Aviation safety
an evolution of change

By Tom Lintner

Everyone who is involved in aviation, regardless of our roles, has always considered safety to be our first priority. Whether we are air traffic controllers, pilots, dispatchers, maintenance professionals or other members of the aviation community, our actions are driven by the principle "safety first".

Interestingly however, when we are asked, "is it safe?" our unanimity ends, since we all see safety in different ways. When I ask an aviation professional, "is your system safe?" the universal answer, after a pause, is "yes" followed very quickly by the comment "but it could be safer." When you ask the follow-up question "how would you measure that?" the answers become less definitive.

Since it is very difficult to manage something which you cannot easily measure, the quest for the "holy grail" of aviation safety metrics continues to be an ongoing challenge, but there are small victories being made along the way.

"Several months ago I had a flight with a student. We were operating out of a general aviation airport without a control tower. It was a one-runway VFR operation and we were holding short of the runway when an arriving Cirrus flew over the threshold. As the instructor pilot, I told my student to line up and wait, anticipating that the landing aircraft would exit the runway at the half way point of the 1500 meter runway.

This particular runway has a rise 500 meters from the threshold, and when an aircraft lines up, you cannot see the end of the runway. Now holding in position on the runway, we waited for the "clear of the runway" call from the Cirrus … and waited … and waited. Knowing that the aircraft must have cleared the runway by then, I told my student "go ahead and roll."

"Are you sure?" he said.

"Yes. Now roll."

"Roger."

As we approached rotation speed, concurrent with arriving at the top of the rise, we saw that the previous arrival, who had not cleared at the half-way point, was just exiting the runway at the very end, 1000 meters further down the runway.

My student, who I suspect was silently resisting the desire to say "I told you so," instead asked "is this a runway incursion?"

"Yes," I said, "now rotate."

I am relating this event not to show that instructor pilots make mistakes but as an example of how "safety is in the eye of the beholder" and to demonstrate the effect on how we try to measure safety."

As a former ATCO and regulator with the US FAA, I recognised this event as a textbook example of a runway incursion. Clearly, there were two aircraft on the same runway at the same time. If there had been an ATC control tower involved, it may have been a question of loss of separation, or not, depending on a number of rather complex rules.

From an aircraft operating perspective, however, and as the pilot in command of the flight, I saw no risk to the safety of either aircraft. As we rotated and lifted off, the previous arrival had cleared the runway. So was it safe? Did this single event derogate from overall system safety? What if there had been thousands of these types of events over time? What would that mean?

In a similar vein, let us look at it from an ATCO perspective. In the United States, as well as the rest of the world, there have been many examples of runway incursions of varying severity. As we all know, varying severity can mean various levels of safety.

There is one event I vividly recall since I was the tower (local) controller at LaGuardia Airport, one of New York City's three major airports. Arriving aircraft were landing on runway 22, and departures were using the intersecting runway 13.

There was a Cessna 172 waiting for a VFR departure from runway 22 intersection "G", which is half-way down runway 22. I had a G-2 on final for runway 22. My plan was to allow the C172 to depart after the G-2 had landed. For planning purposes, I asked "Cessna 123A, will you be able to take it out rolling?"

The pilot answered "roger, rolling!"

At that point, the G-2 was just over the approach lights. Meanwhile, the C172 started moving faster than I thought possible for a C172 on the ground. While I recognised that this was not going to be a pretty event to watch, I made the decision that the best thing was to do nothing except advise the G-2 of the traffic. Owing to the geometry of the runway and intersection and the speed of both aircraft, it turned out that the C172 lifted off just as the G-2

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touched down about 1,500 feet before intersection Golf.

Was it a runway incursion? Yes. Was it a pilot deviation? Yes. Was it safe? Ah, a more complex question. Clearly it was not, but it is possible to argue that it was safer than trying to abort one take-off while sending another aircraft around with additional traffic overhead.

So again, we come back to the question of how we judge and measure safety.

The assessment of system safety from an organisational, or macro, level requires more than just one person's opinion or even one event. The determination of system safety involves a very complex mix of factors, including engineered assessments of runway distances and aircraft performance, weather conditions, the role of ATC, etc. In fact, too many to mention fully.

It also requires operational judgment, based on the experience of the operators and regulators of the system, to be factored into the safety equation. Determining the level of system safety requires a balance between the science of aviation engineering and the inclusion of the expertise of the human element within the system.

We must accept that not all mishaps are equal and even severity levels can reflect different levels of safety within the severity bands.

Several years ago, our industry started to look at the ATM system from a different perspective when we started to examine the degree of "risk" associated with an operation. In the United States, this was a significant change. Prior to that, we had focused principally on traffic volume and delays and how to handle as much traffic as possible. We looked at mishaps, or losses of separation as something to be avoided, and we judged the "safety" of an operation using our experience rather than a systemic approach to identifying and managing risk.

The framework of safety management systems, long applied in European operations, is still relatively new in the United States. While this move toward international standardisation bodes well for aviation, it still brings us back to how we measure safety. In the past few years, the SAFREP group within EUROCONTROL has been involved in the search for this methodology, and it has had significant successes recently.

One of those successes was the agreement that a new concept of representing safety data, called the Aerospace Performance Factor (APF), could allow an organisation to view data and make operational decisions on the basis of a combination of actual event data and expert judgment.

The APF is a graphical "translation" tool which can take the established key performance indicators (KPIs) for an operational unit, lay them out in a mapping mode to show the relationship of the KPIs to one other as well as their relationship within the larger system, develop weighting values for them, and finally use the 'balanced' data to populate the overall output of the system.

The mapping mode is referred to as the 'mindmap' and it provides a view of data elements included within the APF. In the case of the first EUROCONTROL APF, ESARR 2 data was used to

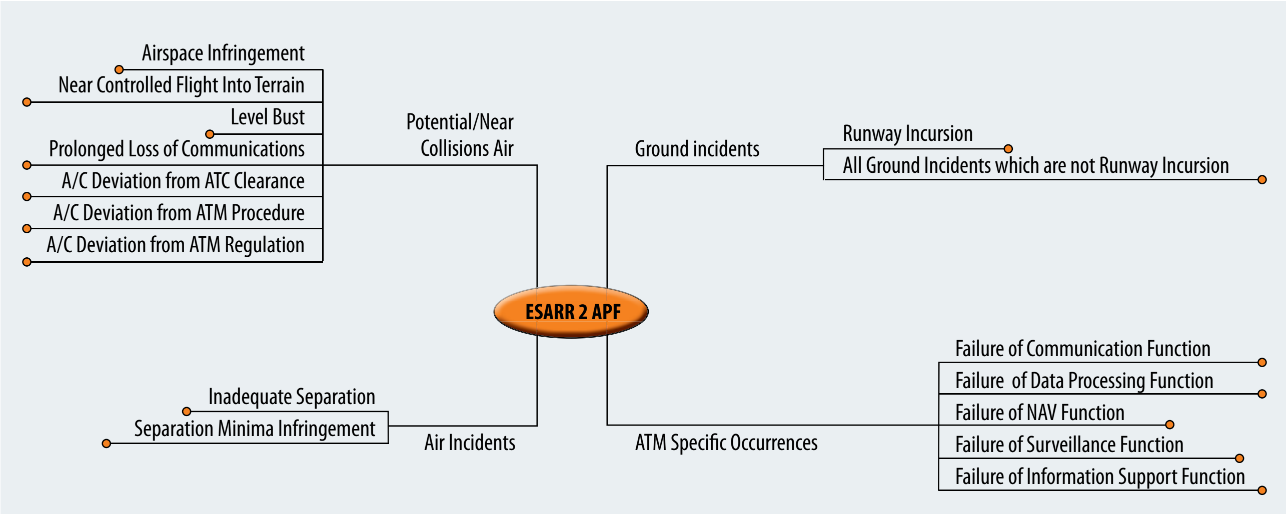

Figure 1

represent a macro level view of safety elements. Figure 1 shows the EUROCONTROL APF mindmap.

You can see on the figure that the "ESARR 2 APF" indicator for safety is influenced by certain elements; these are then influenced by other elements, and so on ... How can we calculate to determine the value for the indicator? We all know that in aviation, nobody knows better where the problems are and how big they are than the people facing them every day – the controllers, pilots, maintenance personnel, etc. This is why once the mindmap has been completed, subject-matter experts are asked to follow a structured process to aggregate their knowledge into a collective estimation.

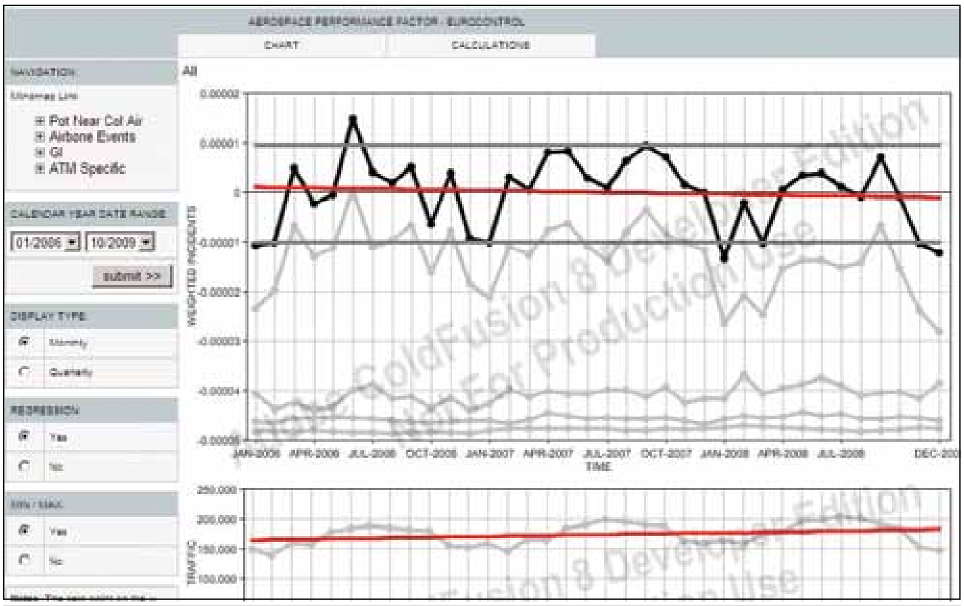

Figure 2

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If one were to put the actual data on how often different events like "separation minima infringement" and "runway incursion" happen into the result of this aggregate expert view, then the result is an indicator like a stock exchange index. This is pretty meaningless as a single measurement but capable of providing a very useful perspective as multi-criteria metric that offers a trend over time. Since the risk picture is changing constantly just like the view from a window onto a busy street, if you take a snapshot of the risk, it will not be the same immediately afterwards. APF allows the user to look at the busy street over time instead of constantly having just unrelated snapshots. Figure 2 above shows the initial EUROCONTROL ESARR 2 APF.

What, however, is the good of knowing that the risk is increasing if we cannot find out what the causes are and fix them? As we all appreciate, accidents in aviation are rare events, and one can more easily explain why it happened with hindsight (q.v.), but it is extremely difficult to predict where the next one is going to be.

APF helps by providing the ability to drill down into the data to determine what is causing a particular trend and, in time, may offer an ability to be predictive. APF output is user-specifiable. The graphical presentation shown in Figure 2 allows the user to see the overall performance (heavy black line) with a trend line showing the overall direction of change through the selected time period (solid red line).

Of course, the APF is not the "holy grail" of safety measurement, but it should provide a useful staging post in the continued search for that elusive goal, and specifically aid the development of a risk-forecasting tool to better manage the delivery of acceptable levels of safety.

Since the beginning of aviation, when the first safety measure was "did the pilot survive?" we have been striving to find tools to better measure, and thus manage, aviation safety. I believe that we are near the point where that breakthrough is possible, and I believe that this success could well happen in Europe because of the dedication of the joint efforts supported by EUROCONTROL's SAFREP team.