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on the

The Continued Quest for Zero Air Accidents

Jurgen Whyte

Chief Inspector of Air Accidents, Ireland

Orville and Wilbur Wright must be considered the Grandfathers of air accident investigation. In their quest to achieve powered flight, in a heavier than air aircraft, they crashed on many occasions and through investigation they determined the reason why such mishaps occurred, they implemented change and through perseverance successfully completed the first powered flight on the 17 December 1903. Orville Wright quoted that, *"There is nothing dangerous in flying except complacency".*

Some years later in September 1908, Orville was demonstrating the "Wright Flyer" to the Marine Corps at Fort Meyers, Virginia, USA. The aircraft crashed killing Lieutenant Thomas Selfridge and seriously injuring Orville. This was the first recorded fatally for powered flight.

Clearly there was risk associated with operating such *'flying'* machines. However, advancement in aviation continued unabated, particularly through WW1. Ireland as a small country on the western seaboard of Europe played no small part in this advancement.

The first non-stop WEST to EAST transatlantic flight from St. John's, Newfoundland to Clifden, Ireland was achieved by Alcock and Brown in June 1919, winning the prize of $10,000 a sum of $150,000 in today's money.

The more challenging EAST to West crossing into the prevailing winds was achieved some years later in 1928. The aircraft a German Junkers W 33 aircraft took-off from Baldonnel Aerodrome, Ireland, on April 12 and flew to Greenly Island, Canada, arriving on April 13 after a flight of nearly 36 hours. The crew was made up of two Germans, namely Ehrenfried Günther Freiherr von Hünefeld, Captain Hermann Köhl and Major James Fitzmaurice, of Ireland.

The Evolution of the Aviation System showed the potential of aviation as a mass transport system, aircraft could now cross oceans, borders and bring wealth to/from nations. However, there was a need to build confidence and have an orderly development of a safe aviation system. Therefore to achieve safe operations there was a need to identify and manage the Risk.

In 1944, Chicago Convention on International Civil Aviation was signed (52 States). This was followed in 1947 with the establishment of the International Civil Aviation Organization (ICAO) - Means to secure international co-operation and the highest possible degree of uniformity in regulations, standards, procedures and organisation. Standards and Recommended Practices (SARPS) where developed through Annexes (currently 19 Annexes) and supported by extensive documentation/guidance material.

Currently 192 states are signatories to the Convention. The SARPS are templates for the development and implementation for all aspects of the aviation system. They are set at a minimum acceptable standard of safety for the inclusion of all. They provide the basis for State aviation Regulation, ATC, Maintainer and Operator requirements. Annex 13 provides the international provisions for Air Accident Investigation and it is enshrined in National and European Regulations.

Such Regulations require that each Member State shall ensure that safety investigations are conducted or supervised, without external interference, by a permanent national civil aviation safety investigation authority capable of independently conducting a full safety investigation. The safety investigation authority shall be functionally independent in particular of aviation authorities responsible for airworthiness, certification, flight operation, maintenance, licensing, air traffic control (ATC) or aerodrome operation and, in general, of any other party or entity the interests or missions of which could conflict with the task entrusted to the safety investigation authority or influence its objectivity. The safety investigation authority shall, in the conduct of the safety investigation, neither seek nor take instructions from anybody and shall have unrestricted authority over the conduct of the safety investigations.

The sole objective of the investigation of an accident or serious incident shall be the prevention of similar type occurrences in the future. Learn from mistakes, errors, omissions, technical/operational failures – recommend change when appropriate. Safety investigations shall in no case be concerned with apportioning blame or liability. They shall be independent of, separate from and without prejudice to any judicial or administrative proceedings to apportion blame or liability. The investigations themselves are held in Private and are Confidential. A crucial element of the process requires that there is a positive non-punitive reporting culture and system.

The investigation is obligated to investigate all Accidents where there is a Fatality – Serious Injury – Damage – Structural Failure. A Serious incident will be investigated where there was a high probability of an accident associated with the operation of an aircraft. An Incident which is an occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation would normally not be investigated but rather recorded for data purposes. In the early years of air accident investigation, investigative authorities were reactive to the investigation of ‘Accidents’ only.

Experienced gained through accident investigations to propeller type commercial aircraft in the 50s and 60s did however identify common contributing factors such as technical failures (unreliability of engines/systems), mechanical failures, problems with airborne instrumentation, ground navigation equipment, air/ground communications, weather and fatigue to name a few.

There were associated common occurrence categories determined such as:

Runway Excursion (RE) – lateral veer off or overrun, Loss of Control in Flight (LOC-I), Controlled Flight into Terrain (CFIT) – collision with terrain, water, obstacle, Abnormal Runway Contact (ARC) – hard landing and System/Component Failure or malfunction (SCF) – related either to its design, the manufacture process or maintenance.

Investigation of accidents could however, be considered a brutal approach to safety…waiting for the accident to happen or *'blood on seats'* before change was made. It was clear that improvements had to be made in Regulation, Regulatory oversight, oversight by the Operator, training, utilisation of technology, but most importantly a move to a proactive approach through the investigation of 'Serious Incidents'.

To investigate serious incidents you require a positive non-punitive reporting culture… The European Occurrence Reporting Regulation aims to improve aviation safety by ensuring that relevant safety information relating to civil aviation is reported, collected, stored, protected, exchanged, disseminated and analysed; that, where appropriate, safety action is taken in a timely manner based on analysis of the information collected; the continued availability of safety information by introducing rules on confidentiality and on the appropriate use of information and through the harmonised and enhanced protection of reporters and persons mentioned in occurrence reports; and that aviation safety risks are considered and dealt with at both International, Union and national level. The reporting has to be done in an environment of "Just Culture" in which air operators and other operators are not punished for actions, omissions or decisions taken by them which are commensurate with their experience and training, but where gross negligence, wilful violations and destructive acts are not tolerated.

Safety is increasingly viewed as the management of Risk and safety oversight plays a key role in that regard. ICAO requires the state to establish a State Safety Programme to achieve an acceptable level of safety in aviation operations. With regard to State Safety Oversight – ICAO checks a state's compliance with the provision of the 19 Annexes through the Universal Safety Oversight Audit Program (USOAP). In 2010, a total of 10,000 protocol questions had to be answered and validated for compliance during the ICAO audit of Ireland. The Aviation Regulator is audited by the European Aviation Safety Agency (EASA) on a regular basis. Operators/Maintainers, Service providers and Aerodrome Operators are required to implement a Safety Management System (SMS)

SMS is viewed as an organised approach to managing safety, including the necessary organisational structures, accountabilities, policies and procedures. SMS also covers areas such as Risk Analysis and Mitigation, Threat and Error management (TEM) and Crew resource Management (CRM).

An integral part of any Operators SMS is Flight Data Monitoring or (FDM). FDM has played a crucial role in enhancing aviation safety as it is the systemic and proactive use of digital flight data from routine flight operations. FDM programmes assist an operator to identify, quantify, assess and address operational RISKS – identify emerging threats and trends. Exceedances are set against the normal expected flight regimes. Operators download all FDM information at the end of flight operations and an automatic comparison is made against normal expected flight regime. Any exceedances are automatically brought to the attention of the FDM 'Gate Keeper' and when deemed necessary an investigation is undertaken by the Operators Safety Office. Safety critical exceedances are brought to the attention of the Investigation body.

Technology has evolved in the four generations of the Jet aircraft:

From 1952: Dials and gauges in cockpit - early auto-flight systems.

From 1964: More elaborate auto-pilot and auto-throttle systems.

From 1980: Electronic cockpit displays, improved navigation performance and terrain avoidance systems to reduce Controlled Flight into Terrain (CFIT) accidents.

From 1988: Fly-by-wire technology enabled flight envelope protection, to reduce Loss of Control in Flight (LOC-I) accidents.

Systems such as Traffic Collision Avoidance Systems (TCAS) and Enhanced Ground Proximity Warning Systems (EGPWS) greatly contributed to the reduction in the accident rate..

We can see the impact that such technology has had on aviation safety:

Lowest sustained fatal accident rate of FIRST generation jets was around 3.0 per million flights. Lowest sustained fatal accident rate of SECOND generation jets was around 0.7 per million flights – meaning a reduction of almost 80% between generations. THIRD generation jets now achieve about 0.2 accidents per million flights, a reduction of around a further 70%. FOURTH generation jets have the lowest accident rate of all, at a stable average rate of about 0.1 accidents per million flights which is a further 50% reduction compared to the THIRD generation.

CFIT accidents - reduction of 85% from SECOND to THIRD generation

LOC-I accidents - reduction of 75% from THIRD to FOURTH generation

Most of the FIRST and SECOND generation aircraft no longer fly, leaving 52% THIRD generation and 47% FOURTH generation aircraft accounting for the majority of the 35 million flights conducted each year.

Airlines recorded zero accident deaths in commercial passenger jets last year, making 2017 the safest year on record for commercial air travel. 10 fatal accidents occurred to small type commercial airlines such as cargo planes and smaller commercial passenger turbo prop aircraft, resulting in 44 fatalities on-board and 35 persons on the ground. However, this must be taken in the context that worldwide, commercial airlines carried just over four billion passengers on scheduled flights in 2017, with 35 million flight departures, using an in-service fleet of 24,550 aircraft.

An area of concern is Runway Excursion (RE) accidents. Most of the accidents over the past 20 years have occurred during the approach and landing phase. It is a highly complex flight phases and places significant demand on the flight crew in terms of navigation, aircraft configuration changes, communications (ATC), congested airspace and degraded weather conditions. This confluence of high workload and the increased potential of unanticipated circumstances is exactly the kind of complex interplay of contributing factors that can lead to accidents. Most longitudinal Runway Excursions (RE) are related to aircraft energy management. (RE) accidents rates will improve with the introduction of real time energy and landing performance based warning systems.

For the future.. Historical data shows air traffic doubles every 15 years. In addition, Industry is planning to deliver 2000 new aircraft per year by 2019 and onwards. An additional +21,430 commercial aircraft will be added to the world's fleet by 2036. This growth must be supported by a proportional increase in the number of appropriately trained personnel. If accident rate stays the same, the industry's increased exposure to accidents, in numerical terms, is in direct proportion to this increase in activity. More flights will mean more accidents unless we work to decrease the accident rate.

Now more than ever, we must avoid complacency and remember to keep our minds clearly focused on new hazards and emerging threats through safety oversight and the investigation of serious incidents.

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