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**Lessons Learned from Aviation Accidents**

**Minor Errors, Major Effects**

**Accidents that Have Helped Shape Aviation Safety**

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Biography for Daniel I. Cheney

*Daniel I. Cheney is Manager of Safety Programs for the U.S. Federal Aviation Administration’s Transport Airplane Directorate. Mr. Cheney has been involved in nearly all aspects of certification activities of Boeing commercial airplanes from the B707, through current activities of the B787 program. He has also been involved in supporting numerous accident and incident investigations, and their resolution. It has been through his involvement in accident investigation, and the realization that costly lessons from major accidents were being lost through the passage of time, that led Mr. Cheney to initiate FAA’s development of the web-based “Lessons Learned from Transport Airplane Accidents” knowledge information system. This accident library, now containing 82 accident modules, is available to the public on the FAA’s main web site at http://lessonslearned.faa.gov/*

With powered human flight now well into its second century, the safety and convenience of today’s commercial air travel would have been almost unimaginable to the early aviation “experimenters” such as the Wright Brothers, Octave Chanute, Otto Lilienthal, and many others of that era. Beginning with the Wright Flyer’s first flight on December 17, 1903, and now 114 years later, nearly three billion passengers are flown each year worldwide. Despite the unprecedented growth in air travel in the last century, and more growth projected into the future, the safety record in nearly every area in nearly every country has steadily improved. In the U.S. alone, commercial operations involve nearly one billion passenger movements, while multiple years in the last few have involved no fatalities, making commercial air travel in the U.S. the safest form of public transportation by far. This enviable international safety record has only been possible by the combined efforts of all involved, and an overarching commitment for safety decision making to be “data driven” above all else.

Despite these remarkable safety achievements, accidents, though rare, still do occur. It is through the detailed investigation of accident causes that careful reviews of existing safety processes and safety defenses are able to be conducted. As a result of these investigations and their findings, continuous improvement initiatives are able to be applied to areas of aircraft designs, operations, air traffic activities, and virtually every element of aviation safety.

Many of the safety measures in place in today’s aviation system involve redundant systems, rigorous training programs, fail-safe designs, robust component life limits, and an array of other well established processes that are ever evolving as more is learned. Some of these initiatives have been the result of lessons that have been learned through accident analysis, and a commitment to apply targeted solutions in order to avoid repeated tragedies. However, a significant challenge exists within today’s aviation community in order to continue preserving these safety gains, and to also advance safety in those areas where improvements are identified. Adding to this challenge is the continuous turnover of experienced safety personnel in both government and industry safety organizations.

In order to help capture and retain key safety information that was being lost due to continuous personnel turnover within the aviation community, in 2009 the U.S. Federal Aviation Administration, with the help of many other organizations and individuals, created a web-based safety knowledge system titled “Lessons Learned from Civil Aviation Accidents.” This Lessons Learned (LL) accident library is located at <http://lessonslearned.faa.gov/> and currently contains 82 of many of the most influential, aviation “safety shaping” accidents that have occurred over the past several decades.

The primary purpose of the accident library is to make key safety information conveniently available to a wide aviation safety community so that current and future safety work is able to benefit by the knowledge of events, actions, and that have led to today’s aviation requirements, policies, and processes. It is through this understanding that future safety programs are able to be applied with greater precision, and that past advances are protected through knowledge.

During the course of developing material for this Lessons Learned library, it was noted by the authors that some of the most serious aviation accidents were actually the result of what were initially determined to be relatively minor errors or omissions by individuals or organizations. By understanding the relationship between these minor errors, an enhanced understanding of the importance of “attention to detail” is able to be achieved in all areas of aviation. This understanding became one of the primary focus areas of the library material, and helps to underscore the criticality of consistency and thoroughness in all aspects of aviation safety work.

Some of the examples of accidents involving “minor errors, major effects” that have shaped aviation, and are detailed in the LL library, include:

* 1977 on the island of Tenerife in the Canary Islands: radio miscommunication between a pilot and an air traffic controller led to the collision of two B747’s on takeoff.
* 1985 near Tokyo, Japan: Structural repair involving a relatively minor change to a splice plate of the aft pressure bulkhead led to fatigue failure and catastrophic explosive decompression of a B747.
* 2000 near Anacapa Island, California; A single plugged grease fitting on an MD-80 horizontal stabilizer trim system was suspected to have prevented lube into a gimbal nut, aggravating wear of the jack screw trim assembly, and ultimate loss of pitch control.
* 2000 at Charles de Gaulle Airport, Paris, France: minor material substitution repair of a DC-10 engine thrust reverser air seal led to ejection of the seal on takeoff, resulting in the debris being struck by a Concorde main gear tire during a subsequent takeoff, leading to catastrophic in-flight fuel leak and fire of the Concorde.
* 2001 at Terceica Island, Azores: A single fuel tube failure on one engine of an A330 resulted in complete loss of fuel and an all engine-out emergency landing.
* 2007 at Okinawa, Japan: A single omitted washer during reassembly of a B737 wing leading edge slat can led to a massive fuel leak, ground fire, and complete destruction of the aircraft.
* 2010 at Dubai, United Arab Emirates: Lithium-ion batteries shipped as bulk cargo ignited after takeoff and resulted in a catastrophic cargo fire in a B747-400.

What these accidents underscore is the importance of adherence to detail in every aspect of aviation safety work. Application and completion of every check list item, careful execution of every manufacturing process, and rigor of crew training programs, all have at their basis a safety objective. An error, even seemingly a minor error, can have the effect of introducing an additional “hole” into an existing layer of safety protection. While many of these errors can go unnoticed, with the number of flights being conducted in today’s aviation environment, eventually the “added hole” can line up to become an accident cause. By learning how these have occurred, today’s safety workforce can be better equipped to advance safety into the future.