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Flight Safety Management "Best Practices" – What Can We Learn from Them?

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Introduction

"Aviation in itself is not inherently dangerous. But to an even greater degree than the sea, it is terribly unforgiving of any carelessness, incapacity or neglect." Aviation safety has progressed a significant amount since the first powered flight by the Wright Brothers on December 13, 1903. The first powered airplane fatality in history occurred in 1908 when Lt. Thomas Selfridge was killed in this plane piloted by Orville Wright. The accident was caused by propeller separation. Orville Wright suffered broken ribs, pelvis and a leg.

Wright Brothers Aeroplane Company and Museum of Pioneer Aviation

During the early stages of powered flight, many of the accidents that occurred were attributed to both mechanical failures and or pilot-induced error. It was not unusual for early aircraft engines to have recommended time between overhauls of as little as twenty hours. As time progressed, aircraft and their propulsion systems became significantly more reliable while the issue of human error-induced accidents remained fairly consistent for many years.

The purpose of this paper is to outline several of the key methods and practices by which the aviation industry has achieved some fairly notable safety milestones. For instance, in 2002 there were no fatal US domestic Part 121 airline accidents. While during this period of time, there were approximately 10 million takeoffs accomplished and more importantly, 10 million safe landings. There is an old aviation antidote, takeoffs are optional, but landings are always mandatory. A good safety objective is when the number of landings equal the number of takeoffs. In 2004, the NTSB reported only one fatal accident in over 10 million scheduled departures. In the three years spanning 2002-2004 there were three fatal accidents in 31 million scheduled departures. During that time, US airlines carried nearly 1.9 billion passengers and recorded 34 fatalities.

This surpasses the objective of six sigma with an error rate objective of less than of 3.4 defects per million. As noted above, this was not always the case in commercial aviation. The following chart illustrates how the trend in fatal commercial accidents has achieved a significant decline in the past 56 years.

So how did the aviation industry achieve these dramatic safety improvements as well as increasing the level of service to the flying public? A combination of mechanical and technological improvements as well as flight standardization processes all had a positive effect on the accident trend rates. This paper will review several of the methods employed by the airlines or required by regulatory agencies to achieve consistent results while still having error prone human beings actively involved in the process. These methods are noted below and they are the types of safety defense methods that all companies can use to improve workplace safety:

1. **Standardization of procedures (SOP's)**
2. **Training**

3. **Behavioral observations**
4. **Human factors**

1. Standard Operating procedures

If you ever had the chance to ride in the jump seat of an airliner and observe the flight crew from the gate push back through engine start, takeoff and arrival at the destination airport you would see and hear a highly choreographed sequence of tasks. These tasks include running checklists, entering navigation data into the flight management systems, responding to air traffic controller commands, and flight control tasks. In order to reduce the chance for variation in behavior, especially when many airlines have over 8,000 pilots employed who do not consistently fly with the same crew member, there must be a set of standard operating procedures that all crew members must follow.

All FAA Part 121 airlines as well as nonscheduled air charter operators Part 135 must have an approved flight operations manual (FOM). The FOM clearly defines the air carrier's flight crew operating procedures for all phases of flight, normal, abnormal as well as during emergency situations. An FOM is a set of procedures that dictate how flight crews will perform certain tasks in a uniform format.

For example, before each takeoff, crews calculate three critical airspeeds called "V" speeds. V1 is the speed up to which the aircraft can experience a safety critical event and still be safely stopped on the runway. After V1 the aircraft must be flown off the runway as it will not be able to stop on the remaining runway due to the aircraft weight and the available brake friction forces. Vr is the speed for rotation at which point the aircraft can be safely rotated for take off and V2 is the speed at which if an engine failure occurs just after V1 at which the aircraft must be flown at to achieve a safe rate of climb to clear any obstacles in the flight path. These numbers are verbally briefed before each takeoff as well as contingency plans in the event that an emergency occurs. In addition, standard callouts are made by the non-flying pilot during the takeoff phase as the aircraft accelerates through the calculated reference v speeds. Can you imagine the high like hood for confusion if all pilots used different terms and phrases to communicate these critical numbers that happen at a fast rate during the take off phase. A classic example is the story of a captain calling for takeoff power during the takeoff roll, the dutiful first officer response to the command was to reduce power by pulling the power levers back. The captain was actually requesting a power setting for take-off but using confusing terminology.

The main point for having or developing a set of standard operating procedures is to reduce the chance for human variation in performing critical tasks and for guidance in emergency situations. Standard operating procedures are written from a technical perspective. This means they must be:

- Clear and concise—getting directly to the point and avoiding wordy sentences. Standard operating procedures should be communicated in the fewest possible words, phrases, and paragraphs. In some situations, pictures may help.
- Complete—containing all the necessary information to perform the procedure,
- Objective—containing facts, not opinions
- Coherent—showing a logical thought process and sequentially listing all steps necessary to complete the procedure.

- Standard operating procedures can serve as benchmarks for performance reviews, training aids, or in the case of quality standards, a starting point for improvement.

2. Training

"I learned that danger is relative, and that inexperience can be a magnifying glass."
— *Charles A. Lindbergh*

A key component in reducing variation in human behavior is providing employees training on how to safely and properly perform required job tasks. All new pilots initially attend a week to two week long class called basic indoctrination. This class typically provides an overview of the company's policies and procedures related to safety and standard operating procedures. This type of class is also repeated on an annual basis in a shorter format called recurrent training. The annual recurrent classes are also an opportunity for the company to review any changes to procedures, company policies or new regulatory requirements.

After the initial indoctrination classes, all pilots receive aircraft based training in full motion simulators. This is the skilled based training portion of the training as well as a strong focus on the company standard operating procedures. Since the early eighties, after a series of accidents attributed to poor flight deck communications between the crew members, training on crew resource management (CRM) became a mandatory element to help in reducing errors in the cockpit. Supporting this emphasis on CRM training, the National Transportation Safety Board (NTSB, 1979) had singled out the captain's failure to accept input from junior crewmembers and a lack of assertiveness by the flight engineer as causal factors in a United Airlines crash in 1978.

CRM is now generally completed on the premise that human error is ubiquitous and inevitable and a valuable source of information to help in preventing future occurrences. CRM training is comprised of a set of error countermeasures with three lines of defense. The first is the avoidance of error. The second is trapping incipient errors before they are committed. The third and last is mitigating the consequences of those errors which occur and are not trapped. The same set of CRM countermeasures apply to each situation, the difference being in the time of detection. A good example of poor error management and CRM use was the American Airlines crash of flight 965 while approaching Cali Colombia on December, 20 1995. Contributing factors in conjunction with erroneous information provided on the pilot's airport approach information plates were:

- Failure of the flight crew to discontinue the approach into Cali, despite numerous cues alerting them of the inadvisability of continuing the approach;
- The lack of situational awareness of the flight crew regarding vertical navigation, proximity to terrain, and the relative location of critical radio aids;
- Failure of the flight crew to revert to basic radio navigation at the time when the flight management system (FMS)-assisted navigation became confusing and demanded an excessive workload in a critical phase of the flight.

Many non-aviation related companies provide safety related training for their employees which is cursory and in many instances never repeated on an annual basis. The old axiom that the first impression is usually the most important is a good one to remember for your initial safety training sessions. Be sure you use your initial employee safety training sessions to set the correct tone for the instilling the importance safety in your organization.

3. Behavioral Observations

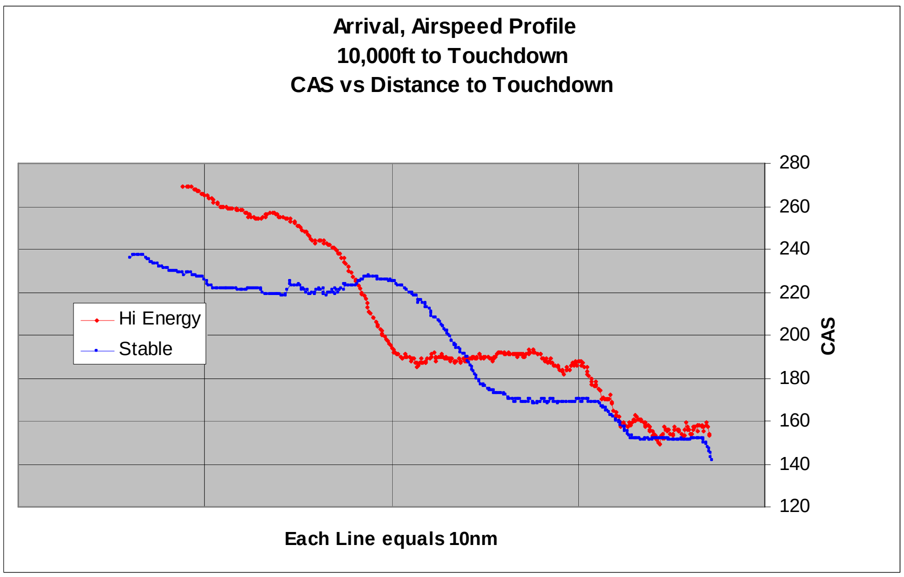
Providing guidance to employees with a set of SOP's and training them on how to use the SOP's are the first two steps used in the aviation industry to affect flight safety. The third step is the use of behavioral observations to insure that flight crews are adhering to the standard procedures. Many companies are currently using behavioral safety management methods to assist in reducing variation of human behavior. From a flight safety perspective, this is completed using several methods to observe and provide feedback to flight crews. The first method is during annual simulator recurrent training sessions. During these annual sessions, flight examiners are constantly reviewing the habits and behaviors of the flight crews to a defined set of operational flight standards to insure the crew operates within acceptable limitations. Crew members that do not meet acceptable performance levels are either re-trained to acceptable levels of performance or fail the required check ride and will not be authorized to fly.

The second method of behavioral observation is accomplished by line check airmen. Line check airmen are pilots who ride with flight crews on a periodic basis to review actual behaviors while flight crews are flying actual trips. These checks are accomplished to insure that crews are adhering to the defined SOP's as well as exhibiting the required skill level for safely flying aircraft. Line check airmen observations are also supplemented by FAA regulatory check rides in that designated FAA line inspectors can at any time present themselves at a flight and complete a line check.

<u>Line-oriented safety observations</u>
Airlines have also started to complete in the last several years special safety observation events that are called line oriented safety observations audits or (LOSA's). A LOSA is normally completed every two to three years. The LOSA audit utilizes trained observers riding in cockpit jump seats to evaluate several aspects of crew performance over a specific time span. In-flight observers record the various threats encountered by flight crew, the types of errors committed, and most importantly, they record how flight crews manage these situations to maintain safety. The observers also collect data on CRM performance and conduct a structured interview to ask pilots for their suggestions to improve safety. These combined data sources provide the airline conducting the LOSA with a diagnostic snapshot of safety strengths and weaknesses in the existing flight operations procedures and policies. The trends that are identified are communicated back to the flight crews and corrective training built into the next simulator training session.

<u>Flight operational quality assurance</u>
Many airlines have also incorporated flight operational quality assurance (FOQA) data collection systems and processes to their behavioral trending tools. FOQA systems automatically collect many parameters from the aircraft flight data recorders after each flight. This data is placed into data management systems where safety analysts use the data to look for adverse trends that maybe occurring either based on the aircraft type, location or phase of flight. Based on the data collected, either SOP's, training or airport approach procedures can be modified to increase operational safety. Below is a short list of several of the parameters that can be measured:

· Late descent compared to distance/time to touchdown
· Late ILS localizer and/or glide slope capture or late turn onto final
· Large heading change below a specific height
· Low energy and high speed
· Late landing configuration of the aircraft/ exceeding flap extension speed
· Weather, turbulence, icing
· Abnormal configuration or any aircraft system fault configuration
· Abnormal high power setting for flight condition
· Unstable heading
· Checklist items late completion
· Missed approach and pull-up
· Abnormal switch position for phase of flight



The above graph is an illustration of the types of trend lines that can be generated. In this example the data shows that aircraft arriving at the airport in question are not following a stabilized approach path. Aircraft are being vectored to a final approach fix that is ten miles from the airport using excess speed. The excess speed has to be bleed off in a short period of time that is resulting in unstable high energy approaches. Corrective actions could be awareness training of flight crews as well as procedural changes at the final approach control facility.

4. Human Factors

Human factors considerations for safety in aviation has made significant progress in the technology available for flight crews. Enhanced ground proximity warning systems that look forward as well as traffic collision avoidance systems are examples of tools available on the flight deck that provide a feed forward information to flight crews. However, one of the best tools still available to get ahead of the accident chain of events is employee reporting of near miss events or situations that could lead to errors. Many airlines have implemented aviation safety action programs (ASAP) that are systems and processes for employees to report errors or events that could have lead to accidents or incidents.

Under an ASAP, safety issues are resolved through corrective action rather than through punishment or discipline. The ASAP provides for the collection, analysis, and retention of the safety data that is obtained. ASAP safety data, much of which would otherwise be unobtainable, is used to develop corrective actions for identified safety concerns, and to educate the appropriate parties to prevent a reoccurrence of the same type of safety event. An ASAP is based on a safety partnership that will include the FAA and the air carrier certificate holder, and may include a third party, such as the employee's labor organization.

The main premise of an ASAP process is a company policy and procedures and a partnership with the FAA that allows employees to report errors without fear of disciplinary action. Errors and events are reported by employees to a safety team or committee that reviews each report and determines if an interview of the employee is necessary for additional information. The information is tracked and if necessary corrective action requests (CARs) are generated to mitigate the identified hazard.

Many non-aviation related companies have implemented near-miss reporting programs. However, in many instances they are disappointed in the amount of participation. Usually, it is perceived or actual behavioral consequences that may lead to punishment or disciplinary actions that will drive employees not to participate. To make a near miss reporting program work well, it takes management commitment and a policy that the messenger will not be shot for trying to report potential work place hazards.

Summary

Many effective safety management practices besides the ones covered in this paper can be bench marked to aviation safety management systems best practices to see if they have merit for adaptation in you industry or company. Currently, the medical field is beginning to use many of the practices noted above in hospital settings to help manage and contain human error types of incidents.

The aviation as well as the nuclear industry are both error intolerant and as a result have multiple layered safety defenses to protect against routine human error from resulting in catastrophic outcomes. Significant events are becoming rare in the US airline industry. Which leads to the best source of information for predicting and managing possible threats to safety are the error trends reported by employees and those observed during routine safety observation processes. The best things we can learn from the airline industry to manage safety is to have defined SOP's , invest in training, complete safety observations, cultivate a culture of "safety first" and to investigate, track and trend human error patterns before they result in accidents.

Maybe the philosopher Voltaire said it best "an accident is not so much caused by the things you see, but rather by the things you cannot see"

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