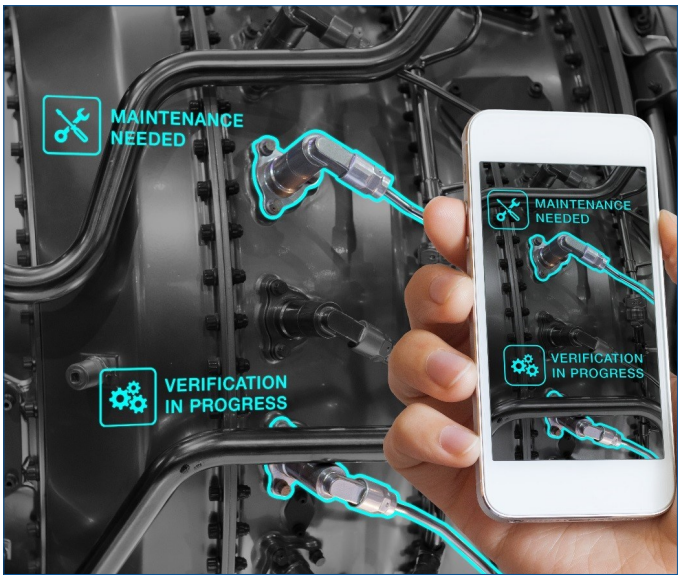
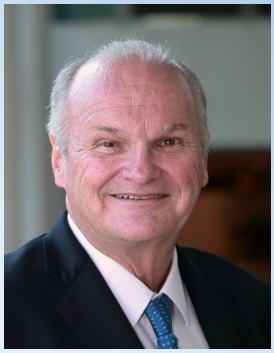
September 2018
Vol 6, Issue 4

Aviation Mx HUMAN FACTORS





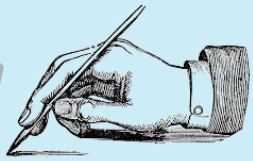
Dr. Bill Johnson, a frequent contributor to this newsletter, is the FAA Chief Scientific and Technical Advisor for Human Factors in Aircraft Maintenance Systems. His comments are based on nearly 50 years of combined experience as a pilot, mechanic, airline engineering and MRO consultant, professor, and FAA scientific executive.

INSIDE THIS ISSUE:

Table of Contents

Authors of this Newsletter	2
The Advantage of "The Floor Model" - Try Before You Buy	3
Workshop Report: The Integration of HF into Safety Management	4
Line Employee Engagement is the Missing Key in SMS	6
How to Optimize Your Human Factors Program for Different Operating Environments	8
Human Factors Integration Opportunities in Maintenance SMS programs	10
Training and Job Aiding Technologies for Maintenance	13
FFP: The Buck Stops with Me	16
Author Appreciation	16

Authors of this Newsletter



Ashley Awwad is a Program Analyst for the FAA's Civil Aerospace Medical Institute (CAMI) Flight Deck Human Factors Research Lab (AAM-510). Ashley began flying as a teenager and went on to become a flight instructor at Embry-Riddle Aeronautical University. Shortly after earning a Master's Degree in Human Factors, Ashley begun working with the FAA on research and development initiatives. She is currently supporting FAA research in the area of Aviation Maintenance Human Factors.

Mr. D Smith has over 35 years of experience in the field of aviation safety. He has assisted over 700 organizations implement safety and human factor programs, including: U.S. and international regulators and private industry. He is considered a leading expert and forward thinker in the field of Aviation Safety and related topics. He served 29 years as a helicopter pilot in the US Army earning the designation of Master Army Aviator. He is the President of the International Society of Safety Professional (ISSP), an International Registered Safety Professional (IRSP), Certified HFACS Professional, Author of "Quantum Safety Metrics" a methodology used by over 600 organizations to quantify their safety status, and contributing author to the book "Implementing Safety Management Systems in Aviation ", Ashgate Publishing. He holds an MBA with emphasis on Occupational Safety and Health.

Dr. Marc Szepan is a Lecturer in International Business at the University of Oxford Saïd Business School. Previously, he was a senior executive at Lufthansa. His primary professional experience has been in leading technical and digital aviation businesses in Europe, Asia, and the U.S. Most recently, he served as Senior Vice President, Airline Operations Solutions, at Lufthansa Systems, the IT services business segment of Lufthansa. He also held leadership roles at Lufthansa Technik, the MRO business segment of Lufthansa, and for two other German industrial companies. In 2012, Marc was recognised as one of *Aviation Week & Space Technology*'s "40 Under Forty: Rising Stars of Aerospace and Aviation". Marc received a doctorate in Management Studies from the University of Oxford. He also holds an AM from Harvard University and an MBA from Duke University.

The Advantage of "The Floor Model" - Try Before You Buy

D Smith

What's your reaction to the three statements below? Do you agree or disagree?

1. Most organizations today have policy, procedures, training, and equipment in place to ensure safety and prevent accidents. 2. A close look at any given organization would reveal that some of the policies, procedures, training or equipment are dysfunctional and not accomplishing the objective. In other words, you could find safety problems in any organization on any given day. 3. My organization has a sure-fire effective method to find our safety issues

If you quickly agreed with 1 and 2, then had to stop and ponder your answer to 3, you are like most.

So why does statement 3 require such thought? Let's take a closer look and run this rabbit down the hole. Let's start with what we know and what we believe. If we know and acknowledge that all organizations have undiscovered safety issues, and we believe there is value in finding those safety issues, then the answer should be simple - just find and fix the safety issues, right? Well maybe not. Why? Because we don't know where to look. Most safety issues present themselves after an incident or accident. That's too late and certainly not ideal. Ideally, we want to find them before they cause a problem. Again, that begs the questions, how and where do we look? The solution is simple - *The Floor Model*! Allow me to provide a little background and insight.

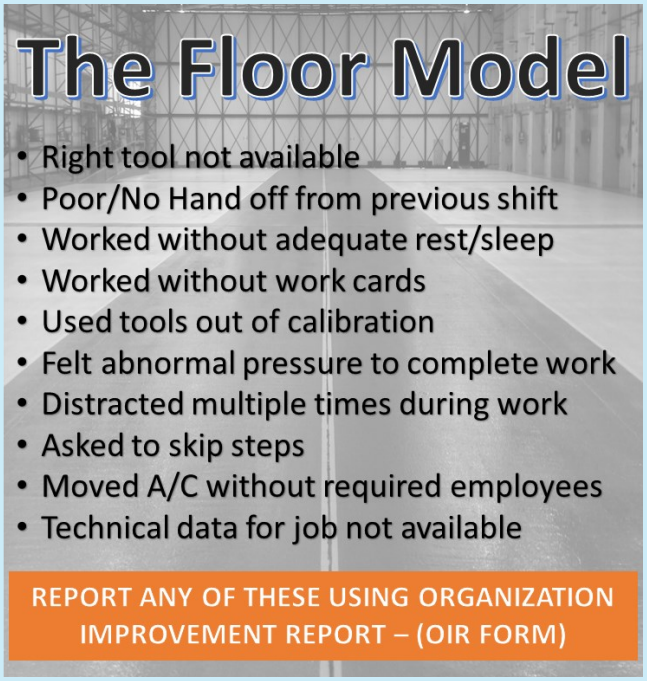
In my 35 years as a safety professional, I've discovered that all organizations have undiscovered **C**onditions **T**hat **E**xist **F**or **A**n **A**ccident **T**o **O**ccur. I call them CTEFAATOs, pronounced See-ta-fought-toos. Further research by *Yoshida and Shuichi,* shows that front-line employees know where the CTEFAATOs exist. The solution seems easy enough - simply ask the front-line employees to report safety issues. Many organizations find that a challenge for a host of reasons. For example, lack of employee buy in, adverse safety culture, employees believe their report won't make a difference, or just plain not knowing something is a safety issue. I want to address one of these in particular, not knowing what to report. In a recent survey, I asked several hundred front-line employees to describe safety issues in their workplace. Most struggled for answers. However, when I asked the same employees if they ever had to improvise and use an alternate tool to get the job done, or if they were ever hurried to complete a job in less than the prescribed time, or if they had ever performed maintenance with less than adequate rest, nearly 100% responded, yes!

These are the CTEFAATOs that we agree to in statements 1 and 2. They exist in most every organization. If your organization can't identify them, it may be that you are not asking the right questions. Ask them to report safety issues and they aren't sure what to report. But what happens when you give them a list of things you want them to report? If you ask the right questions - you'll get the safety intelligence that you need to improve your safety effort! I call that list of questions *The Floor Model* because it represents the vital safety intelligence from the floor, or frontline employees.

Try creating a list of ten things you want to track in order to gather safety intelligence within your organization. Things like, the right tool for the job not available, rushed to complete a job, poor job hand-off from previous shift, etc. You can tailor your *Floor Model* list to fit your organization and the specific desired areas for safety intelligence. Enlist employee participation with incentives for employee reporting and supervisor encouragement to report. Be sure senior management understands the benefits of *The Floor Model*, provide timely feedback to employees on the benefits of their reports, and make it easy to report. You may choose to modify your list as time goes on to target others areas for safety intelligence.

So how do you find the undiscovered CTEFAATOs in your organization? Easy, it's called *The Floor Model.* This model not only adds value your organization's safety effort but also allows you to Try Before You Buy!

Below is an illustration of a The Floor Model that can be displayed in the hangar. You may opt for a 4' x 8' board, a poster size for your bulletin board, or create wallet cards for employees to carry. Any method to get the word out will enhance your safety effort. Ask the right questions - get the right answers!



Workshop Report: The Integration of HF into Safety Management*

Bill Johnson

Summary

In August, the Federal Aviation Administration (FAA) and the Office of the Secretary of Transportation's Safety Institute (TSI) joined forces with the Aircraft Electronics Association (AEA) to host a workshop to enhance Safety Management Systems (SMS) with human factors (HF) information. The workshop defined the status of human factors in SMS and then defined/specified opportunities for improvement. This article summarizes the workshop deliberations and recommendations. The workshop was a success and the information gained will be the basis for many projects and reports for the next few years.

The Opportunity

Maintenance organizations, large and small, have formalized their safety management with SMS. Many organizations have an SMS because it is a regulation. However, by regulation or not, organizations appreciate that SMS enhances not only safety benefits but also economic efficiency. Early identification of hazards and addressing risk helps minimize costly errors, worker injuries, flight delays, and more.

Knowing that human error is the most likely cause of negative maintenance events, an SMS must consider human factors. The workshop defined the "Pain Points" related to integration of human factors into SMS. The ultimate goal was to recognize current best practices and to write a specification for new tools and processes that help to ensure HF-SMS integration.

Delegates

The Federal Aviation Administration, the Office of the Secretary of Transportation –Transportation Safety Institute, and the Aircraft Electronics Association were the workshop co-sponsors. This mix of organizers insured the participation of large and small airlines and Maintenance organizations (MROs) from the Americas and Europe. The airlines were American, United, and Avianca (Columbia). The MROs included Lufthansa Technik (Germany), Summit Aviation, Flightstar, and Brant Aero (Canada). Boeing and the Thales Group provided a manufacturer's perspective. Of course, Dr. Johnson had a reasonable cast of industry and government human factors practitioners on hand.

Everyone attending was active in corporate safety, SMS, and/or human factors. It was an ideal group to fulfill the workshop objectives.

"Pain Points"

A medical doctor often starts a patient interaction by asking your general condition, and may continue diagnosis by asking as series of questions. Does anything hurt? Do you have any pain points? Are you exercising and eating properly? Is health near the top of your priority list? How can you improve your health? Are you keeping track of your health indicators? With such information both you and the medical practitioner can react to your current condition, consider proactive lifestyle decisions to continue good health, and even predict the risks in your current lifestyle. An SMS works in the same way. We asked the same type of SMS diagnostic questions on the first day of the 3-day meeting. Many delegates presented the status of their current safety management efforts. Then, the group collaborated to list the Pain Points. The general Pain Points came from small group-created listings of common post-maintenance discrepancies. Ashley Awwad, from FAA Civil Aerospace Medical Institute (CAMI), was especially diligent in note taking. I credit her for many of the details reported here, and eventually, in the final FAA technical report. Tables 1 and 2 show selected common post-maintenance discrepancies and example pain points, respectively.

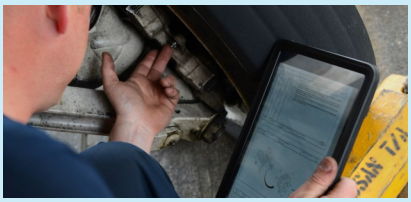


Table 1: Example Listing of Common Post-Maintenance Discrepancies

- Inspection/test not completed
- Lock out/Tag out error
- Loose fittings/lines
- Paperwork not complete
- Improper parts installed

The Table 1 post-maintenance discrepancies are the kind of information that can included in the Floor Model, described by D Smith in this newsletter's article entitled *The Advantage of "The Floor Model" - Try Before You Buy*. In this article, Smith suggests that an expanded list

Continued from p. 4

of common maintenance errors should be visible in the workplace. He suggests that this would help address those errors and hazards that are repeatedly present in most maintenance organizations, and, rightfully, contends that there are few "New" discrepancies. We plan to explore the best methods to capitalize on D Smith's Floor Model idea. He, rightfully, contends that there are few "New" discrepancies. We plan to explore the best methods to capitalize on the D Smith Floor Model idea.

Table 2: Example HF-SMS Pain Points

- Obtaining high value data from front-line maintenance workers
- Insufficient root cause analysis (RCA) before addressing contributing factors
- Need for standardize RCA tools and training
- Corrective actions are too often individual-centered rather that organizational-centered
- Sufficient resources and time for thorough event investigation
- Necessity to enhance the shared management-labor safety culture
- Insufficient communication, understanding, and cooperation between different labor groups (e.g., pilots-mechanics, trainers-engineering, procedure writers and users, and more)

The first-day deliberations showed that many of the post-maintenance discrepancies and Pain Points were identical, but of different scale, between the airlines and the General Aviation organizations. That is a valuable indication that many of the solutions are likely to be generic, but must be adaptable/scalable to different organizations.

Best Practices

On the second day of the workshop, delegates discussed the human factors-related practices that worked well and are applicable to supporting an SMS. There was deliberation on the best practices to address the Day 1 post-maintenance discrepancies. A specific example is the creation of a tool accountability program and technology-based tool identification system to prevent "tools left in aircraft." However, general best practices were more suitable to the workshop goal. Table 3 offers some of the best practice examples. The Day 2 deliberations showed that the integration of HF information into SMS is already well on the way. It is not a novel concept and can be continued and enhanced.

Table 3: Example Best Practices for HF-SMS Integration

- Peer-to-Peer Assessment like Maintenance Line-Operations Assessment (LOSA)
- A "Respect the Aircraft" program focused on preventing a drift away from CRTO procedures
- A Program for increased management presence on the front line of maintenance
- New attention toward fitness for duty, especially fatigue
- Application of the PEAR Model to simplify understanding of HF in an SMS
- A SMS Information Workflow System that all can understand
- The Importance of Frontline Empowerment
- Use a "Floor Model" to offer daily safety
- information data to the workforce
- Use of Daily-Weekly-Monthly…Newsletters for Front-line employees

The HF-Maintenance SMS Tool/Process Specification

Day 3 objectives were summarizing the presentations and discussions to list specifications for tools and process to enhance/integrate human factors into a Safety Management System. The deliberations during the first two days made this a manageable task. Table 4 offers examples of support needed to enhance integration.

Table 4: Example Specifications to Enhance HF-SMS Integration

- Create a Dynamic "Floor Model" to Communicate Safety Management Data to Front-line Maintenance Workers
- Create Means/Motivation for Frontline employees to offer solutions to address hazards and related risk
- Create means for Training Departments to provide SMS-oriented examples and solutions
- Be sure that SMS data are understandable and relevant to frontline workers
- Promote the concept of many HF-Champions within the workplace, to include all levels of the organization
- Encourage peer-to-peer observation and interactive feedback

Continued from p. 5

During the 3 days of discussions, it was surprising to find that maintenance organizations, regardless of size, share many of the same challenges integrating human factors into SMS. It is also very encouraging that everyone, at all organizational levels, seem to understand and appreciate the value of attention to human factors in all aspects of work and safety management. No one needs to be convinced!

The critical next step must be to capitalize on the data from SMS. That data can help formalize and communicate the best practices to identify hazards and risks associated with human factors in maintenance organizations.

Workshop Follow-up: Now the Development Work Begins

This article offered quick summaries of extensive deliberations. The next step will be a detailed report, published in cooperation with the three hosting organizations, that will chart a path of applied research and development. That report will focus on operational SMS practitioners of all sizes - so stay tuned.

Acknowledgements
Thank you to D Smith (OST-TSI), Ric Peri (AEA), and Ashley Awwad (FAA-CAMI) for critical partnership in planning, executing, and documenting this workshop.

Another version of this report is available in the September Aviation Maintenance Technology magazine (**www.aviationpros.com**).

Line Employee Engagement is the Missing Key in SMS

Ashley Awwad

A common challenge that organizations come across when implementing SMS is getting the workforce on board. Change is hard, but there are ways to make it easier. Imagine that you are trying a recipe from your brand new cookbook, and you've just spent hours preparing a gourmet meal. The recipe required hard-to-find specialty ingredients and took careful planning to pull together. It looks delicious. You are proud of your masterpiece and giddy with anticipation as you serve the meal to your family. Then you hear "this smells weird, we don't want this." Now apply this scenario to your maintenance organization's SMS efforts. The newly realized chef is your management, the gourmet meal is your new SMS, and the unimpressed family is your line employees. Your family may not recognize and appreciate the hard work that went into preparing the meal. They didn't shop for the ingredients or help to prepare the meal. All they know is that you want them to try it.

Do you know how to get someone to understand all of these things and get excited with you? Involve them in the process. Make the meal something they are invested in and eager to try because they helped to prepare it. If your family went shopping and helped to pick out the ingredients, if they stirred the pot, and taste tested along the way, their reactions at the dinner table likely would have been pride rather than prejudice. Involvement in the process works because no matter the scenario, it is a human trait to want something to succeed when you have invested your time and energy into it.

Line employees make up the majority of any organization. They do the job day in and day out. They are at the highest risk of making human errors that impact safety, and they are also the ones most likely to

Continued from p. 6

catch those errors. When an accident or incident occurs, who would be the most capable person to identify why it happened? Who is the most qualified to offer realistic solutions to prevent it from happening again? Is it the manager who is removed from the day-to-day work, or the employee who does the job every day and knows it from start to finish?

The topic of engaging line employees was discussed at length during the recent Human Factors Integration into SMS Workshop, summarized by Dr. Johnson in this newsletter's article titled "Workshop Report: The Integration of HF into Safety Management." Experts agree that involving line employees in the SMS process makes perfect sense. So, why don't we do it? One glaring reason is the logistics. While some smaller organizations may be able to include every employee in the SMS process, coordinating and involving large numbers of employees can be unworkable for large organizations, but that's okay. What is important is that line employees are represented and provided a means for their voices to be heard. This can be done via points of contact, or representatives, who speak for the different groups of employees. Ideally representatives would be peer-appointed and have strong communication skills enabling them to receive and express feedback well.

Now, you might say that your line employees are already stretched thin, and you can't afford to spare any of their time to participate in planning activities. You are not alone, this is a challenge shared by organizations both large and small. However, to attain success with your SMS, you can't afford not to involve your line employees. Designing processes and safety solutions that don't work because the line employee perspective was not included will cost your organization more time and money in the long run. Whether or not to include line workers in decision making should not be the question - the only question worth asking is "how" to include them. Any way an organization chooses to do it, the important thing is to get the line employees involved, make their voices heard, and take advantage of the invaluable resource sitting right in front of you.

A successful change requires a shift in thinking and perspective. Your line employees know the intimate details of the processes and procedures better than anyone else, making them your most valuable SMS asset. Remember, when trying a new recipe or introducing a new meal, involve the family – your line employees - in the planning and preparation. Listen to their ideas, heed their concerns, and weigh their opinions with the highest priority. Your line employees are the key to success - unlock your SMS's full potential.

How to Optimize Your Human Factors Program for Different Operating Environments

Marc Szepan

Human factors considerations are important drivers of aviation safety. However, some aviation businesses take a one-size-fits-all approach to implementing human factors programs across global multi-site operations and along global supply chains both of which are often characterized by different operating environments. Sometimes, this one-size-fits-all approach limits the local effectiveness of even the best human factors program. The present article proposes best practices for optimizing human factors programs subject to the constraints inherent in different environments in which a global multi-site aviation business might operate.

One Size Does Not Always Fit All

Imagine you are a repair station; OEM; or provider of safety-critical, non-aviation products and services. You are a truly safety-driven organization and you have developed a world class human factors program, hopefully by drawing on Federal Aviation Administration (FAA) resources. You have committed significant managerial and financial resources to championing the program. Your human factors program has delivered measurable benefits at your home base. As you operate globally, you have rolled out your human factors program to all of your facilities worldwide. But somehow you are not achieving the results for which you might have hoped.

Perhaps you have become victim of your own success and have fallen into the "one-size-fits-all trap." You have transferred what demonstrably has been a human factors success story at your home base to your worldwide operations without considering whether the operating environments away from home are characterized by substantially different constraints and whether such differences might impact the effectiveness of your human factors program. By not understanding these differences, you are foregoing the opportunity to custom-tailor your human factors program in the interest of maximum effectiveness at all sites of your global multi-site business.

Understanding the Four Environmental RISC Factors

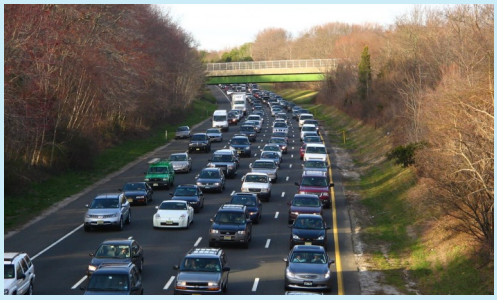
There are many models and tools for analyzing different national and organizational cultures. However, for the purposes of understanding a specific operating environment and of adapting a world class aviation human factors program to its constraints, I propose to analytically break down a given operating environment into what I call the Four Environmental **RISC** Factors: **R**egional, **I**nfrastructural, **S**ocio-Economic, and **C**ultural.

These Four Environmental RISC Factors are discussed below via selective referencing of illustrative examples drawn from the standard "Dirty Dozen" common causes of human factors errors:

Regional: Assume that your home base is located in the American Mid-West or in Central Europe. Allowing for seasonal variation, what is the prevailing climate in which your work force needs to function? What are average temperature and humidity? What are the assumptions regarding average weather-related work conditions that inform your fatigue risk management program? Now assume that you have a subsidiary located in South East Asia, say, in Singapore. What would be the climate in Singapore? Average temperatures and humidity in Singapore during the summer would make for a far more challenging work environment for your work force with significant implications for assumptions underlying your fatigue risk management program. In short, the regional and thereby climatic environment greatly matters for the design of your human factor programs and indeed of your facilities. Assume that you are located in Oklahoma City. You probably need a heated hangar and workshops in winter. But most likely not air-conditioned facilities in summer. In contrast, having non-air-conditioned facilities in Singapore could be a major fatigue risk driver.

Continued from p. 8

Infrastructural: Imagine that you are a repair station located in the U.S. or in Western Europe. Most likely, your work force's average one-way commuting times to and from work are well below one hour. Now assume that you have a subsidiary located in an emerging economy in South America or South East Asia. Given infrastructural bottlenecks and resulting traffic jams in many emerging market metropolitan areas, average



one-way commuting times might be easily two hours or longer. What implications do different commuting times have for work force stress and fatigue and for realistic productivity assumptions? The external infrastructural environment in which your work force is embedded might be as relevant, if not more so, for stress and fatigue as company internal factors. Also, what implications do mega traffic jams have for shift rosters? In your home base, you might have optimized shift rosters based on standard circadian rhythms. In an environment in which commuting for a single shift can take between four and five hours during rush hour but "only" two to three hours during off-peak hours, would it be sensible to re-arrange shift schedules in line with infrastructural constraints? It might actually be safer and more effective to have longer shifts, including sufficient rest time, with fewer commutes instead of shorter shifts necessitating more frequent commutes.

Socio-Economic: Compare typical lifestyles in the U.S. or in Western Europe on the one hand and in many emerging markets on the other. In the former, the majority of your work force is likely to commute to and from work in their own cars or via high quality public transportation. In the latter, many of your employees might commute via private buses that are not air-conditioned, overcrowded, and noisy. This mode of transportation is likely to exacerbate the stress and fatigue caused by long commuting times. In the former, average family size will be smaller and quality of residential housing will be much more conducive to regenerating during daytime after a night shift than in the latter. Clearly, considerations related to the socio-economic environment should be on your radar screen when designing fatigue risk management programs and your operating model. For example, your work force in some emerging markets might prefer to complete

training in air-conditioned company facilities rather than via CBT at home.

Cultural: Eliciting candid employee feedback during all-hands-on-deck meetings can be a challenge even in North America or Western Europe. Keep in mind that cultural norms in many regions of the world outside North American and Western Europe strongly discourage public expression of personal opinion, let alone questioning of or push-back against company leadership. Local culture clearly matters for design of human factors programs. If you operate a subsidiary in one of those regions, what is your strategy for overcoming lack of communication and lack of assertiveness as major potential error causes? Perhaps you could complement public Q&A during all-hands-on-deck meetings with the option of anonymously submitting questions in writing without publicly identifying the person submitting the question.

Adapting Your Human Factors Program

Merely understanding the Four Environmental RISC Factors is not particularly helpful in and by itself. What does it take to adapt your human factors program to a given operating environment across geographically distributed multi-site operations or along a global supply chain? I suggest the following steps:

1. Understand the operating environment. Do not take any assumptions based on which you have developed your home base human factors program for granted. Evaluate human factors program drivers that are internal and external to your business. Do an analytical deep-dive into each of the Four Environmental RISC Factors to understand how the operating environment for each of your sites away from home base might differ from home base.

2. Adapt your human factors program, as necessary. Identify the differences that truly matter and adjust your home base human factors program so that it does justice to the differences you have identified. As you custom-tailor your human factors program to the constraints of a given operating environment, make sure to not throw out the baby with the bathwater and maintain proven

Continued from p. 9

elements of your human factors program that work well across your global operations. Maintain an open line of communication with internal and external safety and quality stakeholders, including regulatory authorities.

3. Rinse and repeat for your supply chain. Global supply chains are very common in aviation. Once you have developed the organizational capability to optimize your own human factors program for different sites in different operating environments, it is fair to have the same expectation for your supply chain. Encourage your suppliers to transition from a one-size-fits-all to a custom-tailored human factors approach. Consider making this integral part of your own supplier audits.

Four Environmental RISC Factors for Adapting Human Factors Programs

© Marc Szepan, 2018

Human factors programs are important drivers of aviation safety in general and of safety in aviation maintenance in particular. As aviation businesses have developed global reach and global supply chains over the past decades, a one-size-fits-all approach to human factors programs is unlikely to be ideal for different operating environments. I propose the Four Environmental RISC Factors as an analytical tool for understanding these differences. Lest one assumes that the Four Environmental RISC Factors only matter for far away "exotic" places such as emerging markets, one would be well-behooved to reflect on regional intra-country differences between, say, Fairbanks, AK, and Phoenix, AZ. Ensuring situational awareness in the context of human factors programs can help multi-site aviation businesses maximize the effectiveness of their human factors programs throughout their entire operations and indeed along their supply chains.

Human Factors Integration Opportunities in Maintenance SMS Programs

Ashley Awwad

The FAA's Civil Aerospace Medical Institute (CAMI) is conducting research to further the integration of human factors into maintenance Safety Management System (SMS) programs. To help identify near-term integration opportunities, AAM-510 gathered information from high risk industries, like aviation and offshore oil. While the motivation of operations in these industries are quite different, human performance remains the critical contributor to safety. Near-term integration opportunities and emerging trends across these industries are highlighted below.

Robust safety reporting programs require bottom-up support. The success of a safety reporting program relies heavily on employee trust and participation. These two variables directly impact the health and integrity of a safety program. To reduce the likelihood and potential severity of a future event, it is imperative that organizations have an active reporting system that employees are encouraged and incentivized to use. For example, D. Smith mentions in his article, *The Advantage of "The Floor Model" – Try Before You Buy*, every organization has Conditions That Exist For An Accident To Occur (CTEFAATO). It is likely that maintenance line employees know these conditions. If line employees voluntarily report these conditions, accidents and incidents could be prevented.

The adoption of a Just Safety Culture will influence safety reporting program participation. For example, organizations that have not fully adopted a Just Safety Culture may respond negatively to safety reports. This in-turn discourages employee participation, instills fear in workers, and adversely impacts the quality of future event reports. To maintain a robust safety program, bottom-up support is required. Bottom-up support is strengthened by the adoption of a Just Safety Culture.

Safety reporting program participation hinges on the example set by management. Throughout all levels of an organization, management must consistently lead by example and set the tone for acceptable versus not acceptable behavior. If management tells a team member one thing, but does another, it is counter-productive and undermines their own authority. This could damage safety reporting program credibility and foster a negative safety culture. Conversely, if management tells a team member to do something,

Continued from p. 10

and management reinforces that message through their routine behavior, then there is no room for question on what is acceptable versus not acceptable. An organization's safety culture and safety reporting program participation level hinge on the example set by management.

Accountability does not always imply sanctions or a reprimand. To foster a Just Safety Culture, the root cause of negative events should be fully understood when evaluating the appropriate course of action. For example, there is a distinction between a genuine error and willful non-compliance. Genuine errors are unintentional, like an employee misunderstanding a procedure. A genuine error, such as this, could be resolved with corrective training. Willful non-compliance is an intentional deviation from standard operating procedures or practices. Understanding the root cause of a negative event is important. In a Just Safety Culture, honest mistakes are forgiven if reported. Noncompliance that is willful and not situation induced, results in consequences that are fair in proportion to the violation. It is management's responsibility to understand the root cause of an event, and to carefully judge each situation fairly. While accountability does not always imply sanctions or a reprimand, it is incumbent upon management to do due diligence to determine the appropriate post-event course of action.

Next steps and near-term integration opportunities: Later this year, CAMI will publish an annotated bibliography that describes the information collected and analyzed in greater detail. In the interim, the author has developed a quick reference table to highlight actionable human factors SMS integration opportunities derived from the information reviewed to-date. These integration opportunities are grouped into 8 topic areas below: reporting, leadership, worker empowerment, change management, culture, risk assessment, enforcement, and training.

Actionable Take-Aways from Human Factors in SMS Literature

Reporting

- Establish and nourish a voluntary safety reporting system.
- Utilize a Line Operations Safety Assessment (LOSA; peer to peer) approach
- Provide real protections for workers, anonymous reporting, and whistle-blower protections.
- Implement a safety reporting structure that assures data privacy, has a consistent reporting structure across the industry, establishes a clear pathway for change to be implemented, and has a strict non-punitive policy.
- Create a blocker reporting system so that workers can report things that are "blocking" their ability to do their job well or things they perceive are having a negative impact on the operation. (This is different from error reporting.)

Worker Empowerment

- Ensure that workers can articulate what they do in their daily actions to contribute to safety.
- Involve the employees in the development and update cycle of the SMS. Give them a say in what it looks like and how it's implemented.
- Ensure that the communication loop is complete with feedback. Employees should be encouraged to discuss what went right, what went wrong, and lessons learned. One example of this is to make consensus decisions when able, which opens the door for employees to voice their perspective and be part of the decision making.
- Empower staff with safety-related duties creating a sense of personal responsibility for safety and the effectiveness of the system.
- Empower workers by having open safety dialogs and bringing them into the loop on safety decisions.
- Involve workers in all aspects of prevention of major accidents – establish a separate and unique focus on process safety.
- Establish a joint plan and roles with authority for worker empowerment.
- Empower workers to take safety leadership upon themselves and look after each other in a safety conscious way.
- Create teams of workers and empower them to address reported blockers by designing solutions based on their knowledge of the job.

Continued from p. 11

Leadership

- Company leadership must communicate and demonstrate that safety is the highest priority.
- Management must lead by example and set the bar for acceptable behavior.
- Put an emphasis on supervisors following company policies and setting the bar for safe behaviors through leading by example.
- Drive change and worker empowerment from the top.
- Use a promotive voice in training and in the operation to communicate why you are making changes and to avoid a fear of consequences being the primary driver for compliance.

Change Management

- Conduct a change readiness assessment in organization before trying to implement changes.
- Take a human centered approach to procedures and policies and design them around workers' activities, motivations, and real-life environment.
- Develop an understanding of the employees' culture, motivations, and how the employees perform their tasks in their everyday environment.
- Provide contextual information to workers by answering questions like the following: Why am I being asked to do it this way? Why is it better than what I have been doing? And why are we talking about this?
- Try to avoid constant change and work toward a system with stability so that workers don't have the urge to not follow procedures because of an "it will probably change tomorrow anyway" attitude.
- Compare an existing system against the 29 HFACS elements to determine what human factors areas are missing in the system.
- Implement systems using a repeating cycle that feeds information into itself for improvement like Plan, Do, Check, and Act.
- When making changes to the system, have the person doing the job design the change.
- Control risk by establishing layers of protection and managing changes.

Culture

- Establish a safety culture that encourages reporting of hazards and incidents including "bad news."
- Use the balance of a Just Culture to hold workers accountable for their work, but offer forgiveness for genuine errors that are reported.
- Get the entire workforce talking about good human factors, not just management or trainers. Don't make it the job of any single person to share the news about human factors, it needs to be the responsibility of everyone.

Risk Assessment

- Work to identify if the human errors in your organization are errors of omission or commission and whether they are advertent or inadvertent.
- Understand risk by actively predicting problems.
- Analyze actual problems and determine weaknesses through root cause analysis.
- When human error situations come to light, continuously ask "why" to get to the root cause of the issue instead of only addressing a symptom.
- When possible, use data to integrate human factors into SMS. For example, using time clock data to track the risk of worker fatigue.
- Do not use personal injury rate as the sole measure for organizational safety.
- Focus on prevention, risk reduction, and continuous improvement, not blame.

Enforcement

- Implement a peer-to-peer observation system to reduce habitual errors and hold workers accountable.
- Consider reprimanding managers as well as workers for willful non-compliance. The managers either failed to ensure compliance or they did not work to change a rule they knew was unnecessary.
- Incentivize employees with appropriate rewards and sanctions to encourage and discourage particular behaviors.

Training

- Use hands on, real world training when possible.
- Follow through with training by providing workers with reminders to apply the learning, provide relearning opportunities, enable additional learning to improve performance, ensure that learners have the resources and time needed to apply and integrate the learning, and provide mentoring to guide continued learning and development.

Training and Job Aiding Technologies for Maintenance*

Bill Johnson

Dr. Johnson talks about the recent Asia-Pacific Aviation Training Summit and the current and emerging technologies possibly available for maintenance training. The article also blends the promise of training technologies, the impact on maintenance staff shortages, and how government and industry can positively influence acceptance.

Background

In the 2018 3rd Qtr. Maintenance Human Factors Newsletter, I wrote about "Another Look at the Aviation Maintenance Shortage and the Solutions." In that article I suggested that schools: modernize training technology, reinforce partnerships with industry, propose new alternative curricula, and ensure recurrent training for instructors. I suggested also that industry: collaborate with schools and help schools with equipment and further suggested that government: recognize the urgency of the need for change, consider all reasonable proposed curricular modifications, and stay the current positive course for change. This article shows more examples of how to follow these suggestions.

Attend a Training Conference

Modern training conferences can be a delight for maintenance training personnel. There are a variety of maintenance and or human factors-related conferences. The Halldale Group is a training company that specializes in training conferences. They offer five aviation training conferences, around the world, each year. The largest is the World Aviation Training Summit (WATS) held in Orlando, FL each spring.

Halldale conferences are great for training professionals. Speakers have an aviation background, but at these conferences, they speak the language of technical training. They actually talk about aviation training system design, job and task analysis, media design and selection, competency-based instruction, student evaluation, instructor selection and qualification, training regulations, and more. The meetings assemble the best selection of aviation training materials from books to the highest technology-based training devices. In August, I attended and spoke at the Asia-Pacific Aviation Training Symposium (APATS). That is the primary basis for this article.

Example Advanced Technology Training

Virtual Reality

Training conference presenters have been talking about the terms Virtual Reality (VR) and Augmented Reality (AR) for over a decade. These presenters spoke about the developments for the Department of Defense, or other well-heeled organizations that conduct high volume training that justifies significant financial investment of expensive equipment. These expenses can also be justified when the use of real equipment is not feasible. Conference presenters would often show pieces of the VR/AR technology, but few were fully developed and in daily use. Today the demonstrations are fully completed and used daily throughout industry.

Simply defined, VR is "almost" like the real world, thus the term Virtual. VR offers a multi-dimensional view that makes our senses believe we are seeing reality. Examples range from toys like the View Master® introduced in 1939 to the modern-day VR headset for gaming systems and phones, to large rooms with VR displays such as the VR air traffic control towers or 360-degree domes for flight simulators.

VR doesn't have to be completely immersive in a virtually real-world environment. Aviation maintenance VR permits users, right from a computer screen, to walk around or into an aircraft, open the cowlings, perform line check activities, or even delve into the internal workings of a system. Commercial air framers, like Boeing and Airbus, have the very best VR systems for use in the factory-training courses. Figure 1 shows an example for Airbus A350 training. Such systems are applicable to individual solo students or can supplement classroom instruction. Often, the manufacturers permit instructors from the Part 147 schools to enroll in the factory courses. That is an example of industry-school collaboration.

Figure 1: An Airbus Example of VR for A380

Continued from p. 13

Spartan College of Aeronautics and Technology, in conjunction with its Computerized Training Systems partner, are developing their next generation version of VR with a virtual Cessna 182 for their Aviation Maintenance Hybrid program. It will have over six thousand pictures, with additional graphics and video to depict many common C-182 maintenance tasks. Figure 2 shows examples of a scaled back VR system from Spartan. It is a great example of schools modernizing their maintenance training delivery systems.

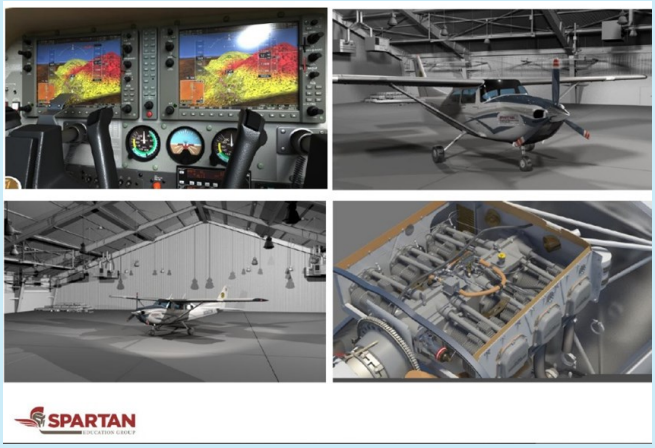


Figure 2. VR for General Aviation Training

Appropriate instructional system design must guide the required level of VR. That is true whether it is for small aircraft maintenance training, a large turbine engine teardown, or an A380 line maintenance check. Extremely sophisticated, fully immersive VR is likely necessary for high sales volume commercial games. A lower fidelity level of VR is more affordable and sufficient for most maintenance training applications. Some training technologists use the term "Mixed Reality" to combine traditional computer-based training with varying levels of VR. Again, this is dependent on task analysis and the required learning objectives.

Augmented Reality

Augmented Reality (AR) is a form of VR that uses either the real world or pictures/video of the real world with an overlay of digital information. Figure 3 shows a type of AR message overlaid on a VR screen. Aircraft or automotive windshields, with projected "heads-up" digital messages are another AR example.

Figure 3. An AR Message on a VR Screen

For some AR applications, a user may wear a pair of glasses with a built-in screen. In actual maintenance, or for maintenance training, a user can ask for or automatically receive appropriate information. Another AR delivery method can be as simple as using a handheld device to obtain maintenance instruction. See Figure 4 for a handheld device-based AR example. It is likely that the evolution of the AR display and associated data technologies will enhance the use and the culture of following technical procedures. Again, this is an example of affordable technology for Part 147 school application.

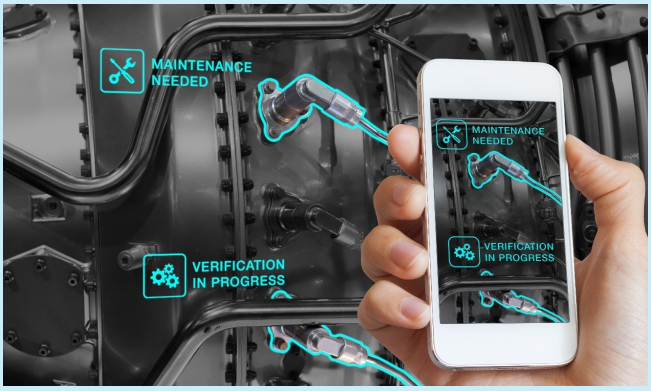


Figure 4. Augmented Reality on a Handheld Device

The Challenges of New Training Technologies

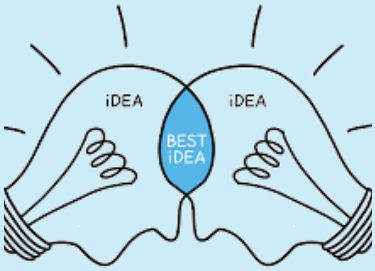
Currently, most VR is expensive to create and modify making it cost prohibitive to most training organizations. That is especially true for the institutions that are delivering initial training for maintenance certification, like Part 147 schools. All trends indicate that the development and delivery costs are going down towards school affordability.

Continued from p. 14

AR has its own set of challenges. For example, the wearable technologies are delicate for daily maintenance use and some users complain about the distraction of the visual display. Also, development and support costs are high. Again, evolving technology will overcome the challenges.

Influencing Factors on Training Technology and Its Impact

National aviation authorities, like the FAA, can have a significant positive impact on the growth of VR and other simulation training technologies. Research has shown that the pace of learning and knowledge/skill retention improves with active learning activities. New training technologies ensure active learning. Regulators must be increasingly willing to accept the curricula change and increased learner competence that VR, AR, and other technologies can provide. Regulations must continue to match instructional technologies and modern generational learning styles to the training regulations. That match will help promote the mass market for VR, AR, and other technologies. A growing marketplace will drive increased capability at a lower cost resulting in an increased number of qualified and safe maintenance personnel.



The collaboration between industry and schools is imperative as the world faces a certain shortage of qualified maintenance personnel. The current maintenance personnel qualifying system is not working as well as it could and the aviation industry help by partnering with manufacturers to advance the use of VR in schools make selected intellectual property and equipment more available to schools. The entire international aviation industry is running out of qualified workers. It is clearly an advantage, to everyone, if newly certified mechanics/maintenance engineers are familiar with modern aircraft systems and maintenance procedures. New modern training systems will help attract today's students and ensure a higher number of graduates that are ready to work.

The Bottom Line

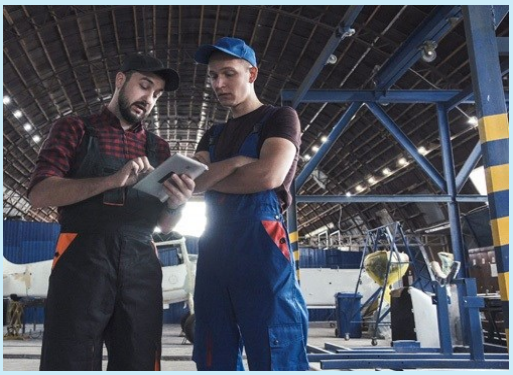
As I participated in the Asia Pacific Aviation Training Symposium, it dawned on me that the justifications for advanced technology training have been consistent and true for decades. Training technology evolves as an enhanced substitute for real equipment and the real world. When compared to live equipment simulation and computer-based training, including VR and AR is the better alternative. It wins on comparisons of cost, speed, effectiveness, availability, reliability, learner safety, and more. I feel confident in that positive trend.

Another version of this paper is available in the October Aviation Maintenance Technology (AMT) Magazine.

ARE YOU READY TO BECOME A SAFETY CHAMPION?

FFP: the Buck Stops with Me!

Aviation Maintenance Technicians (AMTs) and other industry personnel have the technical knowledge to safely perform their jobs, so why does failure to follow procedure (FFP) remain a leading cause in administrative actions? Knowledge of how to perform the job isn't enough. Reducing FFP events and improving an organization's safety culture require continuous effort and a shared commitment to creating a culture of procedure following and becoming safety champions. Workers at all levels must work together and be able to prompt one another to follow procedures at all times. We must all understand that when it comes to **FFP: the Buck Stops with Me!**



The training is available for download from the FAA's Human Factors in Aviation Maintenance website at: www.followprocedures.com

Author Appreciation

We would like to extend our gratitude to the readers and authors for their continued support of this newsletter. We enjoy your reviews and look forward to future article submissions, keep up the good work!

Our best articles and resources come from FAA employees and industry personnel. Our contributors are not primarily responsible for writing articles for this newsletter, however, the vast majority are experts in their fields when it comes to issues related to aviation maintenance.

Most importantly, we value their input and reviews that bring interest and value to readers of this quarterly forum.

Our Request and Promise to You

Every submission will receive prompt feedback from our great editors! With your approval, we will go beyond the Microsoft grammar and spellcheck, followed by an author sign-off prior to the publish date.

Newsletters come out every 3 months, yes quarterly, starting at the end of March. If you get something to us by the middle of the quarter, then we can usually make the deadline.

If you want to talk about your idea prior to the writing phase, please E-Mail Dr. Bill Johnson at bill-dr.johnson@faa.gov for guidance or recommendations. Send your submissions to Janine King at janine.ctr.king@faa.gov. If you have any interesting maintenance safety images, please include in your submission with an image caption. We appreciate your input!

Something missing?

Are you a regular reader of our Mx HF Newsletter? Do you see something we're missing? As always, please let us know! If you have ideas for future articles or would like to contribute, please contact our newsletter staff at: janine.ctr.king@faa.gov