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Recognizing Outstanding Contributions to the *Quarterly*

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We're Taking Submissions

Want to share an article or experience in an issue of the FAA Aviation Mx HF Quarterly?

The *Quarterly* is published every 3 months, beginning at the end of March. We welcome your articles related to aviation maintenance. Our great editorial team will review submissions to ensure that content and format meet the needs of our readers. Editorial feedback is subject to author approval prior to the publication.

Please include the following with your submission

- Short author biography (50-150 words)
- Photo of yourself for biography
- One-sentence summary of your article
- Images and/or graphics (with captions)
- Call-out quote(s)
- Takeaway message (what you hope the readers takeaway) from your article (not to exceed 100 words)

Send your submissions to Janine King at Janine.CTR.King@faa.gov.

Author Appreciation

We, the editorial team, extend our gratitude to our readers and contributors for their continued support of this quarterly publication. Our contributors and authors are not primarily responsible for writing articles for this quarterly newsletter; however, their vast knowledge and understanding of issues impacting and relating to aviation maintenance substantially improve this publication.

If you are interested in providing suggestions or feedback concerning this publication, or would like to submit an article or notify us of an upcoming event, please email Janine King at Janine.CTR.King@faa.gov or Dr. Kylie Key at Kylie.N.Key@faa.gov.

We look forward to not only new article submissions but to reviews and feedback from our readers.

We appreciate your input!

Editorial

Farewell to Dr. Bill Johnson

After 16 years with FAA and more than 55 years as an aviator and maintenance human factors professional, Dr. Bill Johnson has retired from federal service. Among his many contributions to the aviation industry, he is the founder of, and a frequent contributor to, the *FAA Aviation Mx Human Factors Quarterly*. In honor of his tenure, we dedicate this issue to recognizing some outstanding contributions to the *Quarterly*. This issue will reprint some of the favorite articles published over the years.

Dr. Johnson has a unique combination of qualifications. He earned a Ph.D. in Education from the University of Illinois in 1980, and has been an aviation maintenance technician and pilot for over 50 years. He served as a Designated Mechanic Examiner for the FAA and a Professor at the University of Illinois - Institute of Aviation. Dr. Johnson spent over 40 years as a Senior Executive for engineering companies specializing in technical training and human factors, and served as the program manager and technical lead for Lufthansa Technical Training to develop human factors training for over 75,000 customers worldwide. He joined the FAA in 2004 as the first Chief Scientific and Technical Advisor for Human Factors in Aircraft Maintenance Systems, and has spent the past 16 years providing scientific and technical leadership to the FAA in all matters related to human factors in maintenance. Dr. Johnson also taught human factors courses for the DOT Transportation Safety Institute. He is a member of professional societies such as Human Factors and Ergonomics Society, Flight Safety Foundation, International Federation of Airworthiness, Royal Aeronautical Society, and International Society of Air Safety Investigators. Through these diverse appointments, Dr. Johnson has traveled the world providing his expertise to government agencies, academia, airlines, and the aircraft manufacturing/maintenance industry, compiling an impressive list of accomplishments along the way.

Noteworthy Accomplishments:

- Authored more than 500 published articles
- Invited speaker at countless events, nationally and internationally
- Directed and produced a successful fatigue awareness video production *Grounded*. Ranked 2nd place for Public Affairs / Educational Program for video production at National Association of Government Communicators *Blue Pencil & Gold Screen Award* (2011).
- Co-authored the *FAA Operator's Manual for Human Factors in Aviation Maintenance*, which received the FAA Administrator's Award for Plain Language in Publication (2006).
- Developed the *Maintenance Human Factors Presentation System*, a multi-media training program containing 11 original video productions, 150 PowerPoint slides, and 40 animation files.
- Developed *FFP: The Buck Stops with Me*, a web-based training course (2018) promoting procedural compliance, with over 15K users and counting!

Professional Accolades

- Sir Francis Whittle Award for Excellence in Aviation Maintenance Safety (2011)
- Annual Award as "Friend of the Civil Aerospace Medical Center" (2011)
- National Aircraft Accident Investigation School (DOT), Transportation Safety Award (2013)
- Flight Safety Airbus Human Factors Award (2018)
- Charles Taylor Master Mechanic Award (2020)

These are just some of many examples demonstrating the tangible impact Dr. Johnson's contributions have made on aviation safety. He has helped build an extensive network of professionals dedicated to aviation safety, and has shaped the careers of many of his colleagues. He has a knack for connecting people to each other and for fostering collaborative relationships. Dr. Johnson is a true leader, teacher, and mentor in maintenance human factors, and he will be greatly missed by his FAA colleagues.

Dr. Johnson plans to enjoy retirement in beautiful Lake Hiawassee, GA with his fiancée. He shared with us that they plan to travel, garden, go boating on the lake, and spend time with family in both Vancouver and Puerto Rico. Although he is *retired*, from the FAA, he plans to continue to offer his professional services as a safety consultant (drbillj@gmail.com). Please join us in sending congratulations and warmest wishes to Dr. Bill Johnson!

Recognizing Outstanding Contributions – Dr. Johnson's Selections

After 16 years with FAA, and over 55 years as an aviator, Dr. Bill Johnson is shifting gears into semi-retirement. In honor of his retirement, this Special Issue of the *FAA Aviation Mx Human Factors Quarterly* highlights some of the most outstanding contributions over the last decade as selected by Dr. Johnson and our editorial staff. The staff selected three articles for inclusion in this issue, and Dr. Bill selected six articles. He shared the following about his process of selection.

> *The task of selecting my favorites was daunting. I read all of the articles as a means to revisit our extensive applied research and development activity. The Quarterly has also served as a sounding board to many industry and academic writers. In the last decade, the Quarterly has published more than 100 articles. There were many excellent options to choose from, making the final selections difficult. At the end of the day, I chose to re-print contributions from the most prolific authors, who we have relied upon to continually deliver important, quality messages for our readers.*
>
> *The task of reviewing my articles and those of other contributors was a joy. It reminded me of the countless professionals who worked tirelessly to ensure nearly perfect, on-time quarterly delivery of a quality product. I must specifically mention Dr. Katrina Avers, who leads a large portion of the maintenance human factors research being conducted at the Civil Aerospace Medical Institute (CAMI), and who also leads the team that makes this newsletter what it is. Outstanding CAMI co-editors and producers over the years include Joy Banks, Gena Gildea, Crystal Rowley, Dr. Michelle Bryant, and Dr. Kylie Key. Special thanks to Ms. Janine King, who has served as longtime editor and who leads the Cherokee Nation 3-S contract support team responsible for formatting and publishing the Quarterly over the years including Carrie Roberts, Blake Nesmith, and Hailey Grippen.*
>
> *I view the FAA Aviation Maintenance Human Factors Quarterly as part of my FAA legacy. In fact, we all own a part of that legacy. We can share pride in our past and continuing contributions (authorship and/or readership) to the Quarterly. Thank you for that. – Dr. Bill Johnson*

A Phase Check of FAA Maintenance Human Factors

William 'Bill' Johnson

*This article was originally published in **FAA Aviation Mx Human Factors Quarterly: June 2017, Vol. 5, Issue 2. A version of this article also appeared in AMT Magazine, July 2017**, and in this issue it is part of a collection as outlined in the editorial note (here).*

***Statement of Relevance Today.** In June of 2017 this article was "A Phase Check of FAA Maintenance Human Factors." It permitted me to tell a brief summary of the nearly 30-year history of the Maintenance Human Factors research and development program. The work continues to impact worker and flight safety. As long as humans are in the loop, this important work will continue. My time in the industry, so far, has been personally and professionally rewarding. I have been fortunate to have an unbelievably excellent career and the overwhelming #1 reason is because of my association with many esteemed colleagues and friends. My thanks to all.*

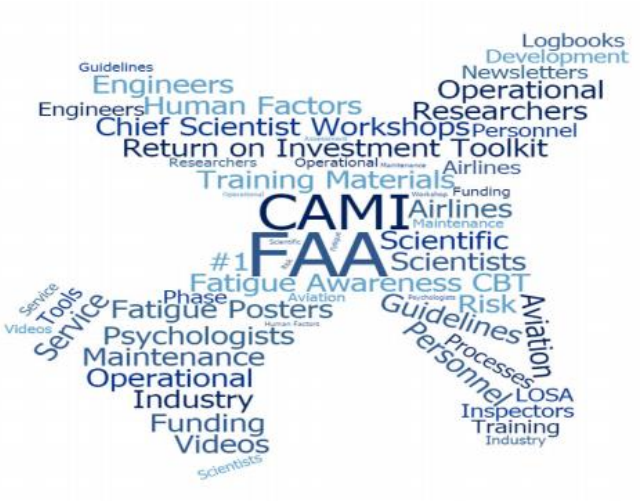
Article Reprint:

Summary

Like aircraft and other heavy equipment research and development programs need regular light and periodic heavy maintenance. In the research environment that is accomplished with quarterly and annual program reviews. Like an aircraft inspection our program reviews check for worn parts (ideas) and often identify new situations that present a hazard to our schedules and budgets. That sounds just like aircraft maintenance. This article will help readers look at some of the components and systems critical for an efficient and effective FAA maintenance human factors research program.

Check the Records/Logbooks

If we look at the age of the FAA Maintenance Human Factors program it would classify as an aging aircraft. It started in 1988, making it just about 30 years old. However, the program is not "ready for the desert!" The FAA Safety Act of 1988 and the robust funding that flowed from Congress coincided with the front-page picture of the convertible Aloha 737. That event drew immediate attention to aging aircraft,



aircraft design and maintenance, and the humans that fly and maintain them. The Act explicitly stated, among other things, that the FAA must establish a program that addresses human performance in maintenance. Like an aircraft in design the first response to the Aviation Safety Act was a committee much like an aircraft's Maintenance Steering Group (MSG). I was a member of that committee and helped write the *The FAA National Plan for Aviation Human Factors*, published in 1991.

The National Plan was followed from program inception, when congressional earmarks provided as much as $1.6 Million/per for maintenance research, to the late nineties when the Safety Act funding expired. By the year 2000, Maintenance Human Factors funding had to revert to the normal FAA R&D

budget, which was adjusted to about 25% of the resources available throughout the nineties. That change, while significant, demonstrated how commercial maintenance organizations, airlines, and consulting companies have assumed much of the activity formerly done by the FAA. That is a success story!

Operational History

Like an aircraft historical review, it is good to consider service history. An aircraft operating many daily segments requires different maintenance than one that flies one long segment per day. The nearly 30-year service activity of the FAA's maintenance human factors research program has three life phases. In the first phase, from the years 1988 to 2000, the program was directed by the Washington, DC Office of Aviation Medicine, with long-term program continuity and a tenure of FAA personnel and program contractors. The program had extensive senior management support and lots of congressional earmark funding. From the years 1988 to 2000, the FAA, with industry and other national aviation authorities, conducted 21 international conferences on Maintenance Human Factors. The human factors conference size ranged from 70 delegates, in 1988, to nearly 1,000 in the year 2000. At the same time the FAA issued multiple research grants and contracts to universities and commercial engineering companies. The FAA was extremely diligent about publishing all of the conference proceedings, reports, and project tools. The materials were first on paper, then on CD ROMSs and DVDs, and finally transferred to the web to including all legacy and subsequent documents. The website continues to be supported and is absolutely the largest and #1 maintenance human factors information source in the world (www.humanfactorsinfo.com).

Phase 2 started during the days after 911. The effects of 911 put the human factors program in a bit of "tailspin," in the early to mid-2000s. A radical reduction in personnel and funding slowed research as well as the annual Human Factors conference. Industry ability to travel to conferences stopped. About that time, the international partners each embarked on their own HF efforts. Most significant in the time period was the establishment of the European Aviation Administration Agency, with their new human factors regulations.

Phase 3 started about 2005-2006. At that time, the management of the program changed, FAA leadership interest increased, and FAA began working with the Civil Aerospace Medical Institute and Industry partners to renew the program. A new focus on applied research and on development of tools and processes for industry has led to a prosperous 10-year period. One of the most noteworthy parts of FAA's maintenance human factors program is the past 10 years of human factors training for all Airworthiness Inspectors. All airworthiness inspectors receive a 3-day course in human factors. Many inspectors have repeated the course for recurrent training.

Table 1: Significant Deliverables in Ten Years

Introduction to FAA Human Factors Video
Maintenance Human Factors Training System
2nd Edition of The Operators Manual for Human Factors in Maintenance
2nd Edition of The Human Factors Guide for Maintenance and Inspection
Return on Investment Tool Kit
Chief Scientist Workshop Reports
Fatigue Awareness CBT
Fatigue Posters
Fatigue Video (Grounded)
Maintenance and Ramp Line Operations Safety Assessment
FAA Mx HF Quarterly Newsletters

Good research and development must be based on sound scientific principles. Good products must be validated and evaluated in operational environments. That process is critical activity always going on in a quality program. The reports from those "scientific" studies are often more interesting to other scientists, psychologists, engineers, and researchers than to operational maintenance personnel. The reports are all published on the FAA website (www.humanfactorsinfo.com). The tools like videos, training materials, and guidelines are more tangible to the aviation maintenance community and to FAA inspectors. Thus they are the more visible part of the program. It is worthwhile to list some of the example tangible products (see **Table 1**) that were delivered in the past 10 years of the program.

Current Observations and Projections

Well, we have looked at the logbooks and considered the operational history. The next step is to look at the current condition and determine the results of the phase check. We must also look to the short-term expected deliverables and long-term strategic direction of the program.

In the past couple of years, we have been in an extensive data collection phase. We have been addressing two of the largest challenges in maintenance. That includes worker fatigue and "failure to follow procedures."

During 2016-17 we collected fatigue data from about 175 workers across the US. Those participants wore Fitbit-like accelerometers, competed diaries of activity, and completed computer-based tests that assessed their alertness levels. We have been actively involved in a variety of operations, large and small, from rotary wing, to large and small airplanes. We structured the data collection so that we could compare current mechanic sleep habits in comparisons to a study competed in 1999-2000. The extensive data analysis is not completed but it appears, initially, that the risk associated with worker sleep habits has improved since that initial study.

In a second study, we spoke to nearly 200 mechanics and managers about the challenges related to using instructions/procedures. We have a renewed understanding of these challenges and are currently working on the final reports. We are seeing that some organizations have found excellent ways to

address the documentation challenge. However, there is significant variance among organizations. We are doing our very best to ensure that the final deliverables include clear and actionable procedures that are ready for industry adoption to be delivered later in calendar 2017.

With respect to projections, I believe that we are transitioning to a new and fourth Phase of the FAA Maintenance Human Factors Program. This forth phase must remain applied. The products must be understandable and useful for all types of industry users. We must link everything we know about maintenance human factors into evolving Safety Management Systems. We must create tools that will provide explicit step-by-step help with risk based decision making (RBDM). We must provide support to today's workers, new and senior. We believe that we can do that in an environment that is rich with data, reported voluntarily, or collected automatically. We must recognize that there are a variety of new technologies at our finger tips. We must work together in a renewed corporate-regulatory cooperative environment. Human factors challenges and solutions are evolving, not ending. We are convinced that the work related to maintenance human factors shall be an on-going and important way to support continuing safety.

***Dr. William "Bill" Johnson**, a frequent contributor to this newsletter, is the former 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, a professor, and an FAA scientific executive.*

Maintenance Line Operations Safety Assessment (M-LOSA) Is Gaining Popularity around the World

Maggie Ma and William "Bill" Rankin

*This article was originally published in **FAA Aviation Mx Human Factors Quarterly: June 2013, Vol. 1, Issue 2,** and in this issue it is part of a collection as outlined in the editorial note (here).*

***Statement of Relevance Today**. Since the publication of the article, implementation of Line Operations Safety Assessment (LOSA) has continued. I (Dr. Maggie Ma) have supported six organizations in implementing Maintenance LOSA (MLOSA) programs. Air France Industries witnessed significant operational benefits and an increase in their safety culture through MLOSA implementation. I also provided LOSA training to another nine organizations, and in doing so learned about three other MLOSA and behavioral-based observational programs developed by airline organizations. Boeing hosted the first MLOSA Best Practice InfoShare (Jun. 12-14, 2019) in Seal Beach, CA. Twenty-seven representatives from five organizations (China Eastern Airlines Technic, United Airlines, Air France, Singapore Airlines Engineering Company, and KLM) attended. This group of safety-minded individuals offered a broad perspective of MLOSA implementation at different levels in the workforce, and showed a common interest in implementing LOSA as a safety tool in their Safety Management System (SMS). It has become more evident how important data from different sources (reactive, proactive, and predictive approaches) are for deriving safety intelligence.*

Many new safety-related developments have taken place in the 7+ years since the original printing of this article. In January 2015, the Federal Aviation Administration (FAA) announced a final rule that requires all air carriers under 14 CFR Part 121 (US commercial airlines) to have a Safety Management System (SMS) in place by January 8, 2018. The ICAO published Safety Management Manual (SMM), 4th edition (Doc 9859) in 2018 to address the changes introduced by Annex 19, amendment 1 and to reflect the knowledge and experience gained since the SMM 3rd edition (2013). It is less prescriptive and has a bigger focus on intended outcomes and performance of each activity and process. It also introduced the notion of integrated risk management (safety, security, finance, and environment) and the importance of focusing on overall risk reduction for the organization (either a State or a service provider). In the US, Part 121 operators and others have been actively participating in the SMS discussions at the twice-a-year FAA safety InfoShare. The discussions tend to be specific and relevant to day-to-day airline operations. A SMS industry forum organized by American Airlines meets yearly. The FAA released Order 8000.369C in June 2020 for SMS at the FAA.

The aerospace community has focused on SMS implementation for the last decade, and it is now considered an industry standard and best practice. Many Boeing customers are now required to have a SMS. The Aircraft Certification Service (AIR) launched a Part 21 SMS Rulemaking Project in September 2014. National Aerospace Standard NAS 9927, SMS and Practices for Design and Manufacturing, was developed to assist design and manufacturing organizations in voluntarily implementing a SMS. The FAA encourages industry to implement SMS into their regular business processes and gain FAA recognition of their SMS program. SMS has been very well received by the Boeing organizations that have adopted it, including Boeing's internal flight operations organizations and military programs based in the United Kingdom and Australia. Boeing Commercial Airplanes started the journey of voluntary implementation in 2014 and is currently working with the FAA to gain approval of its program. Boeing SMS implementation has evolved across the enterprise as an integrated framework for standardizing enterprise safety procedures and risk management, which has further strengthened its

safety-first focus. Boeing has a voluntary reporting channel called "Speak Up" for potential concerns around safety (product and services safety and workplace safety), quality, and integrity. To promote a positive safety culture, Boeing established a Safety Promotion Center in Everett, WA in 2017 as a dedicated space for safety learning and reflection for all employees, contractors, and visitors.

The COVID-19 pandemic has had a tremendous impact on aviation, which is still evolving. SMS thinking has guided regulators, operators, and OEMs in identifying hazards and managing risks associated with the pandemic. At the same time, the financial pressure caused by the pandemic threw many organizations into survival mode. Loss of expertise and resources and shifting priorities within an organization may consequently have an impact on its SMS.

Article Reprint:

Around 2007, based on the pilot Line Operations Safety Audit (LOSA) concept, a couple of US airlines started implementing LOSA into maintenance and in ramp operations. Because of interest in the concept, the Airlines for America (A4A) started a task force whose job was to more fully develop the Maintenance LOSA (MLOSA) and the Ramp LOSA (R-LOSA) processes. Task force members included staff from several airlines, ground services providers, the Federal Aviation Administration (FAA), and Boeing. The FAA funded a Research and Development project in 2008 to help support the effort. The task force worked over a 3.5-year span to develop the observation forms, threat codes, error codes, a database, implementation guides and training materials needed to support MLOSA and RLOSA implementation. To best promote voluntary participation and non-punitive safety culture, the task force redefined LOSA as "Line Operations Safety *Assessment*." Based on the Threat and Error Management framework, MLOSA is a tool for collecting safety data during normal, routine aviation maintenance operations through peer observation in strict non-jeopardy conditions. It is a way for a company to perform a self-assessment. Through observations of both "at risk" and "safe" behaviors, LOSA can identify and consequently mitigate "at risk" behaviors and reinforce positive behaviors.

The Boeing Maintenance Human Factors team within Commercial Aviation Services is committed to provide implementation support to its customer airlines and other maintenance organizations on MLOSA and other safety processes/programs. The team has observed an increasing interest in MLOSA over the past 10 months. Requests for MLOSA observer training come from both airlines and Maintenance, Repair, and Overhaul (MRO) organizations. A large percentage of requests are US domestic; however, MLOSA is definitely gaining interest in Europe and Asia.

Recognizing many potential benefits that M-LOSA offers, maintenance organizations around the world are particularly interested in customizing MLOSA to meet their specific operational needs. For example, one organization is adopting MLOSA as a mentoring technique to extend its in-classroom and on-the-job training. Another organization intends to tie M-LOSA closely with its Maintenance Human Factors Program by establishing observable key performance measures (behavior markers). Organizations are often delighted to discover that MLOSA is able to identify issues that are not revealed by other safety programs, such as event investigations and employee self-reporting. From that perspective, MLOSA is complementing some existing programs.

Through working with several organizations in preparation for implementing M-LOSA, we

recognize the following as key challenges for M-LOSA success:

Continual Support: The organizations need continuous and consistent support, which includes initial training, a platform to share best practices and lessons learned among MLOSA users, and a website to access most recent tools. The suite of MLOSA tools (e.g., observation forms, training, and implementation guide) needs to be updated based on user feedback on a regular basis.

Data Integration: Begin with the end in mind. Better guidance is needed on how to integrate MLOSA data with other sources of safety and operations data. Several organizations have expressed a desire for future data sharing, so that they can benchmark their performance against industry performance. MLOSA is a predictive hazard identification system for an organization's SMS. Along with other safety efforts, it helps reduce costs, improve safety and efficiency. Organizations are facing the challenge of rapid accumulating data from various safety programs within the SMS umbrella. How data from different programs can be integrated and analyzed in a meaningful way requires strategic thinking and good IT infrastructure planning at organization level and industry level.

Safety Culture: Some organizations recognize it is challenging to implement safety programs when their national and/or organizational safety culture is somewhat punitive. These organizations need help regarding how to change their punitive culture in small specific, practical steps. Examples of successes and lessons learned on how to instill a good safety culture, as well as how to deal with negative norms in the workplace, are useful to these organizations in moving toward a safety culture.

Dr. Maggie Ma *is an Associate Technical Fellow who specializes in maintenance human factors at the Boeing Company. Maggie has over 20 years of experience in conducting applied human factors research to improve aviation safety through developing various safety programs. She has worked closely with airlines, manufacturers, maintenance organizations, ground service providers, and regulatory agencies around the world.*

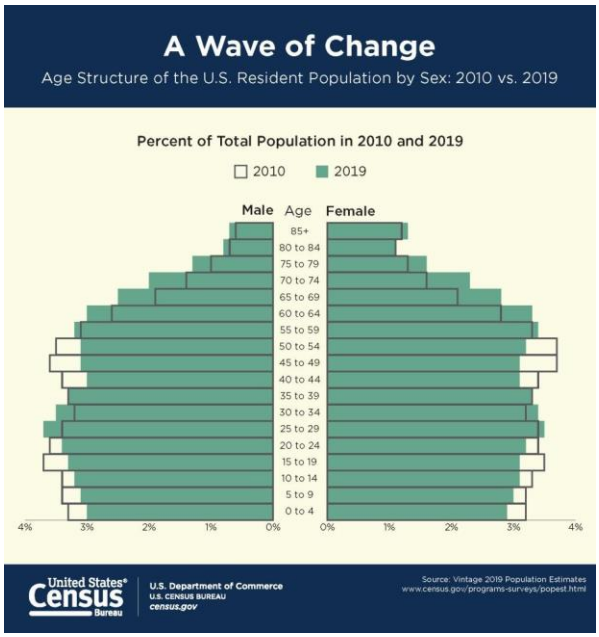
Dr. William L. Rankin *retired from Boeing in April, 2014, as a Boeing Technical Fellow and Lead of the Maintenance Human Factors Group in Boeing Commercial Aviation Services. His responsibilities included the development of maintenance Human Factors processes and training relevant to Boeing customer airlines. In 2000, Bill and the Boeing MEDA Team received the International Federation of Airworthiness' Whittle Safety Award for the MEDA process. In March 2010 Bill received the Flight Safety Foundation/Airbus Human Factors in Aviation Safety Award. He also served on the Flight Safety Foundation's Maintenance Advisory Committee and on the FAA's Human Factors Research Group Advisory Committee for over 15 years.*

Measuring the Workplace: The P Worksheet

James Allen

*This article was originally published in **FAA Aviation Mx Human Factors Quarterly: September 2015, Vol. 3, Issue 3** and in this issue it is part of a collection as outlined in the editorial note (here).*

***Statement of Relevance Today.** Dr. Bill Johnson joins the ranks of retirees. He now becomes part of the "Wave of Change" predicted by the Census Bureau. Compared to 2010, the age structure of the 2019 population shows an increase in those age 55 years and above. These are the retirees.*



Does the increase in retirees mean loss of their contribution overall? Certainly NOT, Dr. Bill. He, like so many other retirees, will continue his trailblazing post-retirement career. While skill levels are high in the aging workforce, so is their risk of chronic disease. Managing chronic diseases becomes a critical component in worker retention. The P worksheet (Table 2) in my article identifies chronic health conditions. So, my article continues to challenge employers. Retaining experts in the aging workforce, requires working conditions that recognize and accommodate chronic disease.

Article Reprint:

The June 2015 newsletter ended a series explaining four Latent Medical or Environmental Conditions (LMEC). These include reduced near vision (Sept 2014), reduced hearing (December 2014), limitations from obesity (March 2015) and consequences of workplace exposures (June 2015). LMEC form the **red** links embedded in an accident chain (**Figure 1**). LMEC have existed as long as humans have repaired aircraft. The recent aging of the workforce has made them more threatening. Public health officials urge employers to assure that these older workers can demonstrate full job performance.

Figure 1. Red link in an accident chain is LMEC

How does an MRO determine when **red** links exist in their workforce? The first step is evaluating aging workers for the presence of LMEC. This newsletter and the other in the series bring tools for completing this evaluation. Title of this series is "Worker Health IS Flight Safety" abbreviated WHISFS, pronounced like "whiffs", and displayed as an icon (**Figure 2**)**.** Expect to see worksheets that offer fill-in-the-blank capabilities.

PEAR is a popular model used to determine the likelihood of a human factors type of maintenance event. Each component of **PEAR** - **P**eople, **E**nvironment, **A**ction, and **R**esources, - represents a worksheet. This first article of the WHISFS series looks at measurement of the **P** or "**p**eople" component of **PEAR**. This first worksheet quantifies workers at risk for forming a **red** link. Remember, the focus is always on flight safety rather than on individuals.

Figure 2. WHISFS icon illustrates that Worker Health IS Flight Safety. (used with author's permission)

One method of determining the frequency of LMEC is to look at two studies of the aging workforce. One is from the AARP based on data from the late 1990s (1). The second is from the Center for Disease Control (2) based on 2009 data. Both examine health and safety issues arising from the aging workforce. **Table 1** compares the five people factors discussed in these two studies.

Despite the 10 years difference between these studies, the findings concerning people are surprisingly similar. AARP projects that by 2008, 16.3% of the workforce would be older, defined as 55 years or greater. CDC states that in 2009, 19% of the US workforce was aged 55 years or over. Projections for 2015/2018 are higher for the CDC than the AARP report because of greater work force participation. On the other hand estimates of obesity, non-fatal injury rates, length of absence and musculo-skeletal limitation are very consistent despite the ten year difference in data sets. Conclusions from both AARP and CDC studies are that aging of the workforce is occurring and has effects.

For the MRO the findings in **Table 1** have implications for identifying LMEC that may lead to maintenance events. Like the rest of the workforce, mechanics are aging. This increasing age and the co-morbidities that it brings limit specific repair processes. Consider these two rather obvious examples. Over 60% of work on aircraft involves visual inspection yet by age 52 workers have lost nearly all ability for unaided focus on near objects. 47% of workers over the age of 55 have arthritis or other co-morbidities of musculoskeletal injures, yet aviation repair demands manual dexterity. The challenge for the MRO is to determine whether their workforce is similar to the averages depicted in **Table 1**.

Table1. Comparison of people factors taken from 2001 and 2011 studies

People Factors	**AARP - 2001**	**CDC - 2011**
Older works as % of total workforce short term projection	16.3% in 2008	19% all workers in 2009
Intermediate term projection	19.6% in 2015	25% all workers in 2018
Obesity	1 in 4 men, 1 in 3 women aged 55 - 65	27% national average (3)
Non-fatal injuries & illnesses injuries	No increase in accidents with age	Older workers - similar or lower rates compared to younger workers.
Length of absences afternoon-fatal occupational injury or illness	5 days for total work force 10 days for workers >55 yrs	11 days median off work 55-64 12 days median for recovery for over 65
Activity limitation – Musculo-skeletal limitations	Among the most common	47% those over 55 yrs have Arthritis

The **P** or **p**eople worksheet, **Table 2**, looks at the same people factors as the AARP and CDC studies. The P worksheet counts the number of those workers who are over 55, obese, or have limited shoulder and back movement.

Table 2. People (P) worksheet for people factors.

People	Number
Workers over aged 55	
Obese workers	
Limitations from shoulder movement	
Limitations from low back pain (degenerative disc disease)	

People factors counted on the **P** worksheet suggest LMEC. The bullets below summarize the relation between the LMEC and AMT's job performance.

- The number of workers over age 55 indicates the likelihood of poor near vision which can impact aircraft inspection
- Individuals in the obese category experience difficulty in performing work due to body size. These individuals are also likely to have physical limitations associated with joint related pain in feet, knees, back, shoulders and hand (4). These limitations impact aircraft repair.
- Mechanics must correctly position their hands to the work. Arthritis of the shoulder and degenerative disc disease of the back produce not only pain but physical limitations in correct hand placement.

Is an employer legally permitted to collected information such as on the P worksheet? The obvious concern is age discrimination prohibited by the American with Disabilities Act (ADA). Once a worker is employed, medical inquiries are permitted as long as they are job related and consistent with business necessity (5). Current workers must be able to complete all aspects of their job.

Remember WHISFS. **Red** links compromise flight safety. The first step in identifying them is to find LMEC in the aging workforce

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Dr. James Allen *is a retired navy physician specializing in preventing health effects due to workplace exposure. His career in the Navy focused on care of workers at shipyards and air rework facilities. He is the author of "Working Healthy" and offers the training course ALC-117 on WING to prevent occupational illnesses and injuries. Dr. Allen resides in Wilmington, DE.*

How to Optimize Your Human Factors Program for Different Operating Environments

Marc Szepan

*This article was originally published in **FAA Aviation Mx Human Factors Quarterly: September 2018, Vol. 6, Issue 4**, and in this issue it is part of a collection as outlined in the editorial note (here).*

***Statement of Relevance Today.** The impact of the COVID-19 pandemic on the global aviation industry and on aviation professionals has been significant. Most likely, recovery will be a long and trying journey. However, most aviation businesses are likely to continue operating across different countries and geographies in a post-COVID-19 world. Hence, ensuring that human factors programs do justice to different operating environments will remain a key priority for leaders of aviation businesses in the future.*

Article Reprint:

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

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.

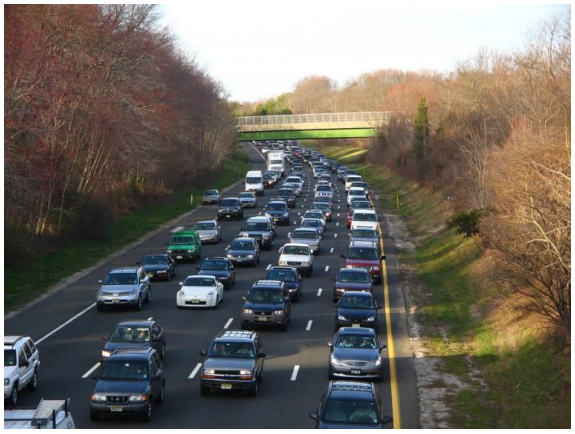
Perhaps you have become victim of your own success and have fallen into the "one-size-fits-all trap." You have transferred what demonstrably has been a human factors success story at your home base to your worldwide operations without considering whether the operating environments away from home are 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.



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 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.

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.

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New Workforce Report Highlights Growing Mechanic Deficit, Proposes Action

Crystal Maguire

*This article was originally published in **FAA Aviation Mx Human Factors Quarterly: December 2018, Vol. 6, Issue 5**, and in this issue it is part of a collection as outlined in the editorial note (here).*

This article originally ran in 2018, at a time when a shortage of aviation technical personnel was looming closer, and initiatives were well under way to develop new workforce pipelines to fill the growing need. While COVID-19 impacts have certainly changed the dialogue for the short term, it would behoove the community to remember where we were just a few years ago, and where we are likely headed again once industry recovers from the devastating pandemic impacts.

ATEC continues to publish its annual Pipeline Report, all previous issues are available at atec-amt.org/workforce-data. The 2021 edition—expected to publish in April—will look at the pandemic's impact on aviation school technical enrollment and graduation. The report will provide valuable data to support workforce development initiatives as the industry pursues recovery.

The article also sought to introduce what was then a concept in its infancy: a new charitable organization with the mission to promote careers in aviation maintenance. Since the article originally ran, Choose Aerospace was officially incorporated and welcomed a slate of directors representing industry, labor, academia, and the government. The organization's first initiative—to build aviation technical curriculum for wide-spread adoption in high schools—is expected to roll out this fall.

Article Reprint:

Each year the Aviation Technician Education Council (ATEC) releases The Pipeline Report, a compilation of data gathered through a survey of aviation maintenance technician schools (AMTS) and FAA and Department of Education databases. The purpose of the report is to identify workforce trends and propose some solutions to help meet the growing workforce demand.

The 2018 report reinforced previous findings: mechanics are retiring faster than they are being replaced. ATEC's model projects that the mechanic population will decrease 5% in the next 15 years. New entrants make up 2% of the population annually, while 30% of the workforce is at or near retirement age. Meanwhile, forecasts by the U.S. government and Boeing project a need for thousands of additional mechanics in the next 10-20 years. ATEC estimates that AMTS will need to increase production by 30% in the next 20 years to meet the anticipated demand.

Schools have the capacity to help close the gap. Right now, only about 1 in 2 seats in technical schools are taken, meaning that today, an additional 17,000 students can be accommodated without any school expansion. While institutions are ramping up recruitment activities and expect enrollment to increase, there is significant opportunity for industry employers to help define career paths and attract more students into the pipeline.

The report identifies some of the top challenges for AMTS to increase enrollment. Survey respondents indicated that the number one barrier to increasing enrollments was the ability to hire and maintain qualified instructors. AMTS also report that the biggest hurdle for recruiting students into aviation programs is negative perceptions and a lack of awareness about careers in aviation maintenance.

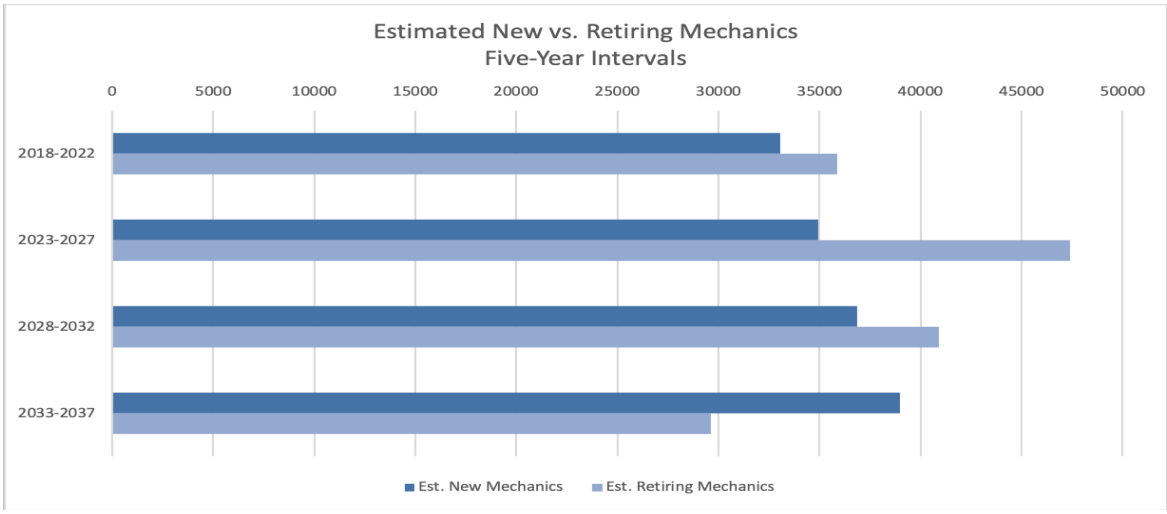

Figure 1. Estimated New vs. Retiring Mechanics in Five-Year Intervals

There is also good news to report.

In 2017, the number of students choosing non-aviation jobs over their aviation counterpart dropped by nearly half over the previous year. In addition, 70% of A&P students are taking the FAA mechanic exam upon graduation, a 10-point increase over the previous two years. ATEC attributes the improvements, at least in part, to a reported increase in education-industry partnerships.

Eighty-seven percent of participating schools said they expect enrollment to increase next year, by an average of 50%. The optimism has markedly increased since the 2015 survey, when only 55% of respondents shared that same expectation.

So, what can we do to help make those numbers a reality?

ATEC survey results support the common assertion that industry-education initiatives are one of the best recruitment tools for careers in maintenance. The trade association will therefore continue to support development of strategic partnerships.

In 2019, ATEC will hold its third employer expo in conjunction with the annual conference, newly dubbed the Employer Link (which for the first time will also include a student career fair). The purpose of the event is for recruiters and workforce development personnel to network with AMTS instructors and administrators and forge new relationships. The networking event supplements an annual conference agenda chock-full of best practices, tools, and resources to support industry-education partnerships.

Given the challenges facing AMTS' ability to recruit new aviators into the field, and the increased collaborations between educational and industry, ATEC believes the time is ripe for a national effort to support recruitment efforts. ATEC is facilitating a new industry-led initiative, Choose Aerospace. The campaign is a partnership of aerospace stakeholders joined together to address one of the biggest threats to continued industry growth: the availability of a diverse, qualified technical workforce.

The initiative aims to unite companies, associations, labor unions, and educational institutions; to spur interest in aerospace careers; and to identify and implement solutions to the aerospace workforce shortage. Get involved by visiting www.chooseaerospace.org. To read the full 2018 Pipeline Report, visit www.atec-amt.org/pipeline-report.html.

About ATEC: ATEC is a partnership of aviation maintenance training schools and employers. The council is dedicated to promoting and supporting technician education through its communications, advocacy programs and networking events.

Crystal Maguire is Executive Director of the Aviation Technician Education Council, the trade association that represents educational institutions with aviation technical programs, and oversees day-to-day operations and strategic initiatives for Choose Aerospace, a charitable organization that promotes careers in aviation maintenance. Maguire also serves as Of Counsel for Denver-based firm, Davis Graham & Stubbs LLP, where she provides legal services to aviation maintenance organizations. Maguire graduated with a B.A. in management from the University of Tulsa. She received a J.D. from American University, Washington College of Law and is a member of the Virginia and Oklahoma State Bars. She is the recipient of AMT Magazine's Next Gen 40 Under 40 Award, and ARSA's Leo Weston Award for Excellence in Government Service.

Safety Culture: Where Do We Stand?

Kylie Key

*This article was originally published in the **FAA Aviation Mx Human Factors Quarterly: March 2019, Vol 7, Issue 1,** and in this issue it is part of a collection as outlined in the editorial note (here).*

Statement of Relevance Today. *My first Quarterly article introduced a new maintenance safety culture assessment toolkit being developed by the FAA. Development of this toolkit carries on the legacy of tangible, useful industry deliverables. The final product will be a stand-alone process providing organizations 100% ownership of their cultural assessment and associated proprietary data. Ultimately, this tool will eliminate the need for outside consultants or FAA assistance to assist with assessing culture. Organizations will own the assessment toolkit, and it will be freely available for download on our website (www.humanfactorsinfo.com) once we have completed validation.*

I'm pleased to report that the toolkit has undergone initial beta-testing but need to collect enough data to complete the validation - ***We need your help!*** *We are actively seeking maintenance technicians and pilots (nonfederal civilian and military) operating within the United States to complete an online assessment that takes about 30-45 minutes to complete. You will be* ***compensated $50*** *for your time completing the assessment! To learn more about participating, email Janine.ctr.king@faa.gov, click here, or scan the QR code.*

Be sure to spread the word to other maintenance technicians and pilots! We need you!

Article Reprint:

It is well known that maintenance (Mx) errors are a contributor in many accidents, incidents, and personal injuries (Goldman et al., 2002; Marais & Robichaud, 2012). One way to reduce such errors is to promote safety culture, or employees' perceptions that safety is a high priority for the organization. In fact, safety culture has been ranked as the top human factors challenge in aviation Mx (Johnson, 2014). A culture where safety is a priority can help to decrease errors, violations or noncompliance, accidents, injuries, and even turnover (Fogarty et al., 2018).

But that's not all. A healthy safety culture can increase performance, willingness to report errors, SMS effectiveness, and productivity. Devoting resources to improving safety culture will ultimately make your workplace safer and more productive (McSween, 2003). Seems like a no brainer!

This article provides practical suggestions for how to assess and improve safety culture in Mx organizations. These suggestions are designed to be easy-to-use and cost-effective, such that any organization, large or small, can use them.

It's important to note up front that safety culture requires continuous improvement and commitment to safety. Everyone in the organization, from front-line technicians to the top CEOs, needs to be involved in all steps of the process. This is illustrated by The Iceberg of Ignorance—that shows that only a small percentage of an organization's problems are above the water and known by top managers, while front-line employees have a fuller picture of the problems below the water (see **Figure 1**). Only the

employees on the front line can tell the organization where improvements are needed. This requires an atmosphere of trust that focuses on learning from mistakes – a Just culture.

If you're still reading then promoting a healthy safety culture in your organization likely is a priority to you. Are you ready to learn the steps?

Step 1: Assess Safety Culture in Your Organization

The most common method of safety culture assessment is a voluntary survey, wherein employees report their attitudes, values, and beliefs about the organization and their workplace. Like an iceberg, only a small part of an organization's problems are "above water" and easy for management to identify. A survey is a great way to peer into the iceberg to see what is going on "below the water" from the front-line employees.

It's critical that organization-wide problems are identified so they can be fixed. Does the organization provide adequate resources to get the job done and minimize demands on employees? When you boil it down, Demands + Resources = Safety Culture. So, a good survey should include questions about resources provided to front-line employees as well the job demands placed on them.

Figure 1. The Iceberg of Ignorance, adapted from Yoshida's 1989 presentation at the International Quality Symposium.

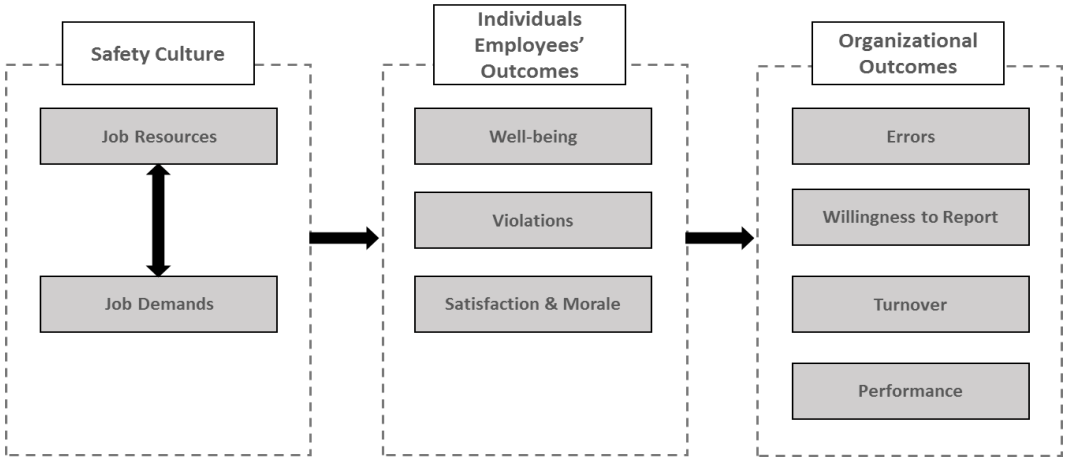

Figure 2. Model showing how safety culture (job resources and job demands) impacts individuals' well-being and satisfaction, which then leads to organizational performance outcomes like errors adapted from Fogarty et al. (2018).

Job Resources

- Training, equipment, and tools
- Adequate personnel and supervision
- Management commitment to safety
- Just culture
- Communication
- Autonomy

Job Demands

- Task overload
- Time pressure
- Pressure to compromise safety
- Group norms

When surveys include questions about these organizational factors, the picture is clear (see **Figure 2**). The organization provides job resources and set job demands (in essence, safety culture), which influence the individual employees' well-being, satisfaction and morale, and motivation to be safe. In turn, the individuals contribute to the organization's overall level of safety performance (Fogarty et al., 2018).

One good survey is the Snapshot Survey, developed for military aviation Mx in Australia (Cooper & Fogarty, 2015). The FAA is developing a new tool, similar to the Snapshot Survey, but for civil Mx operations in the United States. This tool will be accompanied by scoring metrics and recommendations for how to improve safety culture based on the results. This tool will be freely available on the Human Factors in Aviation Mx website so stay tuned!

A word of caution. Survey responses should be kept anonymous. Every employee in the organization matters equally and deserves the ability to make anonymous reports of problems that they see. No matter what the results are, they should NOT be used to punish employees. Instead, everyone should focus on continuous improvement and the idea that we can improve safety if we keep trying.

Step 2: Score and Share the Results

Next, score the responses to determine the current state of your organization's safety culture, and which specific areas have opportunities for improvement. No organization has a perfect safety culture, so the survey results will probably include areas that need more improvement than others. Some areas may already be in good shape. Mixed results are good—it helps the organization target where to go next. Remember that safety requires continuous commitment.

It's important to share the survey results with all employees. This serves two goals. First, it lets employees know that the results matter and management wants to hear from them (this increases trust). Second, it creates a shared vision of where the organization is right now, and where it needs to go. A shared vision is critical to the improvement process.

Step 3: Improve the Safety Culture

Improving safety culture begins with a shared vision that safety is a high priority in the organization. Just culture, or fair treatment of errors/mistakes when they occur, is also critical. Finally, remember the importance of continuous improvement and learning. If these things are not in place, any efforts to improve culture may fail.

So how do you create a shared vision? We recommend a short training on the importance of safety culture such as the FAA's computer-based training, **Follow Procedure Training: The Buck Stops with Me.** This training highlights the concept that everyone in the organization is equally responsible for safety, and therefore must be a part of the solution. It also identifies 11 concrete safety champion tools for the workplace. The training is free and can be used directly from the FAA's website complete with an end-of-course knowledge check at

followprocedures.com. It is available for free download from the Resources: Training and Tools link at humanfactorsinfo.com.

Following training, everyone in the organization should have a shared vision and path forward, which can then be supplemented by interventions targeted at specific work groups. One way to improve safety is via supervisor communications that safety is critical (Zohar & Polachek, 2014). Incentives for front-line employees' safe behaviors, like monetary rewards or social recognition, are also effective (Stajkovic & Luthans, 2003).

These interventions need not be expensive or time-consuming, they just need to be consistent and ongoing. Culture change is a slow, tedious process that requires the continuous commitment of all employees. But safety culture is a critical precursor to workplace safety, so improving the culture should be a high priority for you and your organization!

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Recognizing Outstanding Contributions – Editor's Selections

Kylie Key

In my few years of service as the *Quarterly* Editor, I have been continually impressed by the quality of our authors' contributions. So naturally, I couldn't resist the temptation to select a few of my favorite articles for re-print in this issue.

All of my selections deliver an important message about the critical role that front-line employees play in effective safety management. Because those employees are performing safety-critical tasks, they are most knowledgeable about safety hazards. Encourage front-line employees to report latent hazards in the workplace, otherwise management may never be aware of – or able to manage – those hazards (see D. Smith). Getting the front-line employee perspectives will decrease their resistance to new safety management efforts, and is key to unlocking the full potential of SMS (see Ashley Awwad). So get creative and find morale-boosting ways to reward employees for finding those safety hazards (see MSgt. Steven Fleming). Leverage front-line employees' firsthand knowledge, and utilize your most valuable safety management assets.

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

D. Smith

*This article was originally published in **FAA Aviation Mx Human Factors Quarterly: September 2018, Vol. 6, Issue 4,** and in this issue is part of a collection as outlined in the editorial (here).*

Article Reprint:

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 **CTEFAATO**s, pronounced *See-ta-fought-toos*. Further research by Yoshida and Shuichi, shows that front-line employees know where the **CTEFAATO**s 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 frontline 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 **CTEFAATO**s 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!

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.

Line Employee Engagement is the Missing Key in SMS

Ashley Awwad

*This article was originally published in **FAA Aviation Mx Human Factors Quarterly: September 2018, Vol. 6, Issue 4,** and in this issue is part of a collection as outlined in the editorial (here).*

Article Reprint:

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 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.

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How Does a Golden Bolt Reduce FOD?

MSgt Steven Fleming

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Article Reprint:

What is FOD?

Throughout this article, I will describe how small incentives can promote both safety and morale, at the same time, within a maintenance unit. I will discuss one program specifically: identification and reduction of FOD. First, what is FOD? Foreign Object Debris happens from items left in areas they were not meant to be in. FOD damage can happen from tools, hardware, garbage, and even natural items such as rocks and branches. FOD damage is a serious issue that we, as aircraft maintainers, have a responsibility to prevent.

How to reduce FOD?

In different maintenance units I've worked at within my career, I've seen many variations on how to prevent FOD. For starters we are trained on many procedures, including proper tool control, work area cleanliness, and overall housekeeping. After every job we do, we are required to inventory our tool box to maintain accountability for all assigned items. Immediately before and right after the aircraft taxis in or out of its assigned parking location, we perform an "area inspection" to identify FOD. We perform this task to prevent potential damage to an aircraft. Of course, we are constantly inspected to ensure we are following our training with each of these specific tasks. Despite the tedious tasks towards the end of work Page 7 days, morale remains a must, therefore it's important for us to find ways to insert a little fun.

How does a golden bolt reduce FOD?

Overall, my favorite example of turning everyday requirements into a fun situation must be the "Golden Bolt". On a scheduled basis, we would line

up and walk together in uniformity along the flight line and all search for FOD. This would normally happen 2 or 3 times per week. Expectations were clear; everyone at work at the specified time attended the fan-favorite "FOD Walk". Now, I'm not going to pretend that we all loved this mundane task. In fact, we openly acknowledge there are always other things we need to do such as sign off jobs in the data system, take out trash, and to be transparent, sometimes we just wanted to go home. But, when dealing with aircraft, FOD is serious, and potentially life threatening. Therefore, no matter what "excuses" we had not to participate, at the end of the day we all have to play our part to increase safety.

To expand, we had an individual that was assigned as the "FOD Program Manager". He/she was normally assigned in the quality assurance department. During one of our lovely FOD walks, that program manager had a little trick up his/her sleeve. The manager would hide a "golden bolt" in a specific location with hopes that it would be found by one member on the required FOD walk. The program manager identified a location based on different factors. Sometimes, it was just an area that was easy to skip past. At other times, the manager knew of an incident caused from FOD and wanted to verify that we would be able to correctly identify that area as necessary in a timely manner. Of course, all of this was with the full support of the commander in

charge. Now, before I go further, I must point out a few things…

1. The FOD program manager was not randomly given the job. They were trusted and hand-selected. Hiring for that role is a specific process, usually involving supervisor recommendations and unit commander acceptance.
2. Yes, this bolt was literally spray-painted gold. The manager would take pride in how gold this bolt was. There was no missing it, and the glare alone should blind anyone looking in its general direction.
3. I use the word "hide" loosely. Due to the potential damage of someone not finding it, the program manager had constant eyes on the location of where he/she placed the bolt.

Now, back to the walk. Try to imagine you are walking down the flight line with your ear protection donned. Within your immediate workspace are running engines to keep you cognizant of your purpose behind your task. You carry your small plastic trash bag for any FOD you may find; you are kind of in your own little world while scanning the area you are responsible for. All the sudden, out of nowhere, you hear a friend screaming and yelling. You can't hear much due to your ear protection. Still, the screams are loud enough that you can hear. However, it is apparent that this is a different kind of screaming. Not such that would startle you and have your defenses up. Instead, in an instant, you feel both happy and sad at the same time. Your friend has his hand held up high, with the sun reflecting off that extra bright golden bolt. Then, reality strikes; you missed it again! You searched for the bolt every time you go out to no avail, but now your friend gets to return the golden bolt to his supervisor in exchange for our most highly sought after reward--an extra day off. Lucky for him, but you still wish it was you that found the bolt. So now what? Now, you are motivated. No way is your friend going to find it again before you next time. You hone your vision and go out further prepared to look for FOD anywhere you can. You do so with such energy, leaving no stone unturned in hopes to find that rare, elusive, golden bolt to hold proudly in the presence of your peers as they watch you exchange it for that well-deserved day off from work.

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