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HUMAN FACTORS

QUARTERLY

SMS RELIES ON FAA HF RESEARCH AND DEVELOPMENT PRODUCTS

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Introduction

When I joined the FAA, in 2004, the senior leadership that interviewed me insisted that FAA research must create and support products that can be used in government and industry. Of course, they expected FAA Technical Reports and Newsletter articles like this one. They also respected that selected basic scientific research helped to validate the ultimate applied products. Much of this short article, also appeared in the May, 2016 AMT Magazine but this version has more elaboration.

A key component, or guiding principle, of today's continuing aviation safety is the concept of Safety Management Systems. SMS has significantly raised the awareness towards the human factors hazards in maintenance. Increasingly, industry is capitalizing on the last decades of products/practices generated from FAA's Maintenance Human Factors Program. A few examples are described below.

SMS Implementation Requires Tools for Thinking and for Acting

The regulations currently require that Part 121 operators have a Safety Management System in place. That is clearly happening. The industry is embracing SMS for more reasons than mere regulatory compliance. I have observed that the word "required" is hardly used when industry personnel talk about SMS. I see enthusiasm for the recognized value in a structured approach to spot trends and to recognize and address hazards before they cost money, injure a worker, or threaten the continuing safety of flight for airline operators. The good news is that there is a large "trickle down" approach where Part 121 operators are asking their suppliers to establish and capitalize on a SMS. Of course, a supplier is not likely to have the same requirement for a large SMS that a 7/24/365 airline has. Each SMS is different and matched to organization needs. These organization-

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

S M S R E L I E S O N F A A H F R E S E A R C H A N D D E V E L O P M E N T P R O D U C T S (C O N T ...)

specific needs, in my opinion, have triggered a revised interest in maintenance human factors. I offer four examples here, to include 1) How to categorize hazards, 2) Methods to collect event data and predictive data 3) How to estimate return on investment, and 4) The best fatigue risk management methods and training. All of these topics are worth revisiting.

Categorizing Human Factors

Increased attention to safety management, data collection, voluntary reporting, and hazard management begs for an organized categorization of hazards and errors. Over the years maintenance personnel have used the Swiss Cheese, SHELL, Bow Tie, and PEAR. Of course, I am partial to PEAR being the co-inventor and chief promoter the concept for 20 plus years. PEAR, for review, stands for People, the Environment in which they work, the Actions workers perform, and the Resources necessary to perform the work. PEAR is the main human factors training paradigm for FAA and Civil Aviation Authority of Australia inspector training. It is a key part of FAA's web product, The Maintenance Human Factors Presentation System, which has been an international training application for a very long time. Training support resources are available at www.humanfactorsinfo.com as well as at the CASA website. PEAR is significant because the categories can represent the

holes of error in the cheese or the human resilience represented by solid part of the cheese. PEAR overlaps with SHELL but is a bit easier to remember and utilize. On the Bow Tie, PEAR is an ideal way to offer the proactive barriers that prevent the event of focus.

The purpose here is not to make you a PEAR expert but instead, to insist that the concept is alive and well. If you want more detail then Google "Johnson PEAR Model."

Tools to Collect Data

SMS requires data collection methods must go well beyond standard post-event investigations. Data collection must include not only audit of daily operations but also a way to look ahead and predict possible risk. FAA worked with Airlines for America to develop the Maintenance and Ramp Line Operations Safety Assessment (LOSA) system (see Article by M. Ma in this Newsletter). The system uses a formal checklist-like method to permit peer-to-peer observation of normal procedures. LOSA is a positive method to support SMS because it recognizes daily hazards and strengths. All LOSA forms and training materials are on the FAA Maintenance Human factors website at www.humanfactorsinfo.com.

In a "perfect world" government conducts the initial research and

development to create a product, then industry applies the product to meet company-specific needs. LOSA worked out that way. Thanks to some early industry adopters, like United Airlines (along with Continental's LOSA legacy) and JetBlue , LOSA found early success. Boeing has provided extensive industry support for LOSA in the US and worldwide. The high value of LOSA, for SMS, continues to evolve from industry, rather than government, action.

Justifying your Human Factors Interventions

Engineering/Maintenance managers know where the most significant hazards are. Fostering the positive safety culture, using the technical publications, and ensuring fitness for duty are a few most common opportunities to address hazards. However, organizational-specific information, discovered by voluntary reports or SMS data will identify specific hazards, like aircraft ground movement, availability of specific tools/equipment, scheduling challenges, shift turnover communications and more. Unlimited resources would permit organizations to address all hazards, but that's not the real world. For that reason organizations must apply risk assessment to look at the likelihood that the hazard may cause

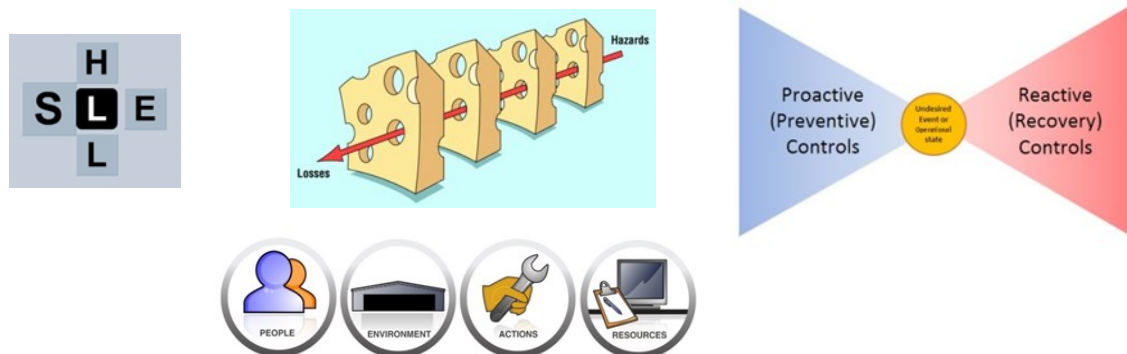


Figure 1. Categorizing Human Factors using the SHELL, "Swiss Cheese," Bow Tie and PEAR methods.

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**S M S R E L I E S O N F A A H F R E S E A R C H A N D
D E V E L O P M E N T P R O D U C T S
(C O N T ...)**

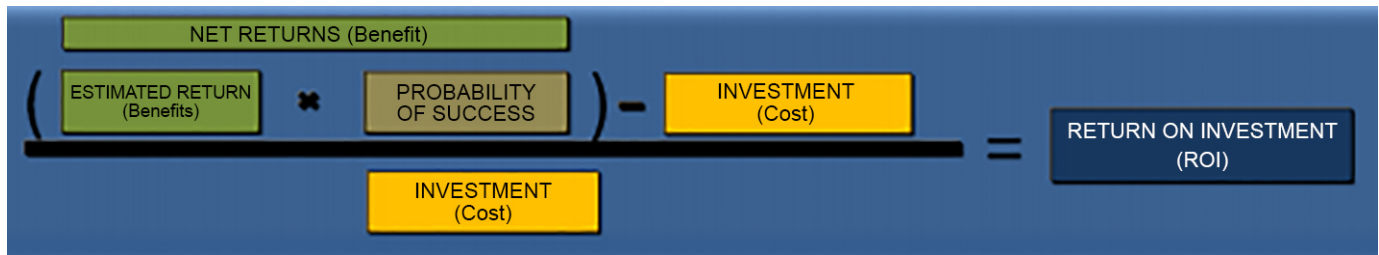


Figure 2. The FAA ROI Model

an error and what is the severity of such an outcome. But organizations must also determine the financial and safety impact of a hazard in order to prioritize which hazard reductions have the highest payoff. That's where the FAA Maintenance Human Factors Return on Investment tools can come in handy.

Figure 2 shows that one does not have to be an economic expert to calculate return on investment. In fact, it is more about understanding your hazards and the associated number of events (or potential events) that will result in an unmanaged hazard. SMS data can help assign costs if you are motivated to assign costs. The aviation maintenance expert will assign cost to the hazard intervention and predict the level of confidence in the estimation. The rest is multiplication and division. The tools and detailed directions are available in the tools section at www.humanfactorsinfo.com.

Many have seen me write or speak that SMS, regulated or not, is the best approach to fatigue management regulations in maintenance. Most authorities do not have strict rules for fatigue risk management. Even when there are national industrial fatigue rules they are usually trumped by a variety of stipulations that permit aviation maintenance personnel to work more consecutive days and longer hours than they should. Proper SMS will quickly discover if there is a maintenance fatigue issue in an organization. By design, an SMS must identify such hazards, determine the

corrective action, promote the action, and assess the impact.

My recent experience suggests that industry is becoming increasingly aware of the hazards associated with worker fatigue. I believe that SMS programs have an impact on the awareness of worker fatigue hazards. The numbers of users on the 2-hour web-based training continues to grow (estimated at over 200k users in the past 5 years. (Course # ALC-258 available at www.faasafety.gov). The multiple award winning video, entitled "Grounded," is available as part of that training or accessible on YouTube.

Demand Remains High for Maintenance Human Factors Support

Industry has stepped up to address the hazards associated with human factors challenges in maintenance. For the most part, they have done that without extensive regulations. The safety and business case speak louder than regulation. FAA intends to continue to support the maintenance human factors website and is open to all suggestions for additions to our website and associated resources.

Comments – Send comments to Dr. Bill Johnson at Bill-dr.johnson@faa.gov





**EVERYTHING OLD IS NEW AGAIN;
REVISITING “THE DIRTY DOZEN”**

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“This new human factors stuff is great!”

A student in a recent maintenance human factors course was really excited about the training and remarked multiple times about the “new” concepts. He asked how long this type of course has been going on, and, as tactfully as I could, I let him know that maintenance human factors training has been evolving for over 25 years. He laughed and said it reminded him of the TV advertising campaign “If you haven’t seen it, it’s new to you.”

Human factors and safety in aviation continue to evolve and have more attention and energy directed towards them than ever before. But are these concepts really all that new? Take the following example:

“The term “accident,” although we use it for want of a better one, is only one degree less unfortunate than the unhappy expression “act of God.” Literally speaking, there is no such thing as an accident. There is always a predisposing cause. It is a common statement that somewhere between eighty and ninety per cent of the misadventures which commonly go by the name of accident are due to the “human factor.”

This is from an article titled “Safety.... It Can Be Done” which was published in

September 1930 in Aviation magazine (now called Aviation Week & Space Technology).

While the FAA moves forward with the “new” and prepares to release the Advisory Circular on Maintenance Fatigue Risk Management, it has its foundation in the “old.” Fatigue is one of the accident precursors documented in the well-known Dirty Dozen, the list of twelve factors

countermeasures, however, all are impacted by a positive safety culture, a strong Safety Management System (SMS), appropriate training, being properly prepared, and adherence to checklists and procedures.

Investigations into aviation accidents involving maintenance error illustrate how these factors can contribute to adverse outcomes. Often, the factors are links in the accident chain of events that lead others (the flight crew, for example) to commit errors. A few examples are listed on pages 5-8 of this newsletter issue.

The Dirty Dozen tends to focus on the maintenance technicians but can also be used to examine the organization in which the action is occurring. Discussions on the Dirty Dozen increase awareness of the factors and the

hope is that will translate into a reduction in error and an enhanced safety culture. It’s also important to remember that the Dirty Dozen, by themselves, do not make up a human factors program. However, they’re a good place to build from and a solid element in a robust SMS.

For a full explanation of the Dirty Dozen, consider participating in a Human Factors in Aviation Maintenance course at TSI. Contact Mr. D Smith at d.smith@dot.gov or learn more about TSI at: www.tsi.dot.gov

Too Much:	Not Enough (A Lack of):
Complacency	Communication
Distraction	Knowledge
Fatigue	Teamwork
Pressure	Resources
Stress	Assertiveness
Norms	Awareness

Figure 1. Too much complacency is detrimental to performance. Alternatively, not enough communication is also detrimental to performance.

recognized to be common contributing influences to maintenance error. Compiled by Transport Canada in the 1990s, the list remains relevant today and is the basis for numerous maintenance human factors training programs.

The Dirty Dozen can be discussed in terms of factors that there are too much of or not enough of (Figure 1). While no single factor is considered more significant than the others, the presence of fatigue, stress, and/or pressure will often amplify the influence of any other existing factors. Each factor has its own specific

FROM “DIRTY DOZEN” TO “FILTHY FIFTEEN” – PROFESSIONALISM IN AIRCRAFT MAINTENANCE

GUEST AUTHORS: MAGGIE MA & JAY GROWER



About the Authors: Maggie Ma is a Certified Human Factors Professional (CHFP) who specializes in maintenance human factors, and a Boeing Designated Expert. Maggie received her Ph.D. in Industrial Engineering/Human Factors Engineering from State University of New York at Buffalo. Her primary Boeing responsibilities include providing implementation support to customer airlines and other maintenance organizations on a wide array of safety processes/programs, e.g., the Maintenance Error Decision Aid (MEDA) process, the Ramp Error Decision Aid process, Maintenance Human Factors training, a Safety Management System, Maintenance Line Operations Safety Assessment (LOSA), and Ramp LOSA. She has worked closely with airlines, manufacturers, maintenance organizations, ground service providers, and regulatory agencies around the world.



Jay Grower has worked for Hawker Pacific Aerospace for nearly 40 years. His aerospace experience as an inspector, auditor, and trainer have given him a unique opportunity to view and understand both the direct causes and underlying causes of maintenance error. Based on his understanding of the impact of human factors on performance and quality, he has worked with Hawker managers to ensure their responses to corrective actions, include both human factor causes and technical causes.

My job allows me to support customers and maintenance organizations all over the world. Learning about different operations, meeting expert practitioners, and experiencing new cultures continue to fascinate me. What I love about my job even more is having the opportunity to embrace best practices from different organizations and then share them with others in the industry.

A couple of months ago, I worked with colleagues from Hawker Pacific Aerospace (HPA), a member of Lufthansa Technik Group. HPA has a number of tools for promoting safety. For example, the “Filthy Fifteen” posters are HPA’s expansion of the “Dirty Dozen” list, and are applicable to the Maintenance, Repair, and Overhaul (MRO) industry. HPA’s “4-C Professionalism” poster highlights key characteristics for an aviation professional. The poster also lists the important job responsibilities. These tools are HPA’s original creations or modifications, and are integrated into its human factors program.

Dirty Dozen

Due to a spate of maintenance-related aviation incidents and accidents in the late 1980s and early 1990s, Transport Canada, together with the aviation industry identified 12 human factors issues, christened the “dirty dozen.”

- Lack of communication
- Distraction
- Lack of resources
- Stress
- Complacency
- Lack of teamwork
- Pressure
- Lack of awareness
- Lack of knowledge
- Fatigue
- Lack of assertiveness
- Norms

The 12 elements impact human ability to perform effectively and safely and are common human error preconditions to accidents or incidents. Of course, these 12 preconditions are not a comprehensive list. In 1994, the Dirty Dozen posters were developed to provide guidance to maintenance personnel around the world. Safety nets for the 12 human factors issues were also introduced so that the appropriate mechanisms can be put into place to capture, reduce, and prevent human errors. The safety nets listed are not comprehensive. There is an infinite amount of possible safety nets an organization can put into place because there is always the possibility to do things better. The Dirty Dozen concept has since become a cornerstone of Maintenance Human Factors training worldwide. Over the

years, different areas of aviation have found that the Dirty Dozen offers a useful introduction to open discussions into human errors in the workplaces and organizations. The list has been adopted for pilots, ramp workers, air traffic controllers and cabin crews (See http://www.system-safety.com/trainingvideos/Training_Aids/Safety%20Posters.htm).

Boeing’s Addition to Dirty Dozen – The Pledge

Boeing has customized the Dirty Dozen for the aircraft production environment in 2014. “The Aviation Professional’s Pledge” was first launched in the 737 NG production line in October 2014. The pledge is composed of 10 action items and states:

“I know the lives and safety of others depend on my skill and judgment as an aerospace professional. I will not be persuaded or influenced by personal gain to approve aircraft or pass questionable workmanship as airworthy.”

HPA’s Expanded Dirty Dozen – The Filthy Fifteen

In its human factors training, HPA expanded the “Dirty Dozen” to the “Filthy Fifteen” by introducing three

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FROM “DIRTY DOZEN” TO “FILTHY FIFTEEN” - - PROFESSIONALISM IN AIRCRAFT MAINTENANCE (CONT...)

more human performance issues: not admitting limitations, lack of operational integrity, and lack of professionalism. The three precursors precisely capture some additional common reasons why aircraft maintenance technicians make errors and deviate from company policies, processes, and procedures, i.e., commit violations. In fact, all 15 precursors may lead to human errors or violations or both. In its Filthy Fifteen posters, HPA illustrates scenarios that pertain to its MRO operations.

Aircraft maintenance technicians are known for their “Can Do” mentality, which motivates them to do exceptional work despite all the challenges. However, this mentality can backfire at times. *“I have not been properly trained on this, but I have so much experience, I can figure out how to do the task without formal training. How hard can it be? I have an A & P license after all. That proves I can do it. Sure, I can take care of those as well!” “I’m tough! I can work 14 hours every day, month after month without much sleep. I’ll sleep when I die!”* Not admitting limitations highlights that everyone has their limits. To be precise, the study/analysis of human performance limitations is a vital part of human factors training. We must understand, thus be honest, transparent, and assertive by admitting our limitations in order to perform our tasks effectively and safely. Exceeding our limitations decreases performance, increases risk to the individual and co-workers, and may lead to aircraft and equipment damage. The counter measures to “not admitting limitations” include:

- Be aware of your physical, cognitive, and technical limitations
- Listen to your body’s warning signs
- Get over your ego
- Admit lack of knowledge

- Always follow the correct procedures
- Seek answers and ask for help
- Take breaks and live a healthy lifestyle

Integrity refers to a firm adherence to a code of moral values and its application is through continuous observance by the company and employees to regulatory requirements and approved maintenance procedures. Lack of Operational Integrity can result in risk taking behaviors, such as both routine violations (ineffective workplace norms) and situational violations (cutting corners due to certain circumstances in the work environment, such as time pressure, unavailability of equipment/tools). *“It was a little out of tolerance last time and it worked! It is a little out again, what is the big deal?”* Integrity is steadfast adherence to a strict moral or ethical code. It means doing the right thing every time, no matter if you are seen by others or not. Deviation from the procedures may not result in immediate negative impact on safety.

As a result, people may become complacent and grow to believe it is low risk to deviate. This makes “lack of operational integrity” particularly insidious. Some safety nets for this human error precursor include the following actions:

- The organization must communicate its commitment to integrity to the workforce
- Know the characteristics of integrity and apply them
- Make your actions consistent with your words
- Speak up immediately if you know you have made an error
- Always consider the safety of others (traveling public, coworkers)
- Always follow the correct

procedures

The third item that HPA includes in its “Filthy Fifteen” is Lack of Professionalism. This addition and HPA’s “Professionalism” poster could not be timelier for the aircraft maintenance industry. Lack of professionalism and lack of integrity have been known to contribute to accidents such as American Airlines Flight 191 in 1979 and Continental Express Flight 2574 in 1991 (Baron, 2011). In recent years, it has been a common complaint from maintenance organizations that technicians, particularly of younger generations, do not exhibit a passion of professional pride, which was once there.

Doctors in many Western countries take the Hippocratic Oath upon entering the profession, as a symbol of their commitment to upholding a number of ethical and moral standards. In the aircraft maintenance world, technicians live by the technician’s creed, which was originally written by Jerome Lederer in 1941. The creed appeared on the back cover of the first issues of Flight Safety Foundation’s *Aviation Technicians Bulletin* in 1953 and proved to be extremely popular. Technicians around the world, “from Tokyo to Frankfurt, from Canada to Puerto Rico,” wrote to request copies of the creed to hang in their offices and shops. And that was certainly evidence of a passion of professional pride.

A professional is a member of a profession. “Professionalism” refers to the skill, good judgment, polite and respectful behavior that is expected from a person who is trained to do a job well. The term also describes the standards of education and training that prepare members of the profession with the particular knowledge and skills necessary to

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FROM “DIRTY DOZEN” TO “FILTHY FIFTEEN” - - PROFESSIONALISM IN AIRCRAFT MAINTENANCE (CONT...)

perform the role of that profession. In aircraft maintenance, “Professionalism” can be interpreted as the willingness to take responsibility for placing the safety and airworthiness needs of the traveling public above individual self-interest. The above is evidence of Integrity. So, Professionalism and Integrity go hand-in-hand, and Integrity is the cornerstone of Professionalism. Professionalism can be further explained from the following aspects (CASAA, 2013):

- Discipline—following approved procedures to perform a given task
- Communication—keeping their team members informed of progress and developments
- Teamwork—working together well to resolve problems and maintain control
- Knowledge—having a deep understanding of aircraft systems and their operation
- Expertise—retaining and transferring knowledge and skills
- Situational awareness—knowing what is happening around them
- Experience—calling upon prior training and knowledge to assess new situations
- Decision making—taking the correct decisive actions
- Resource management—allocating resources to ensure control of the larger situation is maintained while specific problems are being addressed
- Goal prioritization—prioritizing safety above personal concerns

“Professionalism” also emphasizes self-control or self-regulation to exercise personal integrity in order to resist at-risk behaviors. Professionalism is central to the integrity of the work process, quality of the production, and consequently, a safe and successful operation. HPA

teaches the four core characteristics – the 4 C’s for the aviation professional:

- Competence in knowledge and skills in their field
- Commitment to a higher purpose
- Control of their own work
- Communication (written, verbal, and nonverbal other than written)

HPA emphasizes that it is vital to internalize and practice the above core competencies, and has offered their technicians the following safety nets to guard against “lack of professionalism”:

- Work with passion
- Share your knowledge
- Use approved parts, materials, and technical data
- Use proper tools
- Be a diligent judge of quality
- Always follow the correct procedures

To practice professionalism, an aircraft technician must apply all counter measures from the entire list of “Filthy Fifteen” items. For example, one must not hesitate to be assertive or practice distraction and complacency avoidance and at the same time manage stress effectively. An employee must not treat any task as trivial, and takes equal care doing basic tasks as those which are complex. At HPA, the following is emphasized frequently: “that most accidents are not caused by very complex technical issues, but by simple and avoidable errors, such as failing to finish the torquing of a nut.”

Technicians who are professionals readily admit errors. Those technicians have the discipline and assertiveness to ensure they are trained and certified for the task. HPA continually emphasizes “Raise Your Hand” in new

hire orientation and recurrent training. That is, when a technician has any doubt whether he/she can perform a task effectively and safely, the technician must raise his/her hand and notify the management that an issue needs correction. Then management that is made aware can ensure the technician get the help and training he/she needs. Simultaneously, each technician is encouraged to always strive to be the best he/she can be through continuous learning and professional development.

In the past couple of years, several maintenance organizations I work with have launched professionalism campaigns to promote product quality and safety. Those professionalism campaigns were also designed to inspire/re-kindle the pride for the aircraft maintenance profession. The organizations have observed some significant positive improvements.

In conclusion, professionalism and integrity should be an important topic in any human factors curriculum for aircraft maintenance technicians. However, the application in the workplace largely remains the responsibility of each individual. Technicians need to buy into these values, and are proud to practice professionalism and integrity. This is a process that begins in the heart and is instilled into the mind, then put into practice by the hands that touch and work on the aircraft or components.

References:

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- Civil Aviation Safety Authority of Australia (2013). Human Factors – Resource Guide, Chapter 11: Professionalism.

**“ T H E D I R T Y D O Z E N ” I N C O N T E X T : A V I A T I O N
C A S E S T U D I E S**

Sundance Helicopters, December 7, 2011

Eurocopter AS350-B2, N37SH
Las Vegas, Nevada
Passengers and Crew: 5
Fatalities: 5
Damage: Destroyed

Potential Dirty Dozen Contributory Factors: Fatigue, Lack of Resources, Lack of Awareness, Pressure, Complacency, Lack of Assertiveness, Lack of Knowledge, Norms

From the NTSB Executive Summary

On December 7, 2011, a Sundance Helicopters aircraft crashed in mountainous terrain.

The accident occurred when the helicopter unexpectedly climbed about 600 feet, turned about 90° to the left, and then descended about 800 feet, entered a left turn, and descended at a rate of at least 2,500 feet per minute to impact. During examination of the wreckage, the main rotor fore/aft servo, one of the three hydraulic servos that provide inputs to the main rotor, was found with its flight control input rod not connected. The bolt, washer, self-locking nut, and split pin (sometimes referred to as a "cotter pin" or "cotter key") that normally secure the input rod to the main rotor fore/aft servo were not found. The investigation revealed that the hardware was improperly secured during maintenance that had been conducted the day before the accident. The nut became loose (likely because it was degraded)[1] and, without the split pin, the nut separated from the bolt, the bolt disconnected, and the input rod separated from the linkage while the helicopter was in flight, at which point the helicopter became uncontrollable and crashed.

Probable Cause

The NTSB determines that the probable cause of this accident was Sundance Helicopters' inadequate maintenance of the helicopter, including (1) the improper reuse of a degraded self-locking nut, (2) the improper or lack of installation of a split pin, and (3) inadequate post-maintenance inspections, which resulted in the in-flight separation of the servo control input rod from the fore/aft servo and rendered the helicopter uncontrollable. Contributing to the improper or lack of installation of the split pin was the mechanic's fatigue and the lack of clearly delineated maintenance task steps to follow. Contributing to the inadequate post-maintenance inspection was the inspector's fatigue and the lack of clearly delineated inspection steps to follow.

American Airlines Flight 1400, September 28, 2007

McDonnell Douglas DC-9-82, N454AA
St. Louis, Missouri
Passengers and Crew: 143
Fatalities: 0
Damage: Substantial

Potential Dirty Dozen Contributory Factors: Distraction, Complacency, Pressure, Norms, Lack of Resources, Lack of Awareness

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**“ THE DIRTY DOZEN ” IN CONTEXT: AVIATION
CASE STUDIES
(CONT...)**

From the NTSB Executive Summary

On September 28, 2007, the American Airlines aircraft experienced an in-flight engine fire during departure climb. During the return to STL, the nose landing gear failed to extend, and the flight crew executed a go-around, during which the crew extended the nose gear using the emergency procedure.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was American Airlines' maintenance personnel's use of an inappropriate manual engine-start procedure, which led to the uncommanded opening of the left engine air turbine starter valve, and a subsequent left engine fire, which was prolonged by the flight crew's interruption of an emergency checklist to perform nonessential tasks. Contributing to the accident were deficiencies in American Airlines' Continuing Analysis and Surveillance System (CASS) program.

Note: A flawed internal Safety Management System, which could have identified the maintenance issues that led to the accident, was cited as a contributing factor.

Chalk's Ocean Airways Flight 101, December 19, 2005

Grumman Turbo Mallard G-73T, N2969
Miami, Florida
Passengers and Crew: 20
Fatalities: 20
Damage: Destroyed

Potential Dirty Dozen Contributory Factors: Complacency, Norms, Lack of Awareness, Lack of Assertiveness, Lack of Knowledge, Lack of Resources

From the NTSB Executive Summary

On December 19, 2005, the Chalk's Ocean Airways aircraft crashed into a shipping channel adjacent to the Port of Miami, Florida, shortly after takeoff from the Miami Seaplane Base. The airplane's right wing separated during flight.

The safety issues discussed in this report focus on air carrier maintenance programs and practices and FAA oversight procedures for air carrier maintenance programs.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the in-flight failure and separation of the right wing during normal flight, which resulted from (1) the failure of the Chalk's Ocean Airways maintenance program to identify and properly repair fatigue cracks in the right wing and (2) the failure of the Federal Aviation Administration (FAA) to detect and correct deficiencies in the company's maintenance program.

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**“ T H E D I R T Y D O Z E N ” I N C O N T E X T : A V I A T I O N
C A S E S T U D I E S
(C O N T . . .)**

Air Sunshine Flight 527, July 13, 2003

Cessna 402C, N314AB
About 7.35 Nautical Miles West-Northwest of Treasure Cay Airport
Passengers and Crew: 10
Fatalities: 2
Damage: Substantial

Potential Dirty Dozen Contributory Factors: Lack of Communication, Norms, Lack of Resources, Lack of Knowledge, Complacency

From the NTSB Executive Summary

On July 13, 2003, the Air Sunshine aircraft was ditched in the Atlantic Ocean following the in-flight failure of the right engine.

The safety issues discussed in this report include maintenance record-keeping and practices, pilot proficiency, Federal Aviation Administration (FAA) oversight, and emergency briefings.

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the in-flight failure of the right engine and the pilot's failure to adequately manage the airplane's performance after the engine failed. The right engine failure resulted from inadequate maintenance that was performed by Air Sunshine's maintenance personnel during undocumented maintenance. Contributing to the passenger fatalities was the pilot's failure to provide an emergency briefing after the right engine failed.

Air Midwest Flight 5481, January 8, 2003

Raytheon (Beechcraft) 1900D, N233YV
Charlotte, North Carolina
Passengers and Crew: 21
Fatalities: 21
Damage: Destroyed

Potential Dirty Dozen Contributory Factors: Complacency, Fatigue, Norms, Lack of Knowledge, Lack of Awareness, Lack of Resources, Pressure

From the NTSB Executive Summary

On January 8, 2003, the Air Midwest aircraft crashed shortly after takeoff from runway 18R at Charlotte-Douglas International Airport, Charlotte, North Carolina.

The safety issues in this report focus on maintenance work practices, oversight, and quality assurance; aircraft weight and balance programs; maintenance training; FAA oversight; and Beech 1900 cockpit voice recorder problems.

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**“ T H E D I R T Y D O Z E N ” I N C O N T E X T : A V I A T I O N
C A S E S T U D I E S
(C O N T . . .)**

Probable Cause

The National Transportation Safety Board determines that the probable cause of this accident was the airplane's loss of pitch control during takeoff. The loss of pitch control resulted from the incorrect rigging of the elevator control system compounded by the airplane's aft center of gravity, which was substantially aft of the certified aft limit.

Contributing to the cause of the accident were (1) Air Midwest's lack of oversight of the work being performed at the Huntington, West Virginia, maintenance station; (2) Air Midwest's maintenance procedures and documentation; (3) Air Midwest's weight and balance program at the time of the accident; (4) the Raytheon Aerospace quality assurance inspector's failure to detect the incorrect rigging of the elevator control system; (5) the Federal Aviation Administration's (FAA) average weight assumptions in its weight and balance program guidance at the time of the accident; and (6) the FAA's lack of oversight of Air Midwest's maintenance program and its weight and balance program.

Additional information on the factors in the Dirty Dozen can be found in the following:

Aviation Maintenance Technician Handbook – General

http://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/media/AMT_Handbook_Addendum_Human_Factors.pdf

Avoid the Dirty Dozen

<https://www.faasafety.gov/files/gslac/library/documents/2012/Nov/71574/DirtyDozenWeb3.pdf>

NASA's Aviation Safety Reporting System (ASRS) Maintenance Reporting Callback September 2008

http://asrs.arc.nasa.gov/publications/callback/cb_345.htm

Safety Behaviours: Human Factors Resource Guide for Engineers

https://www.casa.gov.au/safety-management/standard-page/safety-behaviours-human-factors-engineers-resource-kit?WCMS%3ASTANDARD%3A%3Apc=PC_100999

Operator's Manual: Human Factors in Aviation Maintenance

http://www.faa.gov/about/initiatives/maintenance_hf/library/documents/media/human_factors_maintenance/hf_ops_manual_2014.pdf

Welcome FAA Schools of Excellence PEGASUS Fellows!

It's a busy time around the Civil Aerospace Medical Center in Oklahoma City, OK. To help us out with that, we have some highly skilled graduate students who have joined us for 10 weeks from the FAA Schools of Excellence Partnership to Enhance General Aviation Safety, Accessibility, and Sustainability (PEGASUS) program. Taken from the PEGASUS website:

PEGASUS is comprised of world-renowned universities and institutes with top-tier aviation programs as well as highly respected schools of engineering, science and policy... PEGASUS strives to expand general aviation's sustainability in a way that allows general aviation to serve the needs of future stakeholders, encompassing environmental, economic, and educational concerns.

We were fortunate to be able to collaborate with PEGASUS to award Audrey Reinert, from Purdue University, and Indira Maharaj, from Florida Institute of Technology a prestigious Fellowship to live and work here in Oklahoma City on Maintenance Human Factors projects. Welcome to you both!

Learn more about PEGASUS at: www.pegasus.aero



Audrey Reinert is a 1st year Ph.D. student in Industrial Engineering at Purdue University. Her work with the PEGASUS Fellows program focuses on identifying trends in ASRS reports to design effective interventions which reduce human factors maintenance errors. Prior to working with the FAA, Audrey has interned with NASA and United Technologies Research Center.

Indira Maharaj is an avid aviation enthusiast who has pursued an academic path dedicated to understanding and advancing the relationship between the human user and automation in aviation. She is a 2nd year Ph.D. student in the Aviation Sciences, Human Factors track at Florida Institute of Technology. Her interests in aviation include, the cognitive influences of human performance in "glass cockpits", bringing a new perspective to the old problem of how to maximize the benefits of aviation technological advancements such that a highly effective and efficient human-in-the-loop system can occur. She has over 8 years of research experience and managing projects which includes membership in the Human Factors and Ergonomics Society. In addition, she is an active member of Women in Aviation and is working on her PPL, with a goal of obtaining instrument rating prior to graduation. When she is not involved in research or aviation, she enjoys volunteering at the Second Harvest Food Bank, advocating for world peace, cuddling with puppies, smelling the rain, and listening to thunderstorms (especially at night).



Maintenance Human Factors Lab Update

As many of you might know from seeing Dr. Michelle Bryant out and about, we are in the midst of collecting data from over 300 maintenance technicians across the nation. The current study is a follow up from a fatigue study published by Dr. Bill Johnson, Dr. Steven Hall, and Jean Watson in 2001. You can find that report by clicking [here](#). The primary recommendation from that study indicated that there was a need for a Sleep Culture among maintenance organizations. As a result, the Flight Deck Lab produced a flurry of documents and training focused on the importance of sleep and the impact of fatigue. You can find these resources by clicking [here](#). Now, we are interested to see if there have been any changes across the industry. We have currently collected data from about 220 maintenance personnel across the industry and expect to complete all 300 by July of this year. Once we have completed data collection, we'll update you on what our participants do in the study, and the anticipated date when results will be available. Thank you to the maintenance community for welcoming our researchers into your hangars. We couldn't do our work without you.

Maintenance Human Factors Recent and Upcoming Events

CHC Safety Summit: Co-Key Note Speaker and ROI Workshops Dr. Bill Johnson	April 5-7 2016 Vancouver, BC
AMFA Conference: Attention to Maintenance Human Factors Dr. Bill Johnson	May 2, 2016 New Orleans, LA
Regional Airlines Convention: Not Your Grandfather's SDRS Dr. Bill Johnson	May 11, 2016 Charlotte, NC
Transportation Safety Institute: Maintenance Human Factors Course Dr. Bill Johnson	May 25, 2016 Mike Monroney Aeronautical Center, OK
Navy Squadron Safety Stand-down: A Focus on Fatigue Dr. Michelle Bryant	June 18th, 2016 Tinker Airforce Base, OK
Transportation Safety Institute: Maintenance Human Factors Course Dr. Bill Johnson	June 19th, 2016 Mike Monroney Aeronautical Center, OK
CSTA Workshop: Train the Trainer Dr. Bill Johnson, D Smith, and Dr. Michelle Bryant	August 2-4th, 2-16 Mike Monroney Aeronautical Center, OK

See 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:

crystal.rowley@faa.gov.