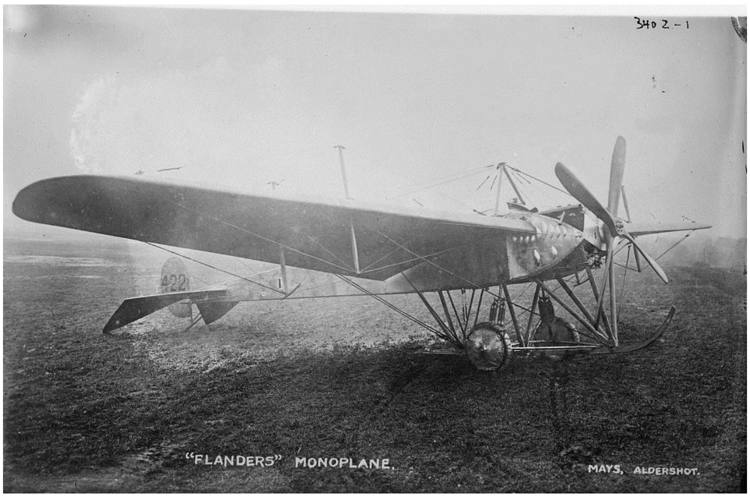
Predicting and Preventing the Next Accident

The Defence Aviation Approach

Aviation has a long history of learning from accidents; the first recorded air accident investigation in the UK was carried out in 1912 involving a Flanders F4 Monoplane.[1] The aircraft took off from Brooklands Aerodrome with the pilot and a passenger onboard, it flew two circuits of the aerodrome before the aircraft was seen to side-slip, stall and crash from an altitude of 200 feet. Both pilot and passenger were killed. The incident was investigated by the Public Safety and Accidents Investigation Committee of the Royal Aero Club who determined the cause to be pilot error.

Figure 1 - Flanders F4 Monoplane[2]



The Committee concluded:

The Committee is of opinion that the cause of the accident was the aviator himself, who failed sufficiently to appreciate the dangerous conditions under which he was making the turn, when the aircraft was flying tail down, and in addition was not flying in a proper manner.

A side slip occurred, and Mr. Fisher lost control of the aircraft.

It seems probable that his losing control was caused by his being thrown forward on to the elevating gear, thereby moving this forward involuntarily, which would have had the effect of still further turning the aircraft down. This would explain his being thrown out whilst in the air.

In the opinion of the Committee it is possible that if the aviator had been suitably strapped into his seat he might have retained control of the aircraft."

It's now mandatory for aviators to wear a seat harness and with 100 years of knowledge and hindsight this requirement seems blatantly obvious; but could its necessity have been sensibly predicted at the time?

Safety has improved markedly since the days of these pioneers of early aviation.[3] However, with a significant reduction in the number of accidents from which evidence can be drawn, how do we

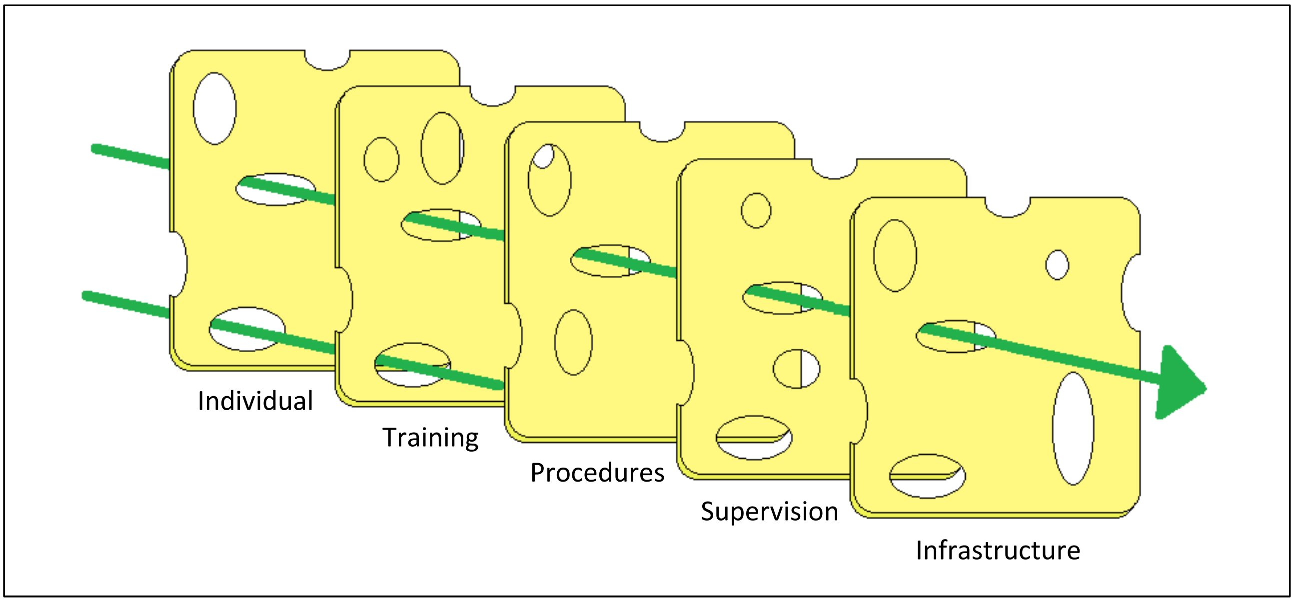
[1] FlightGlobal.com - PDF Archive Home - Aviation History 1912
[2] Commons.wikimedia.org - jpg (Free of known restrictions under copyright)
[3] Quote from: Boeing Statistical Summary, Commercial Jet Airplane Accidents, Worldwide Ops - 1959-2016.

continue to learn these valuable lessons and predict how the next accident is likely to be caused, not only in aviation but in all domains?

Defence needs to shift from the traditional reactive measures to proactive and predictive management – but how:

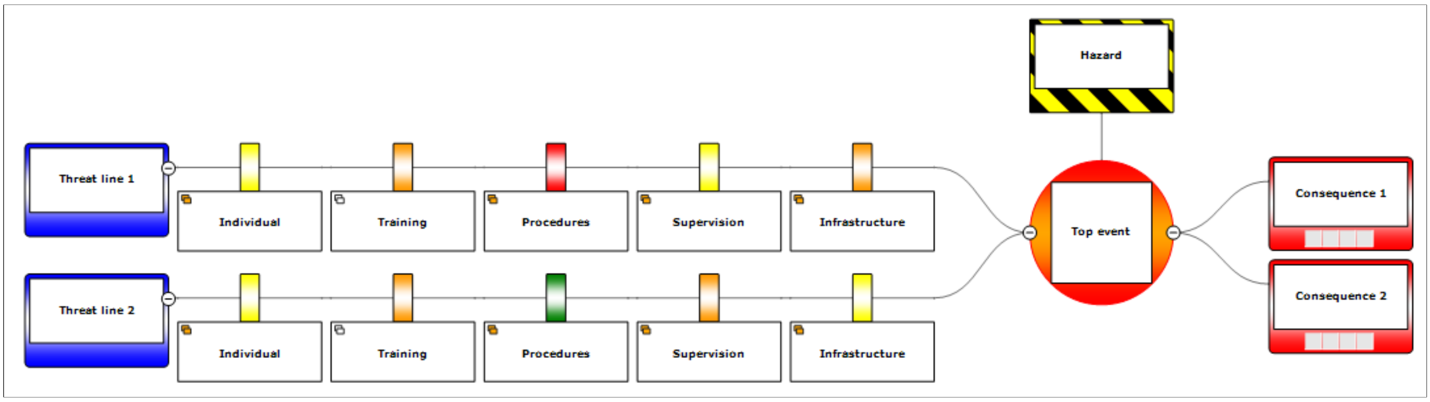
The Defence Aviation approach is based upon the recommendations made from the Nimrod Review carried out by Charles Haddon-Cave QC.[4] The report cites the Swiss Cheese Model of Accident Causation produced by Professor James Reason. The cheese slices represent barriers, safeguards or defences to prevent accidents from occurring. The holes in the cheese represent gaps or flaws in the barrier, these holes are constantly moving, opening and closing. When the holes align, a threat line can breech all the barriers and an accident is possible. The amount and types of barriers are numerous; an example is shown at Figure 2, with one partial and one complete breech of the barriers by threat lines.

Figure 2 – James Reason Swiss Cheese Model



The Military Aviation Authority (MAA) encourages the use of Bow Tie Risk Management tools both as a means to identify the barriers and to assess their effectiveness by determining the nature of the holes. The bow ties offer a visual representation of the risks and the barrier effectiveness, Figure 3. The barriers and risks should be appropriately reviewed using subject matter experts and data analysis.

Figure 3 – Bow Tie example



[4] The Nimrod Review

Defence Aviation uses the Air Safety Information Management System (ASIMS), an online system, to report and record air safety related occurrences, near misses and hazard observations. In 10 years of reporting, over 245,000 occurrence reports have been raised. This number represents a wealth of data that can be analysed to determine the effectiveness of barriers and to identify potential threat lines.

The Nimrod Review report also cited another theory - 'Heinrichs Triangle' - which is often represented by an Iceberg, as shown in Figure 4. This theory proposes that there are very large numbers of (often unreported) hazardous observations and occurrences (near misses) in relation to the numbers of reported incidents and accidents. The near misses are shown as the vast unseen submerged element of the iceberg, which, if detected and dealt with effectively, could significantly reduce the likelihood of an accident occurring.

Figure 4 – Heinrichs Iceberg

How many times did other Flanders Monoplane pilots *almost* fall out of their aircraft due to harnesses not being worn - and would these near misses have been reported?

An Engaged Safety Culture is one in which open reporting is encouraged, including the routine reporting of hazard observations and near misses. Analysis of all these reports supports improved mitigations or barriers to help prevent future occurrences.

In order to encourage reporting, personnel must feel that they can openly disclose information without fear of inappropriate reprisals. Personnel at all levels within an organisation must understand that honest errors are made and can be reported without the fear of unjustifiable or inappropriate blame.

A 'Just Culture' strikes the balance between holding people properly accountable for their acts or omissions and ensuring the right lessons are learned for the future.[5] Whilst punitive measures in the military are sometimes necessary, inappropriate punishment may have a significantly negative impact on reporting culture and thus miss the opportunity for an organisation to learn and improve overall performance and safety.

Investigations must be carried out to determine the underlying causes of an occurrence; they should not focus solely on apportioning blame on individuals, but on identifying all factors which led to the event, including organisational factors. There is rarely a single root cause to an occurrence; more likely is a complex root system (like that of a tree), with flaws evident across all barriers.

[5] The Nimrod Review – Chapter 27

Based upon the work of Professor James Reason, the MAA Manual of Air Safety identifies 5 'Values and Behaviours' components: Just, Reporting, Learning, Questioning and Flexible, these help to formulate an Engaged Air Safety Culture,[6] as shown in Figure 5. For it to be most effective, the model highlights the need for the culture to be reinforced by Leadership Commitment, Open Communication and Effective Decision Making. In all probability, the generic basis of this model could be considered equally appropriate when applied to safety in other regulated environments.

Figure 5 shows the components of an Engaged Air Safety Culture

Further details of the Defence Aviation's approach to air safety can be found in the Manual of Air Safety which is located via the MAA's GOV.UK pages.

Accident Threat Line – Incorrect Aircraft Tail Number Flown

Returning to the theme of predicting and preventing an accident, the following scenario is an example of identifying a potential threat line and establishing associated barriers to prevent an accident occurring.

In the last 12 months at least 10 occurrence reports have been raised on ASIMS across Defence Aviation - citing aircrew mistakenly taking, or almost taking a different aircraft to that which had been signed for; or engineers inadvertently conducting maintenance on the incorrect aircraft. Anecdotal evidence suggests that there are significantly more occurrences of this nature than are being reported. None of these occurrences that have been reported have resulted in an incident, but could they?

In signing for their aircraft, the pilot confirms their understanding of the airworthiness state of that specific aircraft, it having undergone a series of authorised maintenance and documents checks to ensure the aircraft is airworthy. If the pilot then takes a different aircraft, the checks signed for may have not been carried out on that particular aircraft, which could also be in a different configuration than expected. There is potential that the aircraft mistakenly taken is unserviceable and therefore the top-level event, identified in the bow tie as the 'release of an unairworthy aircraft', could occur.

There are already several barriers in place with some aircraft types to help prevent taking the wrong aircraft occurring; for example, most helicopters have a plate fitted to the pilot's console stating the aircraft tail number, although this is less prevalent on some fast jet types. When pilots walk out to their Tutor (Fixed Wing training) aircraft, they hand over a tally to the groundcrew which

[6] Found at Chapter 3 of: MAA Manual of Air Safety.

is marked with the allocated aircraft tail number, helping to ensure they are taking the correct aircraft.

Several possible mitigations or barriers are listed below. The list is not exhaustive and applicability to aircraft types will vary. They are presented as an example bow tie at Figure 6:

- Clearly displayed external tail numbers.
- Clearly displayed internal tail numbers.
- Tail number checks embedded into pilots walk-round checklists.
- Groundcrew / crewman to double-check tail number.
- The use of aircraft keys to permit or prevent access or start-up.
- Aircraft placards marked 'Unserviceable' on display.
- Specific aircraft / task line spots on the dispersal and / or in hangar.
- Aircraft identified by nicknames (it could be easy to mistake ZJ566 for ZG566).
- Risk awareness – flight safety posters.

Most of these measures would be inexpensive and easy to implement, and the potential benefit in preventing an accident could be significant.

Figure 6 – Example Bow Tie