

# Aviation MX

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## HUMAN FACTORS

### QUARTERLY

#### HUMAN FACTORS TRAINING FOR FAA AIRWORTHINESS INSPECTORS

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#### Summary

FAA Aviation Safety Inspectors (ASIs) have a variety of primary responsibilities that are related to oversight. However, they also are safety advisors. This article describes the current training that helps prepare Airworthiness ASIs to have the knowledge and attitude to be able to add value to new and evolving maintenance human factors programs. Johnson writes this article having just participated in a class for ASIs.

#### Introduction

When friends and colleagues ask me about some of my favorite activities as the Chief Scientific and Technical Advisor, I always comment that it is my interaction with Airworthiness Aviation Safety

Inspectors. In my opinion the ASI workforce are the primary FAA safety ambassadors to the industry maintenance management and workforce. They may be a bit like the "Beat Cop" who rides a bike or squad car through the neighborhoods. The good guys like to see them around while the bad guys are not as comfortable. Most ASIs worked a lot of their career, in industry or military, doing the very same jobs that they now oversee as FAA Inspectors. They know the technical content and can relate to the work challenges. This is particularly true with respect to knowledge and attitude about maintenance human factors. I like to teach the ASIs because they are very enthusiastic about addressing

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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](http://humanfactorsinfo.com)

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human performance. Plus, their stories about human error are usually better than mine. Both the professor and the students learn in the maintenance human factors classes (Figure 1).



Figure 1. Author in an ASI HF Class

### Current Delivery Method

The Department of Transportation, Transportation Safety Institute (TSI), currently delivers the FAA human factors training. TSI also teaches many of the FAA's accident investigation courses at the Accident Investigation School in Oklahoma City, which makes human factors a topic familiar to their staff. In fact, the dedicated accident investigation center served as the course site for the past couple of

classes. All Airworthiness ASIs receive a 3-day instructor-led Human Factors in Aviation Maintenance course reaching about 2,500 ASIs in the past 8 years. Many have also received refresher training by repeating the dynamic course. TSI's course structure is extremely flexible making it easy to modify content and instructors based on the feedback given by attendees. Class size can be as many as 30 students but averages about 25 allowing for extensive student discussion and event investigation activities.

### Introductions

As the instructor I emphasize that ASIs, by nature of their pre-hire industry and subsequent FAA activity, often know better human factors stories than the instructor. We can dedicate as much as 2 hours to student introductions, where many offer a personal experience of a significant event related to human factors. The stories are often serious and may have

involved substantial damage, injury, or loss of life. I have noticed, repeatedly, that ASIs take their safety job very seriously. They feel the emotion when an organization that they oversee has a serious event. Of course they are the governmental oversight but they also are a partner to ensure safety. When stories get too serious I revert to an experience I had while training a group of international human factors trainers. In that example, a Chinese student, speaking about communication, warned westerners to be careful when using hand gestures in China. She demonstrated that an extended/spread thumb and index finger meant the number eight (8) in China. The German student next to her showed that the same hand gesture meant two (2) in Germany (Figure 2). He further exclaimed that he now he understood why he received 16 beers when he extended the hand signal at

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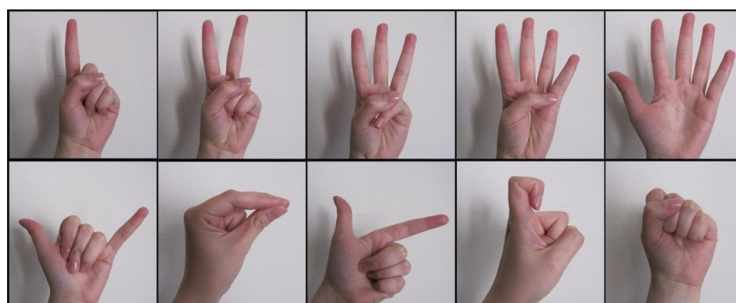


Figure 2. . Beware. Hand Signals are Culturally Dependent – A Communication Lesson. Arabic numbers as represented by hand signals in China. (Image Credit: <http://thought-ripples.com/archives/tag/images>)

## HUMAN FACTORS TRAINING FOR FAA AIRWORTHINESS INSPECTORS (CONT...)

2-for-1 happy hour in Beijing! Another student, from the UK, indicated that the North American “thumbs up”, in the UK, can be equated to on the

**Table 1. Sample Content from June '15 TSI HF Course**

Review of Fundamentals
Communication
Fatigue
North American and European Maintenance HF Challenges
Use of Technical Publications
Questions to Assess an HF Program

meaning of an extended middle finger in the US.

### Example of Current Content

The content in the recent June 2015 HF class varied considerably. It started with a 2

hour presentation from Mr. Jeff Coe, of the TSI staff on sensing, perception, and cognition. He borrowed on the term “fast thinking,” from Daniel Kahneman’s NY Times best seller *Thinking Fast and Slow*. Mr. Coe also spoke about conscious and subconscious decision making, using practical examples. The purpose of these topics was to highlight the many ways in which the human perceives actions and content in the world, and how one acts on those perceptions. Knowing how we take in information helps to explain why and how there can be errors.

### The Johnson Content

There are a variety of

applicable topics for a 3-day HF class. I make the assumption that participants have already had some initial human factors training while capitalizing on materials that are available from the FAA maintenance human factors website ([www.humanfactorsinfo.com](http://www.humanfactorsinfo.com)). I use supplementary materials from current publications like AMT Magazine, Aviation Week and Space Technology, Flight International and more. I’ve also found that utilizing recent NTSB reports are a good way to stay abreast of current accidents/events. Table 1 contains the contents of the June '15 course.

The contents from Table 1 are supplemented, throughout, with example accidents and events related to the topic. One such event is a quick small-group analysis of the *Titanic* event. In this activity, the class is given a handout describing the events leading up to the infamous sinking. Unbeknownst to the students, however, half the class received the accurate story while

### Whatever Works for You: “The Models”

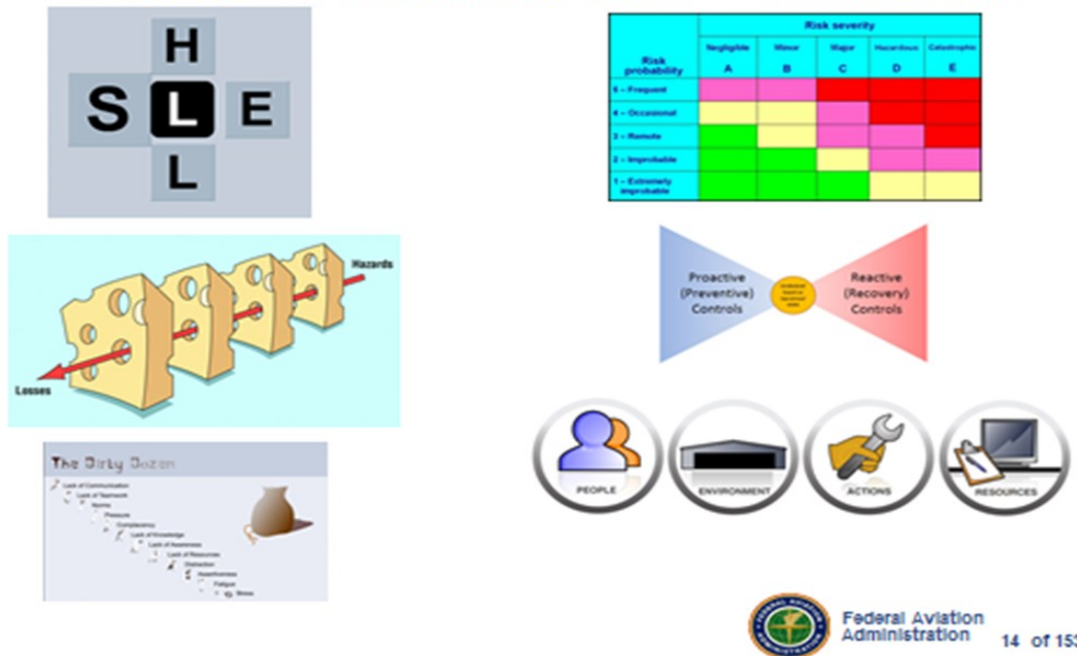


Figure 3. Six Fundamentals for Assessing Human Factors

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Figure 5. Go to YouTube to see [Grounded](#)



the other half received a modified story. In the modified story, the threats were mitigated and the *Titanic* arrived safely in New York. The outcomes of this exercise were interesting. The groups that received the "Threat-Mitigated Version" had so many preconceived notions that they needed to re-read the story in order to see all of the facts. Without knowing the outcome, the students needed to re-read the story in order to see all of the facts. The groups receiving the accurate story finished faster and had a long list of "wrongs". It was an excellent

reminder to carefully consider all event details before making conclusions of the outcome and contributing factors.

### **Review of the Fundamentals**

I remind the class that even the very best golf pros and other professional athletes continue with weekly lessons. For that reason I cover the information in Figure 3. I pay particular attention to the PEAR Model, which focuses human factors on People, the Environment, the work Actions, and the Resources necessary to complete the job.

Another "Fundamental" HF topic is worker fatigue and

fatigue risk management. The content that supports that section of the course also comes from available FAA content. There is a two hour web-based fatigue awareness training program available at [www.FAASafety.com](http://www.FAASafety.com). That training is supplemented with a 20 minute video entitled [Grounded](#) (Figure 5). In this fictional story, a maintenance manager suffers from a number of personal life issues which lead to fatigue and bad decision-making. The fastest

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## HUMAN FACTORS TRAINING FOR FAA AIRWORTHINESS INSPECTORS (CONT ...)

way to access that award-winning video is [YouTube](#).

The topic of worker health and safety are also important points within the course. Dr. Jim Allen has covered the topic in this Newsletter for the past year, referring to it as, "Latent Medical and Environmental Conditions" (LMEC). LMEC includes all of the conditions related to the health and safety of maintenance workers. For example, we are an aging workforce. That means the population is at risk for diminished hearing, vision, flexibility, and more.

Some of the factors are merely a function of age. Others are a function of the noise, stress-inducing, and vapor-ridden environment in which we have worked for a long time. Dr. Allen emphasizes that "worker health and safety IS flight safety." Some say that the topic is for OSHA to worry about, it is not a FAA issue. Dr. Allen contends that safety is an FAA issue. With that in mind, he emphasizes that we should be cognizant of all factors that affect safety, including worker health.

### Other Speakers and Topics

Since the DOT TSI is able to have real-time changes to the class, the course is often supplemented with speakers from varying backgrounds and perspectives. For example, Dr.

Michelle Bryant from the Civil Aerospace Medical Institute spoke to the class about an on-going sleep study that will focus on maintenance workers, flight mechanics, and cargo load supervisors. Mr. D. Smith from DOT TSI delivered the DOT view of Safety Management Systems. Many ASIs commented that Mr. Smith covered the topic in a way that allowed them to see the unique relationship between what maintenance crews see every day and their role in mitigating error through SMS reporting. His focus on those "in the trenches" brought a fresh perspective to the underlying purpose of SMS.

Day 3 of the class included Mr. Jeff Grenier, who presented from the perspective of the safety department of an air carrier. He combined stories from the airlines with discussion of the Dirty Dozen and safety nets that may have prevented accidents. Mr. Pat Duggins joined the course for the last 3 hours to explain human factors as an experienced aviation mechanic in MROs and General Aviation maintenance environments. His discussion brings a great deal to the course with a focus on the realities of maintenance errors for the mechanics, the organizations, and the industry as a whole.

### Summary Perspective

Aviation Safety Inspectors are

excellent safety ambassadors and human factors advocates. One reason these classes are so great is because of the ASI participants and their willingness to have extensive discussion in every class. ASIs comment that they like and learn from interacting with the mix of inspectors from GA, 121, 145 and more. The blend of military and civilian experience also keeps the class interesting. The June '15 class had an average aviation experience of 32 years. That makes for some excellent high value human factors "story telling" and shared experience. This instructor/student is always looking forward to the next maintenance human factors class experience.

**Comments** – Send comments to Dr. Bill Johnson at

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## EXPOSURES IN THE WORKPLACE: LMEC FOR THE AGING WORKERS

JAMES W. ALLEN MD, MPH

**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](http://www.WorkingHealthyAlways.com) or email at [jallen@workinghealthyalways.com](mailto:jallen@workinghealthyalways.com).



Previous articles examined how anticipated or abnormal medical conditions influence the AMT's work. Reduction in near vision is a signpost of aging that is anticipated in all AMTs over the age of 50 years. It compromises the visual inspection of aircraft. Obesity is an abnormal medical condition that leads to multiple metabolic changes. It produces behaviors described by the Dirty Dozen of human factors. These consequences from normal aging or abnormal medical conditions are classified as Latent Medical or



Figure 1: Red link in an accident chain is LMEC

Environment Conditions (LMEC). They form the red link in an accident chain, figure 1. Breaking this red link interrupts the chain that could lead to an undesirable event.

Exposures at work can cause disease or disabilities. Can exposures also form the red link of the LMEC? To highlight the difference between disease

and LMEC, consider two exposures that have expanded medical knowledge. The first occurred in 1914 at the start of WWI (1). Airplanes were new technology used by both the German and Britain military. Workers building these aircraft began to die from a work process

involving doping (figure 2), a process that attaches then shrinks fabric to the fuselage and flight surfaces. Fortunately, both the German and British physicians were sharing information about these deaths. After experimentation using dogs, the German physician identified Tetrachloroethane (TCE) as the offending agent. Both countries used TCE as a component in dope because of its non-flammable characteristics. After absorption through the skin, TCE destroyed the liver resulting in the long and painful death of many workers. This unfortunate situation advanced the understanding of solvent absorption, liver physiology, and protective methods for workers.

Less dramatic but equally informative was the disability experienced by workers using vibrating tools for polishing and burring metal aircraft parts in 1944 (2). These workers experienced numbness and blanching of the fingers, a medical condition called "white finger." This condition occurred after an average of eight

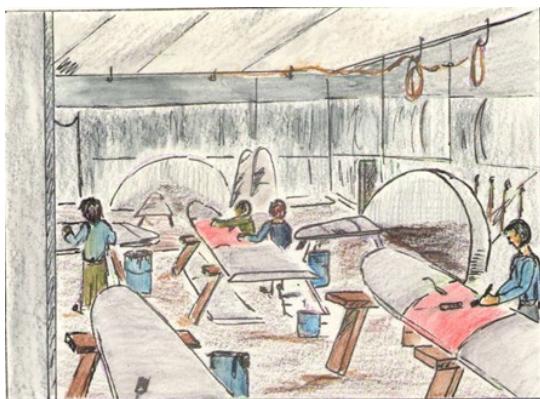


Figure 2: Doping process in a factory without workplace controls of the TCE hazard. (based on a 1917 photograph provided by Glen Curtis Museum, Hammondsport, NY) (used with permission of author)

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## EXPOSURES IN THE WORKPLACE: LMEC FOR THE AGING WORKERS (CONT ...)



**Figure 3.** Refrigerator and other kitchen items next to work areas inside the hangar

months of usage of the vibrating tools. Some workers, especially females, experienced white finger after one month. Other risk factors that

increased the likelihood of white finger were the manner of holding the tool and the temperature of the work environment. These disabled workers advanced the understanding of a condition now called Hand Arm Vibration syndrome.

While some learning though a negative experience is inevitable, most prefer a preventive approach. For example, by 1925 TCE was excluded as a doping chemical in military procurements. In the 1970s, workers received broader protection from work place exposures through legislation such as the Occupational Health and Safety (OSH) Act in the US and the Health and Safety at Work Acts in the UK. Both these acts use a concept of Occupational Exposures Limits (OEL) that is specific for each chemical or physical agent. Exposures below the OEL are considered to have low potential

**Table 1.** Medical effects from workplace exposure found in repair stations

Exposures to	Medical effects
Solvents, CO	Cardiac effects
Lead	Hypertension
Ergonomic stresses	Joint and muscle limits
Acrylates, solvents	Skin rash

to cause a disease or disabling condition.

Understanding the assumptions for creating an OEL illustrates how exposures below that level can still lead to disease or disability. Under the OSH Act the legally enforceable OEL is called the Permissible

Exposure Limit (PEL). Assumptions used to establish a PEL are a normal aged working population, 8 hours of exposures followed by a 16 hours of recovery period and exposures limited to a single agent (3). The aging workforce challenges the first assumption. A Health Hazard Evaluation (HHE) of a repair facility by the National Institutes of Occupational Safety and Health (NIOSH) explores the not-so-subtle effects of workplace exposures below the PEL. Aviation safety is not assured with exposures below the PEL.

In May 2012 scientists from the NIOSH visited a repair station and flight school after the family doctor identified elevated blood lead levels in a child who was at the repair station daily. Assessment of the child's home found no obvious source of lead, so the scientists examined the worksite. Aircraft at the station used 100LL fuel containing tetraethyl lead. Inorganic lead is a byproduct of combustion. Lead also originated from sandblasting sparkplugs. Poor shop hygiene combined with food service inside the work area (figure 3) spread lead well outside of the work area. Testing showed lead dust throughout the station, on the child's toys, and in personal vehicles. Employees had blood lead levels that were below the PEL.

Since the PEL was not exceeded, employees may falsely assume that unlike the child, they experienced no ill effects of the lead.

Acute lead poisoning from



**Figure 4.** Doping process in a factory with ventilation, separated work process, and workers using protective aprons and goggles (based on 1918 Buffalo, NY, photo 86-5702, National Air and Space Museum) (used with permission of author)

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## EXPOSURES IN THE WORKPLACE: LMEC FOR THE AGING WORKERS (CONT ...)



**Figure 5. Worker Health is Aviation Safety.** These disabled workers are not effective in completing repairs safely (used with permission of author).

inorganic lead is rare in today's workplaces. By contrast, symptoms of chronic inorganic lead poisoning include such common complaints as

headache, joint and muscle aches, weakness, fatigue, irritability, depression, constipation and abdominal discomfort. While OEL may protect the worker from overt symptoms of lead poisoning, they are not sufficient to protect workers from more subtle adverse effect such as hypertension, kidney failure, and reproductive and cognitive effects (4 & 5).

An aging workforce, seen in most repair stations, brings their medical conditions to work every day. Arthritis and hypertension are the two most common health conditions, impacting 47% and 44% respectively of worker over age 55 years (5). For the hypertensive and arthritic workers, lead exposure contributes to these conditions. Table 1 shows other exposures likely in a repair station that contributes to medical condition common in the older workforce.

Exposures in the workplace can and do cause disease and disability. An overlooked consequence of exposure is its effect on the aging worker. Exposures well below published OEL add to the disease burden in the aging population. Lead in a repair station provides an example of both the clinically obvious consequences and the likely formation of an LMEC.

So how do you correct an LMEC due to an occupational exposure? The answer depends on many factors including the characteristics of the exposure, the specific work process, and the environment. Consider the use of TCE after the

deadly experience in early WWI. By war's end, engineers developed factories with adequate ventilation, a work process that minimized spills, and solvent resistant aprons with eye protection for the workers (figure 4). Deaths from TCE declined dramatically. Implementing these same accommodations at the repair station will limit the subtle effects of lead.

Disease and disability are not the only consequences of overexposures at work. The aging workforce with chronic diseases, like the child in the lead study, is susceptible to medical effects that are below legally enforceable PEL. These low level exposures in susceptible workers form the red link in an accident chain. Breaking this red link prevents an undesired consequence. Exposures at work, like all LMEC, reinforce the message that "Worker Health is Aviation Safety" (figure 5).

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**SPOTLIGHT:  
CAMI HUMAN FACTORS MX TEAM**

Dr. Michelle Bryant is a research psychologist working in the Flight Deck Human Factors Research Laboratory. She recently completed her Ph.D. at North Carolina State University, where she studied individual differences in human performance with a specific emphasis on stress and workload. Since joining the FAA she has become a member of the maintenance human factors team researching issues related to fatigue, fatigue risk management, and the endless pursuit to understand and mitigate the issues surrounding "Failure to follow technical instructions." She currently lives with her husband and daughter and their two dogs in Oklahoma City where they enjoy the theater, festivals, and outdoor adventures.

Gena Drechsler has been a Psychology Technician in CAMI's Aerospace Human Factors Research Division for nearly 13 years and has worked on both the flight deck and air traffic sides of human factors research. She is currently researching scientific literature relevant to the failure to follow procedures and will be publishing a technical report on the topic soon. She enjoys spending time with her family and sightseeing on her bike.



**CAMI Aviation Human Factors Maintenance Team (pictured left to right: Gena Drechsler, Crystal Rowley, Dr. Bill Johnson, Dr. Michelle Bryant, Matt Hollomon)**

Crystal Rowley is a Psychology Technician in the Flight Deck Human Factors Research Laboratory. She has M. A. Degrees in Psychology and Education, with a concentration on human motivation as it applies to extreme exercise. She is a disabled veteran, having served 11 years in the US Air Force as a Graphic Artist and Force Support Officer. As a trained graphic artist, Crystal has integrated her knowledge to assist research marketing and presentations. Additionally, she is assisting Dr. Michelle Bryant with research regarding fatigue risk management and other projects. She currently lives with her husband, a retired US Air Force officer, her daughter and their two dogs in Oklahoma City.

Matt Hollomon is a Psychology Technician working at the FAA's Civil Aerospace Medical Institute, Human Factors Research Division. He graduated from Embry-Riddle Aeronautical University after researching the impact of navigator removal on pilot workload. His research supports human factors issues in aviation maintenance, gaze control technology, and aircraft angle of attack. He was previously stationed at the Air Force Operational Test and Evaluation Center, Detachment 5. There he served as the Detachment's Lead Human Factors Analyst supporting the planning, development, execution, and reporting of over 30 aircraft test programs, including maintenance and flight operations.

**W W W . H U M A N F A C T O R S I N F O . C O M**



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](http://hfskyway.faa.gov) or under a number of alias addresses like [humanfactorsinfo.com](http://humanfactorsinfo.com), and [mxfatigue.com](http://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 [michelle.bryant@faa.gov](mailto:michelle.bryant@faa.gov) or [bill-dr.johnson@faa.gov](mailto:bill-dr.johnson@faa.gov). The editorial staff will help writers with layout and graphics.

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