Reactive & Proactive Flight Data Usage

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The flight data community has come a long way since the early days of the five parameter foil flight data recorder in the late 1953. Flight recorders were installed to investigate perplexing accidents of the era and it was cumbersome to retrieve the data for a variety of reasons including the need to crash protect the information.

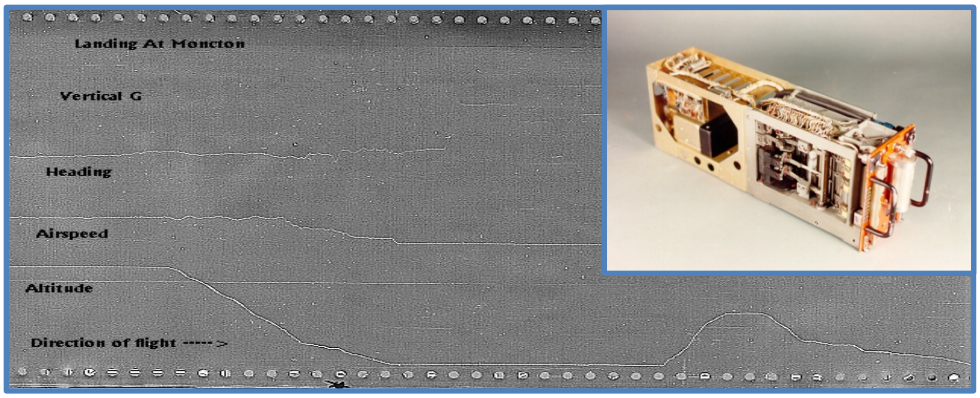

Figure 1: 1953 era foil flight data recorder, designed exclusively for accident investigation.

Today it is not uncommon to record +1000 parameters in readily downloadable solid state memory. Flight data can also be wirelessly transmitted from the aircraft when on the ground for easy airline access and increasingly snapshots of subsets for flight data related to special on board reports can be telemetered to the ground while in flight via satellite communications.

Not that long ago, similar to the early flight recorder concept ISASI membership was limited exclusively to accident investigators. When the proactive flight safety community started to show interest in ISASI membership some at ISASI felt that ISASI should remain limited to accident investigation. However, in recent years, ISASI has expanded its membership criteria to include aviation safety prevention community. Membership now reads *'to be eligible for full (ISASI) membership…three years of experience…involving aircraft accident investigation* ***or prevention****'*. Mike Poole presented an ISASI paper in 2003 entitled 'Accident Investigation without the Accident'. The point of this paper was to point out the proactive flight data monitoring community was using flight data to identify the precursors that lead to them in order to develop recommendations to reduce or eliminate them thereby preventing an accident. Whether or not the aircraft hits the ground at the end of the sequence of events is simply the luck of the draw and the safety potential was independent of this outcome. Mike went on to say not

to be surprised when a new ISASI member joins and says that he has looked at the flight data for hundreds of 'accidents' and developed safety recommendations but the aircraft did not actually crash in any of them! There is an increasing realization that accident investigations ultimate aim is accident prevention and you don't have to wait for an accident to achieve this. Indeed some investigation authorities intuitively and purposely use the word 'safety' as opposed to 'investigation' in the name of their agency, such as TSB and NTSB. While this was done to not limit their mandate, most investigation authorities are still, understandably, heavily reactive to accidents. It can be argued that the regulatory side of government is proactive through the rule-making process. Neither the investigative or regulatory side have embraced the use of flight data for proactive safety measures. There are indications of movement in the right direction however. ICAO expanded its mandate to States to investigate serious incidents in addition to accidents and with SMS, there is direction for States to have a State Safety Program with requirements to 'collect data'. Although ICAO does not say 'flight data', flight data is an excellent source of data!

A common understanding of definitions is always important to ensure mutual and efficient evolution of concepts. To that end, it is worthwhile taking a moment to explore the definition of the terms 'Accident', 'Incident' and 'FOQA Event' in the context of aviation safety. Starting with the latter, a FOQA Event is a flight (or trend) of interest due to anomalies that if left unattended could lead to an accident. Airlines identified these through automated reporting programs and when they find a flight of high interest, much like a 'mini' investigation, they study it and develop solutions to prevent the anomalies from repeating; knowing that failure to do so might eventually culminate in an accident.

Figure 2: Example of a FOQA Event

Figure 3: Example of an Incident

An incident is typically the next level up whereby the attention of the national authority is often warranted. Definitions vary around the world but by in large serious incidents are one short of loss of life and/or substantial material damage. Incidents are flights with anomalies that could easily have led to a catastrophic outcome had the crew not been 'lucky' for lack of a better word.

An accident is a flight which involves loss of life and/or substantial property damage. Accidents experience high media attention and increased scrutiny due to the high profile they garner and high interest from the general public.

Figure 4: Example of an accident; loss of life and substantial damage

By way of example, the following is a brief overview of what was categorized as an incident by the national authority at the time. A B757 struck the tail during a night landing in VMC CAVOK conditions. The peak vertical acceleration was 2.6g and resulted in significant damage to the aircraft and one flight attendant requiring hospitalisation. While descending through approximately 9000 feet the crew deployed the speed brakes to more rapidly reduce speed and lose altitude. Passing through 3500 feet on final approach, the crew received a normal Master Caution/Altitude Alert. The Master Caution was cancelled per normal procedures. At this point the aircraft was approximately 7 NM to the threshold descending at 1500 fpm and about 1.5 dots above the glideslope. Passing through 2500 feet at 4NM the crew received a second Master Caution/Altitude Alert and the Master Caution was again cancelled as would be expected. At this point the aircraft was slightly over 2 dots high on the glideslope. At 2.7NM descending at 2100fpm to gain the glideslope at 1.5 dots high, the flaps were lowered to 25 degrees. This constituted the landing configuration logic for the aircraft which triggered a third Master Caution but this time it was not an Altitude Alert but a landing configuration warning that the Speed Brakes were extended. As in the previous two Master Cautions, the crew cancelled the Master Caution but the flight data showed that the Speed Brakes remained extended. This would result in a SPD BRK amber warning message on the flight displays. The aircraft overshot the glideslope by .5 of a dot and had to climb back up to the glideslope while passing through 0.7NM from the threshold. The speed brakes remained out for the landing which resulted in a much higher than normal pitch attitude required to maintain the 700 fpm final descent rate and substantially reduced the crew's ability to flare the aircraft resulting in a hard landing and tail contact.

Figure 5: B757 landing with Speed Brakes extended resulting in tail contact and hard landing

The data also showed that the Auto-throttles were engaged in Speed mode managing thrust during the approach and that the pilot was manually flying the control column. This resulted in minor pilot induced oscillations in pitch exacerbated by the Auto-throttles having to work more aggressively due to extra drag as a result of the speed brakes being extended.

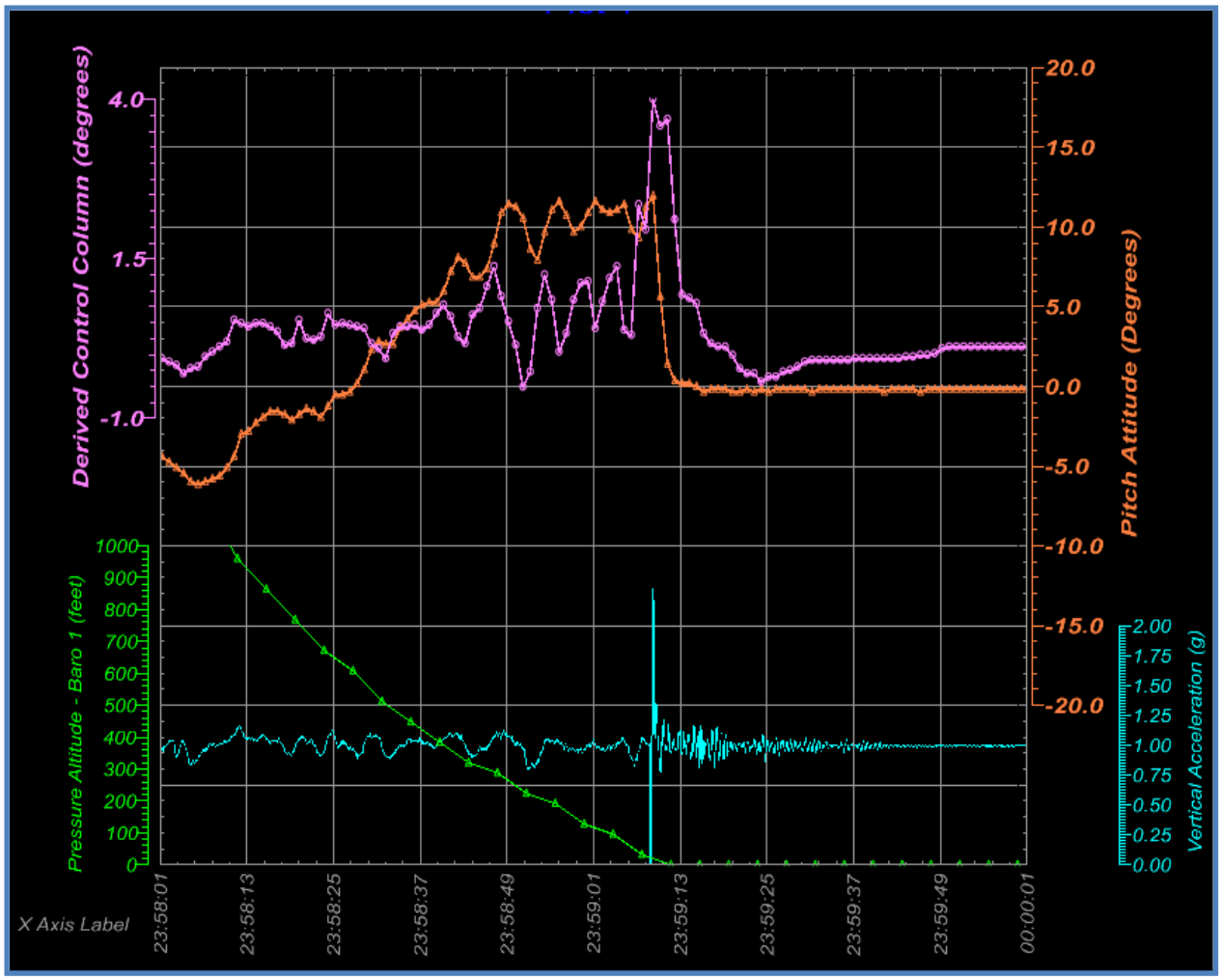

Figure 6: Plot showing pilot induced pitch oscillations

This 'incident' could easily have been a catastrophic accident. Conversely, this 'incident' could have as easily been a FOQA Event had the crew retracted the Speed Brakes just prior to touchdown and landed normally. The *end result* determines the category of accident, incident or FOQA event yet the safety actions for prevention are *identical* regardless of the outcome/category of the flight. The USAF Safety Center has both a Mishap Analysis (reactive) component and a FOQA (proactive) component under the same umbrella organization. The military has the luxury of being the regulatory body, investigation authority and operator, unlike civil aviation. The civilian equivalent independent safety authorities focus on the 'mishap' part and the regulatory side tries to be proactive on the rule-making part but typically does not avail itself of flight data in the process. Airlines have discovered the benefits of using flight data proactively; *is it time for change and for the government to consider the same?*

While the very though conjures about much controversy, there are merits in exploring the use of flight data by governments in addition to airline use for the overall benefit of improving safety. Authorities charged with a safety mandate such as the investigation authorities could use flight data to identify national trends for all operators in their airspace as a whole. Flight data could assist in determining how far to investigate a particular accident so as to avoid diminishing returns. If the data shows that the accident was truly unique, it is not possible to prevent unique accidents. On the other hand the data may well show that the accident was an accident waiting to happen. Flight data can assist authorities in conducting more objective safety studies; assist in providing a more objective foundation for rule-making and can also benefit smaller operators that are statistically insignificant.

With proactive access to flight data, governments could 'investigate' and identify safety actions of national interest to all operators.

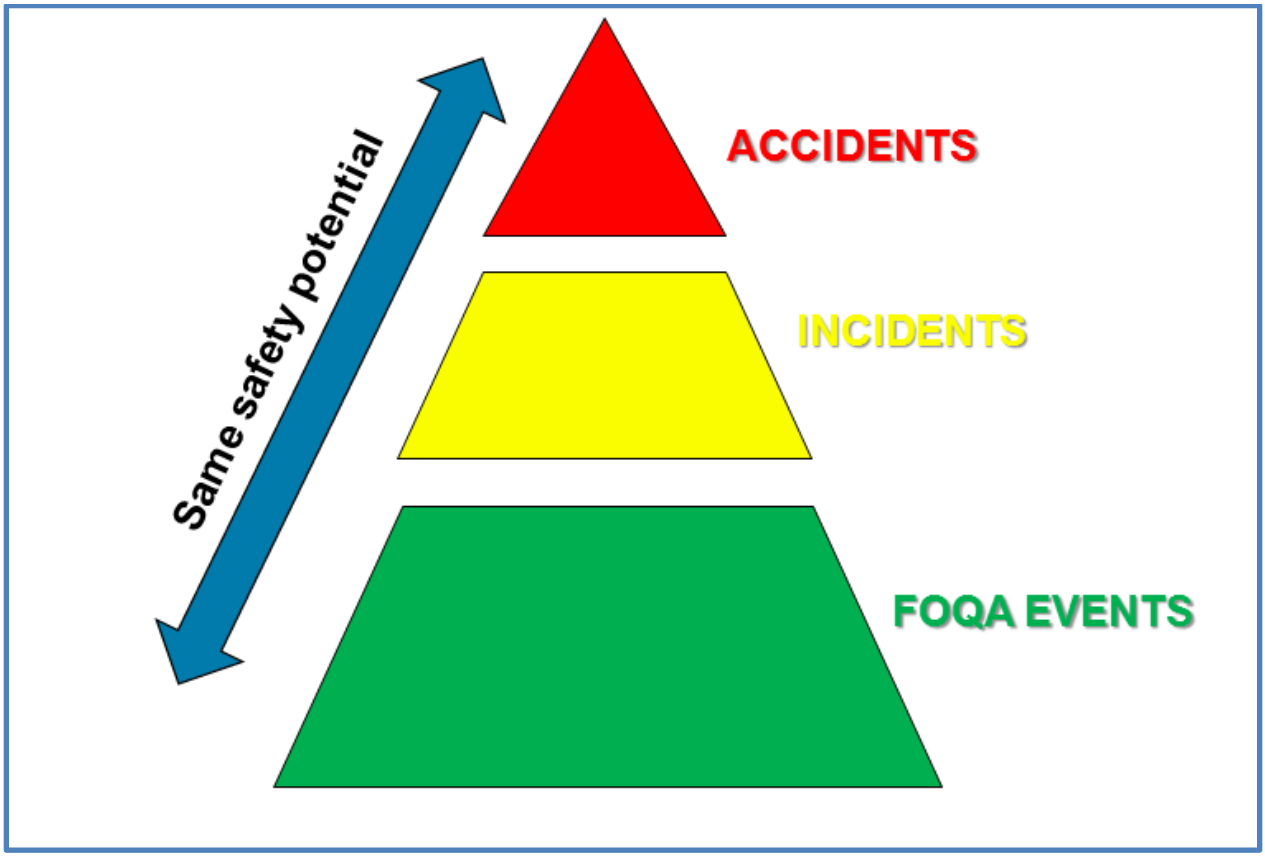

Figure 7: Traditional safety pyramid showing FOQA events are a rich source of safety potential currently untapped by governments

It is notable that the FAA through its ASIAS (Aviation Safety Information Analysis and Sharing) and IATA through its recent GSIC (Global Safety Information System) facilitate the sharing of flight data among participating operators. While this is long overdue and valuable it should not obviate the value of government agencies using the same source data for proactive aviation safety purposes. Unlike the CVR which is protected, flight data is generally not protected when it comes to an authority using the data for a safety investigation. Ideally this would apply to the investigation of an accident, incident or FOQA

event yet governments today do use flight data for the proactive advancement of safety. It remains reactive to an accident or serious incident for understandable historic reasons. The authors submit that governments charged with the advancement of safety should consider accessing flight data proactively to achieve national safety programs more objectively. Airlines do not wait for an accident to improve safety so in some ways why does the government safety authority not share the same philosophy.

The Nigerian Accident Investigation Bureau decided a few years ago that they needed to have a flight recorder analysis capability to meet their investigative obligations as an ICAO signatory to ICAO Annex 13. To rely on the goodwill of other States with capabilities, while perhaps acceptable in the wake of a major accident, is not an efficient means to investigate frequent incidents under their charge. Flight data analysis, unlike the past where by recorders were limited and infrequent, is common place today and is required on virtually every investigation of a large commercial aircraft. When the Nigerian AIB argued for funding for the flight data analysis capability at higher levels of government, the government was reluctant to invest on a system that would be limited to reactive use only. This intuitive reluctance, similar to the intuitive nature of some authorities wanting to put 'safety' in their name, inspired a proactive national data monitoring initiative in Nigeria within the government. The Nigerian government plans to require Nigerian registered aircraft to provide flight data to the AIB for a national safety program. The hope is that this will be viewed a valuable service to the airlines. Similar to a confidential reporting system (which some government operate), the data will be kept confidential and used to develop safety action in the form of safety recommendations. It will not be used for punitive measures and it is not intended in any way to replace an operator's internal FOQA program. Rather it is intended to focus on broad issues that transcend airline boundaries and in some cases transcend aircraft type. Much like the IATA GSIC and FAA ASIAS programs, the government of Nigeria can use the data to identify the most problematic airports as well as the identify the top events nationwide for example.

The government of Nigeria will be taking delivery of a comprehensive flight data analysis capability later this year. This is a reflection that the Nigerian government is serious about improving safety in Nigeria and the surrounding region and to use the new capability flight data capability for more than just reactive investigations of accident and incidents.

This paper has hopefully demonstrated that the differences between an accident, incident and FOQA events are somewhat inconsequential when it comes to safety. It is recognized that there is considerable controversy of the suggestion that governments should have routine access to flight data. However, there remains merit in governments charged with advancing safety in playing a more proactive role when it comes to the wealth of objective flight data available today. Utopia would be an industry whereby proactive programs have eliminated accidents. We are all trying to get there. Rather than the industry getting there and putting the safety authorities out of business as is often said, it might be wiser for the safety authority's long term to stay in business with the business being proactive prevention of accidents.