



“A Systemic Investigation – Where do you start?”

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by

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Good afternoon ladies and gentleman, it is indeed a privilege to be given the opportunity to speak to you today at this forum. I am in the company of a group of professionals whose role in life is to make our domestic and international airways as safe as is humanly possible. I say humanly possible because as you all are aware, where human factors are involved, anything is possible.

My presentation today will outline a BASI investigator's perspective to the (often daunting) task of conducting a large systemic investigation. In particular, the planning and conduct of the *Systemic Investigation Into The Factors Underlying Air Safety Occurrences In Sydney Terminal Area Airspace* (TMA) This was a significant investigation and one in which I was involved.

The presentation will cover the *concerns* that were first raised following a series of air safety incidents involving large RPT aircraft. These *concerns* led to identifying a need for a systemic investigation. During my presentation, I will discuss the team composition, the development of the Terms of Reference, the subsequent planning for the investigation, the conduct of the investigation and how the final report was put together. The outcome of the systemic investigation was the report, which will not be discussed today because it is available on BASI's internet website at www.basi.gov.au.

While the identity of the airlines may be determined from today's presentation, it is most important to remember that the crews of the aircraft and the airline companies involved, were the innocent parties to all of the incidents that will be discussed during my presentation.

The Incidents Preceding the Systemic Investigation

On the morning of Friday 29 May 1998, the Bureau received a telephone notification of a serious breakdown of separation incident near Sydney airport involving a Boeing 737 (B737) and a Metroliner. It was classified as a Category (CAT) 3 incident, (under the Bureau's classification system, a CAT 3 may include a serious incident involving fare paying passenger operations aircraft that has a MTOW greater than 5700 kg). As this was my first major investigation, I was appointed the IIC under the supervision of another very capable ATS investigator, who spoke to some of you at last year's conference with a paper on the SODPROPS safety case. A human performance investigator was also assigned to the incident investigation team.



Figure 2. Boeing 737

The Departures North controller decided that, rather than hold his aircraft down at 5,000 ft, with the other controllers agreement he could release his aircraft to climb and get it well above 8,000 ft before the tracks of the two aircraft crossed. This method of control removed any degree of separation assurance and was a fail *un-safe* manoeuvre.

What happened during this event was that the Approach controller thought that he should keep his aircraft (the Metroliner) inside the outbound track of the B737 and he turned his aircraft accordingly. The Departures North controller was surprised by the turn and believed that the B737 would not be able to climb fast enough to get above 8,000 ft before separation was lost, so elected to maintain the B737 at 6,000 ft.

As you have seen from the radar replay, the B737 did at one stage climb to 7,100 ft, 100 ft higher than the Metroliner. The B737 then descended to 6,000 ft. When the aircraft merged on radar, there was 600 ft between the aircraft. Although the incident occurred at dawn in VMC conditions and emergency traffic information was passed by both of the controllers, the crew of the Metro never saw the B737.

After interviewing the controllers, the initial findings of this incident investigation indicated a concern with the degree of change that controllers were being exposed to, due to the continuing introduction of new procedures associated with Sydney's Long term Operating Plan (LTOP). Also identified were concerns with the SIDs and STARs associated with the LTOP, a reduction in controllers skill-based performance levels, teams and supervision, fatigue, the impact of TAAATS training and low morale.

After the on-site investigation and while reviewing the data from the incident, the Bureau was notified of another breakdown in separation in the Sydney TMA involving two B737s, one inbound and one outbound. This was on 12 June 1998. The crews of both aircraft had been complying with the requirements of their SID and STAR profiles. The

ATC data was requested and an on-site investigation was planned for 30 June 1998 because one of the controllers directly involved was unavailable for interview during the period immediately after the incident.

While waiting for the data, radar and audio tapes to be delivered to BASI in Canberra from the Sydney TCU (terminal control unit), I was alerted to another breakdown of separation occurrence involving a two B737s that had occurred earlier during May 1998 in the Sydney TMA. One aircraft was flying a SID and the other was flying a STAR at the time of the breakdown in separation. This investigation had initially been assigned to the Melbourne field office but was transferred to me as the IIC because of the similarities with the other two incidents that had since followed.

The situation that I was faced with in the middle of June last year is as follows. Three serious incidents in the Sydney TMA, each of which raised concerns over the SIDS and STARS. Active failures by controllers, in parallel with what appeared to be latent organisational failures. My dilemma was, should I concentrate on one investigation and hope to get some recommendations out, or were there more serious problems that needed addressing. What if there was a mid-air collision and I as the investigator had not alerted the Government and its agencies to the potential problem with air traffic management in the Sydney TMA.

A Systemic Investigation?

Earlier discussions with the Sydney Safety and Quality manager, unrelated to these three incidents had raised the possibility of a systemic investigation to look at human factors issues, which he had determined were a problem since the introduction of the LTOP.

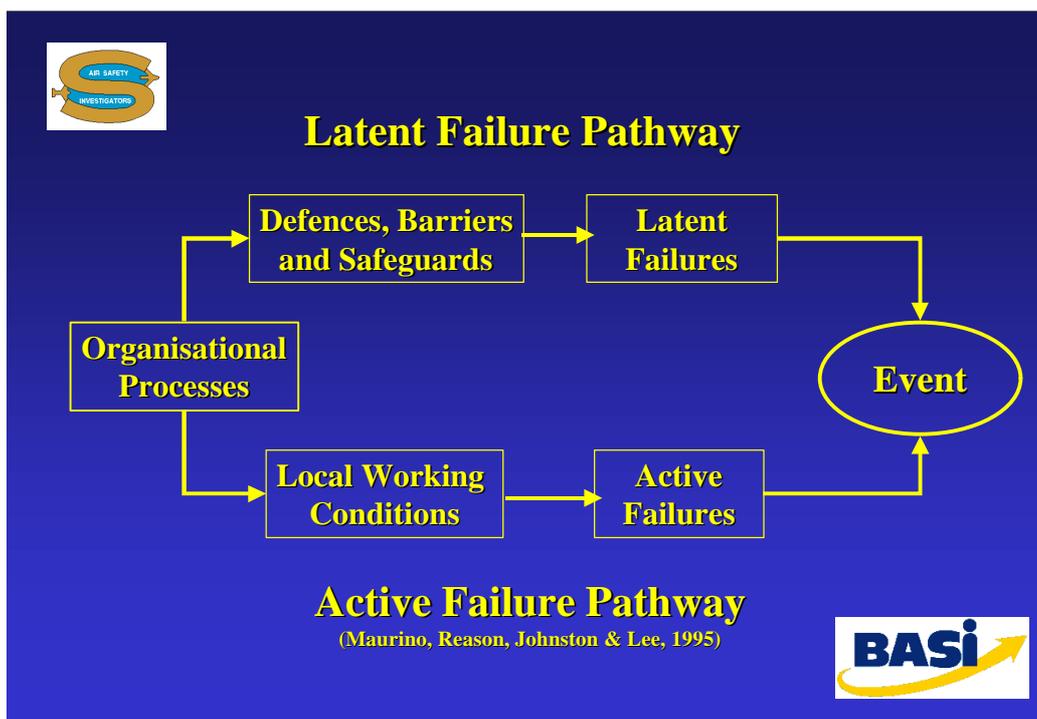


Figure 3. Pathways to events

As I mentioned earlier, the controllers were making **active failures**, yet these seemed in parallel with **latent organisational failures**. Occurrence data from ATS incidents have the potential to provide information regarding the functioning of the ATS system and its many components. While the most apparent indicator may be the active failures of controllers and how the defences of the ATS system were breached, the investigation of these occurrences sometimes provide insights into latent organizational failure types within the ATS system.

A structured systemic approach is not normally applied to investigations at the outset. Normally, identification of the local factors immediately proximate to the incident are sufficient and once identified, recommendations may be made to prevent a recurrence of a similar incident.

However, the broader systemic approach to air safety investigation, in addition to determining local factors, also aims to identify and remedy in a structured manner, the organizational factors that facilitate safety occurrences. The systemic approach to investigation is becoming “The BASI way” of doing business.

I raised my concerns with my manager at the time, and after discussions with the executive it was decided on the 18 June 1998 to conduct a systemic investigation. A team was formed, that included an operations specialist, an ATS specialist, and a psychologist to look at the human performance aspects. CASA and Airservices were advised and invited to participate in the investigation.

I phoned a field office manager, who had been involved in an earlier BASI systemic investigation into the Brisbane Area Approach Control Centre back in 1993, and a follow up investigation in 1995. He gave me the following advice, which was simple but sound. Talk to the controllers and find out what the problems are and then tell Airservices what you find. Following this advice and after reviewing his investigation reports, our first task was to develop a terms of reference.

A Terms of Reference (TOR) document is a useful tool in any large systemic investigation. It provides a degree of protection for both the investigation team and the organisation being reviewed by providing a focus for what your scope and objectives are. However, it should not constrain your activities if new issues become apparent during the investigation that demand addressing. TORs can be amended. This particular TOR included an introduction, scope, objectives, organisational considerations, and the timing.

Scope

The investigation team was to address whether the safety impact of the implementation of operational changes at Sydney had been fully analysed. In particular, the following areas were to be examined:

- human performance limitations
- traffic segregation procedures in the TMA,
- controller preparation and training for changes to procedures,
- the application of separation assurance procedures and culture,
- coordination procedures,
- airspace constraints imposed by the changes, and
- possible workload issues due to additional training.

Objectives

The objectives of the investigation were to:

- determine whether there are underlying organisational factors impacting the safe management of traffic in the TMA,
- identify safety deficiencies,
- examine ways to minimise the impact of identified deficiencies, and
- where considered appropriate, make remedial recommendations.

Timing was to prepare a draft report by 31 July 1998. The TORs were signed on Monday 22 June 1998 and faxed to Airservices and the Civil Aviation Safety Authority on the same day, which did not leave us with a great deal of time.

The first formal meeting was held on 25 June 1998 with an agenda to develop an initial strategy for the conduct of the investigation. We basically had five weeks to conduct the investigation and prepare the report and we had yet to discover whether Airservices and CASA were going to participate on the investigation.

The systemic investigation was conducted very much like an academic research process. With such a research process you would normally:

- define the research problem
- commence a literature review
- develop a methodology
- obtain permission from participating organisations
- develop materials
- ethics clearance
- acquire the data
- analyse the data, and
- prepare a report.

These were the same steps that we followed, even though the terminology may have been different.

We decided that week one, from 29 June – 3 July 1998, would be an information gathering exercise, to be augmented by an on-site investigation on 30 June 1998 of the incident involving the two B737s. This would also provide an opportunity where additional data could be collected by hand from Sydney. A questionnaire would be developed to gather quantitative data during the field investigation, which was planned for the second week over the period 6-10 July 1998. While the questionnaire would be used for the collection of quantitative data, in order to obtain the richer qualitative data, we anticipated interviewing about 20 TCU controllers during the field investigation. We were hoping to meet with the Airservices and CASA nominated members on the 1 or 2 July 1998, at the end of week one.

On 26 June 1998, Airservices nominated an experienced TMA specialist from the Brisbane Centre to participate on the investigation team, a controller whose enthusiasm and experience was invaluable. CASA were unable to provide a representative, because they had very few ATS specialists on their staff. Notwithstanding the non-provision of a staff member from CASA, the investigation team received the utmost cooperation,

controllers well over an hour to complete, assuming that they stayed awake long enough to complete it. The questionnaire was rapidly re-worked and trimmed down to 32 questions. An interview proforma was also prepared to structure the interview process.

The proforma included opening questions to acquire descriptive data of the demographic make up of the group being interviewed. And then issues were raised to capture qualitative data on subjects such as rosters, training, safety concerns with LTOP, SIDS/STARS, temporary local instructions (TLIs), change processes, TAAATS, management, SODPROPS, separation assurance and other issues. At the conclusion of the interview, the controller would be asked to complete the revised 32 question questionnaire.

As mentioned earlier, our plan during the field investigation was to interview about 20 controllers, team leaders and local ATC managers and airline staff where available. Two teams, comprised of two members of the investigation team would conduct the interviews. All interviewees would be asked to participate on a voluntary basis during their rostered breaks, or prior to or at the conclusion of their shifts. The BASI team would make themselves available within an office adjacent to the TCU from 0600 until 2200 hours daily.

The response surprised us and over 35 controllers presented themselves to us for interview. We also interviewed and listened to airways data systems operators and tower controllers but did not include this data into the analysis for the report which, had we done so, may have contaminated or confounded the results. We were there to investigate the operations of the TMA controllers in the TCU and that was the focus of our report.

As I said earlier, the response surprised us. The controllers were coming forward to speak with us during their breaks, before their shifts or before they went home. My interpretation of this response was that these controllers were professionals who were genuinely concerned with aviation safety. They didn't want the incidents to occur, they didn't want to be stood down, they didn't want an accident, and they were as concerned with the events that had been unfolding as we ourselves were as the safety professionals. I also personally believe the process was cathartic for the controllers. We were there providing them with an outlet to their emotions. We listened to their concerns. Concerns which they believed had been ignored by management.

On return to Canberra, further interviews were conducted with Canberra based Airservices managers, managers from CASA and representatives from airline companies that regularly operated into or out of Sydney. It was very obvious to the investigation team that the perceptions of what was happening in the Sydney TCU by Canberra higher management, differed from the views expressed by the controllers at the Sydney TCU.

The Report

Completion of the report was not as difficult as at first envisaged. While analysis of quantitative data is a relatively simple process, the analysis of qualitative data as any researcher will tell you, is a much more complex process. Reviewing over 40 hours of interview notes is a daunting task. We attacked this problem first, by numbering each of the interview reports at the conclusion of the interview to ensure the participants remained anonymous. We then extracted the findings for each issue that had a common thread. For

example, if a respondent had stated that “management is imposing changes before I have had a chance to adapt to the last change” and we found that such a statement was a recurrent finding, but had been stated in various ways, it was an important finding. This qualitative finding could be transposed into a quantitative result by annotating the finding with the identifying number of the interview report. Such a finding may have been annotated 2, 3, 8, 10, 12, 13, meaning that the interviewee numbered 2, 3, 8, 10, 12, and 13, all said the same thing with regard to that particular point.

Team members were then able to complete their sections of the report before it was brought together as a whole, and massaged in the usual BASI way. The final product was the Investigation report “B98/90 - Systemic investigation into factors underlying air safety occurrences in Sydney Terminal Area airspace”, which is available on BASI’s website www.basi.gov.au. Nine recommendations were made, all of which were accepted by Airservices Australia and CASA as appropriate. The Bureau is monitoring actions taken in response to the recommendations.

Conclusion

The air safety occurrences that were described involved high capacity air transport operations. The subsequent investigation of each incident raised similar issues that were of concern to both myself and other investigating officers. The issues raised, suggested systemic safety deficiencies relative to airspace configurations, separation assurance and changes in runway configuration. As I said at the beginning, the incident that you observed on the video occurred within 18 minutes of a Mode change. There is empirical evidence that 45 per cent of controller errors occur within 15 minutes of taking over a control position. The controller has to warm up, to get up to speed. A new configuration such as a Mode change has the same effect. It takes time for controllers to adapt to the new routines. The LTOP provides many of such routines. Other factors indicated possible limitations in human performance in the increasingly complex Sydney air traffic environment. If we did not have an incident reporting system, and/or the incidents were not investigated, dangerous trends or concerns would not be highlighted. Incidents would go unreported and would be unrelated events occurring in a vacuum of knowledge.

The similarity of these issues was the catalyst for the systemic investigation conducted by BASI. We considered that the recent air safety incidents were manifestations of broader problems being experienced in the management of air traffic by controllers employed in the Sydney TCU. The investigation revealed that the major concerns were focussed on the LTOP and the associated changes to air traffic processing. These changes were perceived by Sydney TCU controllers, to be imposed on them in response to community demands for respite from aircraft noise rather than a more pressing need to increase efficiency in air traffic processing.

As mentioned in the Final Report, for high morale, management must be well informed and sensitive to controllers’ needs at work. Moreover, management should be willing and able to communicate effectively with the workforce on all matters of mutual concern. Morale will ebb away if controllers are blamed for delays that were not their fault, particularly when their forewarnings were ignored. ‘Constant disparagement of a profession whose members are doing their best does no good for its morale’ (Hopkin, 1995, p363).

So, to answer the question “where do you start with a systemic investigation?”, you start at the beginning. Treat it like a research project, define the problem, review the paperwork, develop a methodology or a plan, consult with participating organisations, develop materials, acquire the data, analyse the data and prepare the report. Or as has been said earlier, talk with the controllers, find out what the problems are, tell the managers. Effective communication solves many problems.

References:

- BASI Investigation Report B98/90, (1998). *Systemic investigation into factors underlying air safety occurrences in Sydney terminal area airspace*. Canberra, Australia: Department of Transport and Regional Development.
- Hopkin, V.D. (1995). *Human Factors in Air Traffic Control*. London, UK: Taylor and Francis.
- Isaac, A. & Ruitenber, B. (1999). *Air traffic control: human performance factors*. Aldershot, UK: Ashgate.
- Maurino, D.E., Reason, J., Johnston, N. & Lee, R. (1995). *Beyond aviation human factors*. Aldershot, UK: Ashgate.
- Wiggins, M. (1999). *Student Workbook: Research design & methodology*. Melbourne, Vic: Swinburne University of Technology.