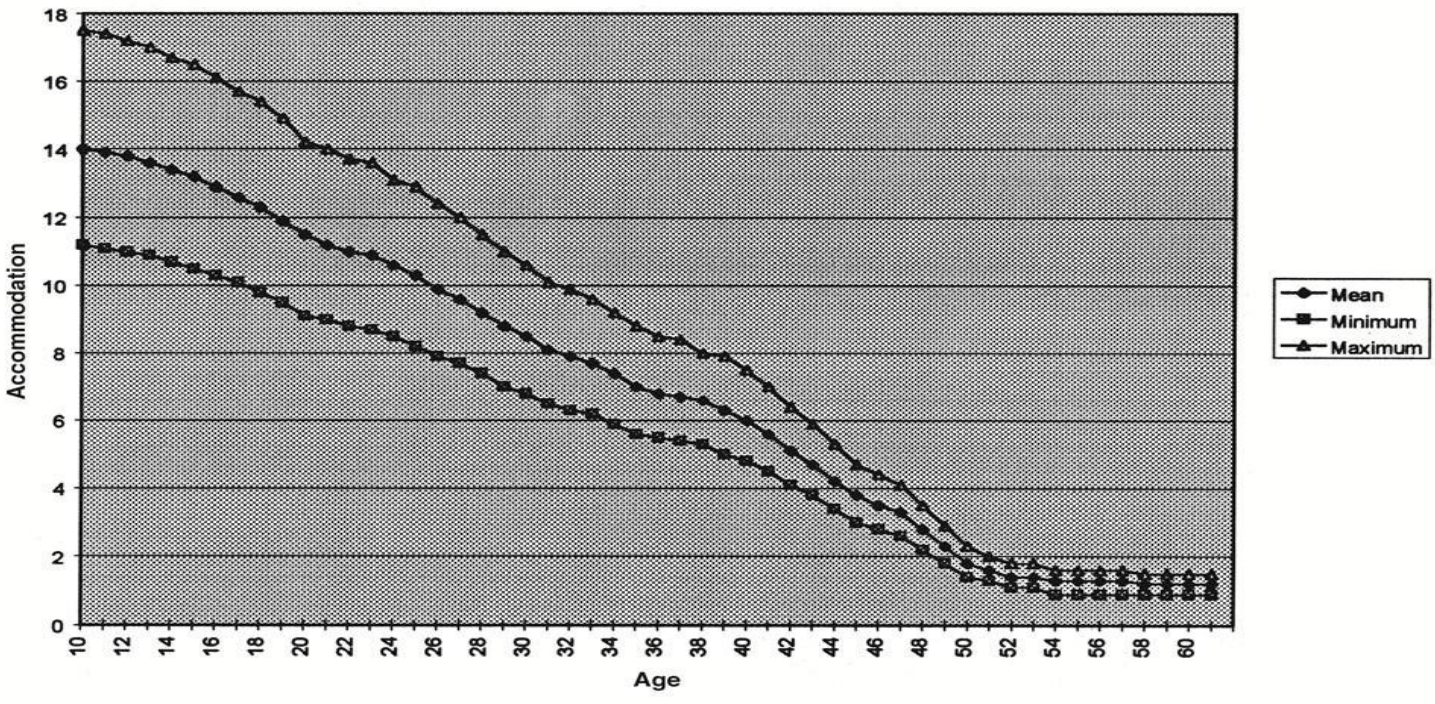

Figure 4: Numerical values of maximum, minimum, and mean diopter of accommodation by age: (Taken from Clinical Neuro-Ophthalmology, page 730, based on Duane A. JAMA 1909)

workforce. With the average AMT age of 53 years in the US, 58 years in Australia, and 45 years in Europe, figure 4 shows that accommodation is completely lost at these ages.

Will prescription spectacles or over-the-counter readers reverse the effects of presbyopia for those older mechanics who inspect aircraft? While both offer additional refractive power, the wearer must recognize their zones of vision. Figure 5 shows the zones of vision for five common lens designs used as correction for presbyopia (4). For each lens design, this figure shows the areas of fixed-focal vision. Those wearing bifocals will note a line of

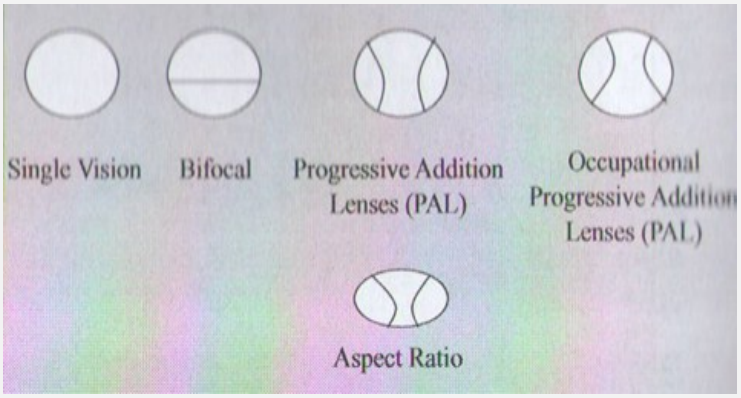

Figure 5: Zones of fixed-focus vision for different designs of lens commonly prescribed to correct for presbyopia (taken from reference 4)

discontinuity producing changes in the image. For other designs the optical performance produces blending of near and far vision (5). In other words, readers and prescription spectacles can compensate for loss of accommodation but wearers must be knowledgeable which zones of vision will place the image in sharp focus. Head and eye movement may be necessary to ensure clear vision of the work under inspection.

Breaking the Link

How can the SMS break the red link formed by presbyopia? The first step is a risk assessment of those work processes that require inspections. Common considerations involve the tradeoff between speed and accuracy of the inspection process (6). From this assessment the manager can determine the potential risk from presbyopia. Education of the employees, especially mechanics over the age of 52 years, provides awareness training to those most likely affected by presbyopia.

Aging affects a variety of health conditions, including the severity of chronic disease and impact of on-the-job injuries. Presbyopia is the age related loss of near vision that can hinder the inspection process. Since this condition can influence safety of flight, identifying its risk through the SMS is appropriate.

References

1. Cassel GH, Billig, MD, Randal HG, The Eye Book, Baltimore (MD), Johns Hopkins Press, 1998, p 9-10
2. Walsh & Hoyt, Clinical neuro-ophthalmology Baltimore (MD): Williams and Wilkins; 1998. P 728 – 730.
3. US Dept of Transportation, FAA," Visual Inspection of Aircrafts", Advisory Circular 43-204 chapter 1 paragraph 1, August 14, 1997
4. Remple D . "Updates in Occupational Health, lecture series", UCSF (San Francisco) March 2014
5. Meister DJ Fisher SW. "Progress in the spectacle correction of presbyopia, Part 1 Design and development of progressive lenses" Clinical and Experiment Optometry 2008; 911:3:240-250
6. Melloy Melloy BJ, Harris, JH, Gramopadhye, AK. "Predicting the accuracy of visual search performance in the structural inspection of aircraft" International Journal of Industrial Ergonomics 26 (2000) 277 – 283
7. Readers' Comments: For comments on this article, respond to redlink@workinghealthyalways.com . Future issues of the Newsletter will publish readers' comments.

Comments – Send comments to Dr. Allen at jallen@workinghealthyalways.com

Ground Operations Line Operations Safety Audits: LOSA

Mr. Kevin P. Crowley

About the Author: Kevin P. Crowley is a Senior Ground Safety Analyst at JetBlue Airways Corporation. He has 21 years of aviation experience and has been with JetBlue Airways Corp. for thirteen and a half years as ground operations instructor, ground damage investigator, Certified Quality Auditor with the American Society of Quality, OSHA General Industry Instructor for the U.S. Department of Labor and ground LOSA program coordinator.

Line Operations Safety Assessment (LOSA) is a predictive data collection process to complement the Safety management System (SMS). It helps to identify and manage risks within airline operations. It capitalizes on *Threat and Error Management (TEM)* principles and pays particular attention to human factor issues. This article describes successful implementation in a ramp environment.

Threat and Error Management understands that threats (such as unfavorable weather), errors (such as speeding on the ramp while driving GSE), and undesired states (such as a late arriving aircraft) are everyday events that employees working in an airport environment must manage to maintain the safety of aircraft and equipment, other employees, customers and themselves. A healthy LOSA program will support predictive analysis of events that occur on during normal, everyday operations. A primary goal of a LOSA program is to provide a systematic approach to control risk and to ensure that the risk controls are effective. This program is an operational strategy for real-time data analysis of normal operations. Results from this analysis support organizational change based on employee threat and error management at the ramp operations level.

Line Operations Safety Assessment is comprised of several characteristics that include:

- Peer-to-peer observations during normal operations,
- By trusted and trained observers,
- Using observation techniques based on Threat & Error Management (TEM) philosophies

Joint management/labor sponsorship must be coordinated to ensure success. Such cooperation provides a “top down” support with a “bottom up” implementation approach. Ground operations employees that have the opportunity to participate in safety programs such as LOSA, gain knowledge and understanding of what being “safe” actually means. Such understanding helps build a company safety culture as well as taking the correct steps towards a “just” culture. Trained

observers that return back into the operation help develop ground employees into more mature advocates for safety in the organization.

The word "assessment," like "audit," often has negative connotations. The words suggest there could be "findings" or "violations." That is not the case. If you look at safety programs that are implemented throughout the aviation industry and ask yourself, how do you best promote teamwork? The simple answer is: **You work TOGETHER**. The data collection process, or "assessments" are non-

punitive. They are **anonymous and confidential** with observational data being housed in a secure database. Once data has been collected, organizations verify the data with a LOSA team and operational leadership. That results in data-derived targets for improvement. These targets can focus on areas such as improving initial and recurrent training programs, enhancements to operational policies and procedures, and more accurate manual revisions that support safety in the operation. Feedback from the LOSA observations, when communicated back out to the workforce, helps ground operations employees understand threats, and errors, as well as risk that is in the operation. They become better risk managers.

Let's look into risk factors and errors that are present in the everyday airport operating environments. Threats are considered something (normal or abnormal) which could lead an employee into a situation that can cause him or her to commit a potential error or result in a bad outcome. Errors occur when a mistake or threat has been mismanaged. **Managing errors requires recognition and correction before** these errors have a negative consequence to safety. Some types of errors are intentional, often because of non-compliance with procedures. Others errors are mistakes caused by such factors as miscommunication. Proficiency errors and operational decision errors can be inconsequential to safety, but can also lead to an undesirable state if not addressed correctly or ignored. This may also lead to additional errors and may make situations worse.

Error management is a process that focuses on the errors that have been committed by employees in the operation. It identifies the errors and implements a corrective action plan in order to eliminate them. Error management may also try to contain the errors or reduce their severity. Error management is often considered managing the past where threat management is considered managing the future.

Once threats are identified through the LOSA observations a more in depth assessment of these identified threats can be addressed. Implementing controls to reduce or eliminate the risks from these threats and every day hazards, present in the fast paced environment on an airport ramp, will prevent employees from committing errors. **LOSA results will also identify repetitive errors and risky behavior**, such as procedural noncompliance. Examples may be, not wearing required personal protective equipment (PPE) or taking shortcuts during a process in the operation.

Safety programs are commonly developed as a response mechanism to events (incidents and accidents) that have already occurred in the operation. Line Operations Safety Audits (LOSA) can help actively identify hazards in real time, through the analysis of the organizations processes. **A healthy LOSA program will also assist with proactive analysis** that closely looks at the system processes and environment to identify any potential problems that may occur in the future based on past and ongoing observational data.

One of the main objectives of LOSA is to identify employee behaviors that lead to effective and ineffective threat and error management. There are many "red flags" or as mentioned, "threats" that

occur in the operation at any given time. Usually they do not lead to an accident or incident. However; if an error is committed due to the mismanagement of threats, the probability of an accident or incident increases. LOSA helps

organizations understand employee response to these "red flags" or "threats" that have not led to negative consequences (errors) such as aircraft and equipment damage or employee injuries.

Human Factors affect employee behavioral choices and decision making. Ground Operations Safety Assessment (LOSA) is a tool that can be used in the operation to help identify threats, errors and undesired states and can assist in building strategies and mitigation plans to reduce risks in the airport environment. LOSA helps front line employees become better threat managers by actively identifying threats in the operation. It helps build a safety culture by encouraging open and honest communications and fostering teamwork.

LOSA works for my company, in ground operations, at all of our locations. I am quite sure that it will work equally well for maintenance. I encourage you to access the LOSA materials that are available on the FAA website (www.humanfactorsinfo.com).

Send Comments to Kevin Crowley at Kevin.Crowley@jetblue.com

www.humanfactorsinfo.com

The FAA maintenance human factors site was launched in the late nineties. Its popularity grew tremendously over the years. Google hits reached in the hundreds of thousands yearly by 2010. Being over a decade since launched, the website was overdue for a "Heavy Check" to improve its search engine and public accessibility. Fortunately, the "Heavy Check" was not an "out with the old and in with the new." It continues to serve as an important dynamic repository of reports, conference proceedings, and other important MX HF materials. The new HF in Aviation MX website can be found at the original address hfskyway.faa.gov or under a number of alias addresses like humanfactorsinfo.com, and mxfatigue.com. Take a look today and please pass this information to your colleagues.

If you have a story to tell that will help enhance aviation safety, please email katrina.avers@faa.gov or bill-dr.johnson@faa.gov. The editorial staff will help writers with layout and graphics.

If you would like to be added to our quarterly distribution list, please email joy.banks@faa.gov

Broadening the Reach of this Newsletter Involves You!

This Maintenance Human Factors quarterly Newsletter is in its fifth year. It started as the Maintenance Fatigue Focus Newsletter but after a couple of years it changed titles to include all of maintenance human factors. There have been a number of industry contributions to the Newsletter and that has helped readership to get a "Real World" perspective. The Newsletter needs more of that!

The frequent authors are Bill Johnson, Joy Banks, and Dr. Jim Allen from Working Safe Always. However, Newsletter writers do not have to have an MD or PhD after their name. We would rather see A&P or IA as important credentials.

You send me E-mails about critical maintenance human factors issues that you observe in your workplace or elsewhere in the industry. Those E-Mails are articulate. They tell an important story. They start a dialogue. We need more of that. Example applied topics could be: how you are using ASAP reports, how you discovered a maintenance error, or how a particular intervention was a big maintenance savings. We also extend an invitation for aviation maintenance students to send in a short article. Everyone associated with aviation maintenance is welcome to contribute to this Newsletter.

Here's how article submission works. The writer submits an article to Ms. Joy Banks (joy.banks@faa.gov), from the Civil Aerospace Medical Institute. She reads and edits the document. She gets rid of the "big" words and long sentences. She makes it more readable and understandable before sending it back to the author for approval.

Article length can be from 500 to 1,200 words. That is a page or two. As you know, MS Word has a feature that counts words for you. This article has about 500 words. It is difficult to make a point in a short article. However when you know what you are talking about it, is an easier task. When it comes to maintenance human factors, you know what you are talking about. Interesting high value articles do not always have a solution. They can highlight a problem and emphasize that a solution is necessary.

You don't have to write the article first. Instead, E-Mail Johnson or Banks with your idea. We will get back to you on how the topic fits the Newsletter. We may offer some writing tips and will also give you the production schedule to be sure we can get your idea to the newsletter as quickly as possible.

Your Questions Answered

In this issue of the newsletter we have listed each author's E-mail address. Send the author a comment or a question. If we get appropriate response we will feature a Q&A section in the next newsletter.

Sincerely,

Dr. Bill Johnson