

**Title: A holistic approach to aircraft accident/incident investigation**

**Author: Phil Sleight BSc(Hons) CEng FRAeS MCMI - Principal Inspector of Air Accidents at the Air Accidents Investigation Branch.**

*Philip Sleight is a Principal Inspector of Air Accidents (Engineering) with the Air Accidents Investigation Branch. He joined the AAIB in 2002 and has been involved in over 200 investigations as an investigator, Accredited Representative and Investigator In Charge (IIC). These investigations have including the accident to the Boeing 747 in Halifax in 2004, the Boeing 777 at London Heathrow in 2008, the Nimrod XV230 in Afghanistan in 2006 and the AS332 L2 Helicopter in the North Sea in 2009.*

## **Synopsis**

The goal of any non-blame aircraft accident or incident investigation is to identify the safety issues early so that actions can take place to prevent recurrence. In a bid to maintain independence, some State investigation authorities will exclude other stakeholders from the analysis discussions of the factual evidence. With increasingly technically complex investigations, this can result in important safety issues not being addressed in a timely manner.

This paper describes a holistic approach, used successfully by the AAIB in a number of significant aircraft accident/incident investigations, where the stakeholders are encouraged to be involved in the investigation, but in a way that does not conflict with the independence of the State investigating authority. The approach has demonstrated to result in timely resolution of safety issues early in the investigation.

With a holistic approach, each stakeholder is very much part of the analysis, as well as the gathering, of factual evidence. The investigating State's investigators take the lead and determine the direction of the investigation, thereby maintaining the independence. However, this is an iterative approach, with analysis being conducted as the facts are gathered. This allows for early scoping and focus of the investigation on the important safety issues and makes the most efficient use of resources available.

As stakeholders are fully aware of the findings of the investigation, at an early stage, they are able to initiate safety action proactively. It also means that the independently produced final report focuses on the identified safety issues and emphasises the proactive actions taken, as well as any resulting Safety Recommendations.

## Common approach

For air accident investigation, the most common system that is employed by Safety Investigation Authorities (SIA) involved in major investigations is the group system model; this is the system that is advocated by the current ICAO Manual of Aircraft Accident and Incident Investigation, it is easy to follow and does result in a reasonably thorough and consistent investigation.

Usually the Investigator in Charge (IIC) initiates and commands a set of standard groups, each of which have chairman who is an investigator, from the Safety Investigation Authority (SIA) of the state of occurrence, with a specialism in the subject area on which the group is based. Investigators, Accredited Representatives and Advisors are then placed into these groups to gather and provide the factual information to the group chair.

In this system each group is assigned the task of gathering the evidence only for their particular area of specialism, and in most cases produce 'field notes' agreed by all the group members, to be subsequently presented to the IIC.

The advantage of the system is that all the factual evidence, whether it is relevant or not, is documented for use by the IIC. The expectation is that nothing will remain unrecorded, so that a full analysis of all the facts can be carried out.

The disadvantage is that it can take a long period of time for the group reports to be produced and it is labour intensive, so it takes up a lot of resource, something most SIAs do not have access to. The system of specialist groups only dealing with the facts within their specialism can also promote a 'silo' attitude, as each group focuses on their own particular area and not communicating effectively with other groups. The IIC then becomes the only person in the investigation who has the overall 'big picture view' of the investigation.

Members of a group are often isolated from other aspects of the investigation, so Advisors from manufacturers and regulators may not receive the full information on specialist areas that may at first appear to be outside of their specialism, but which might be important to their understanding of the circumstances.

There is usually no analysis carried out amongst the groups until all the facts are gathered and group reports are produced. The analysis then takes place, in some cases without discussion outside of the immediate SIA team and in some cases the Accredited Representatives. The process does not allow iteration as it is assumed all

the facts have been gathered, and can be quite time consuming. It is only after the analysis that safety issues are identified and the potential safety recommendations produced. The whole process takes time and it may be a matter of months before the group chairs produce their final agreed factual reports, before any analysis takes place. It is only after analysing the facts that any safety issues are identified, safety recommendations produced.

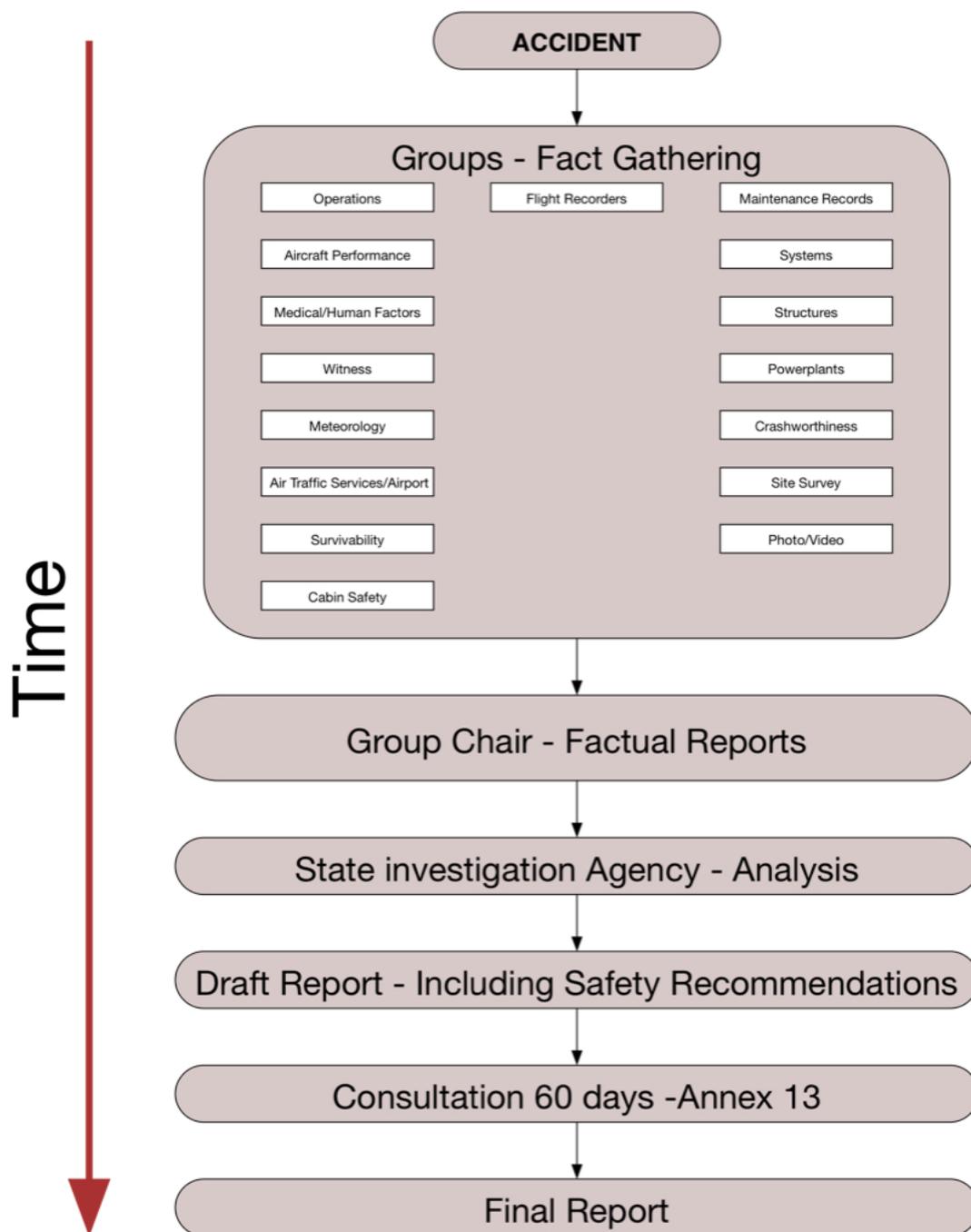


Figure 1 – flow chart of the common approach

## **Reason for different approach**

The common approach described above focuses on a rigid structure for the gathering of factual evidence. Due to its rigid nature and bureaucratic nature, it can take weeks or months to gather the facts before any analysis takes place. It can therefore distract the investigation team from the early identification of the safety issues that may need to be addressed. Indeed, in many cases the analysis of the factual evidence is carried out only by the experienced investigators of the investigating SIA, with little reference to the specialist expertise of the other parties to the investigation.

Aircraft are becoming more complex with the use of advanced avionic systems, interconnected networked systems and exotic materials. For these advanced and complex aircraft the knowledge of the system or materials sometimes only lies with the manufacturer. So to successfully identify a safety issue the full co-operation of the manufacturer at all stages of the investigation is essential.

Once a safety issue is identified, the aim would be to address the issue to prevent recurrence of the accident. In some cases this will require the regulatory authorities to take early and immediate action, something that can only be done if they are involved in the investigation process and are aware of the findings. Indeed the regulator can provide valuable input on interpretation of rules, regulation and certification requirements and how they were applied or meant to have been applied when the aircraft, engine or system was first designed.

## **Holistic approach**

The holistic approach encourages the engagement of all the parties at an early stage of the investigation, which then continues throughout the investigation process. The aim is that safety information and facts about the accident are gathered methodically, analysed, and shared with all the parties. Importantly this enables the timely identification of pertinent safety issues that may need immediate action by some of the parties. It also allows for early decisions on the size, scope and direction of the investigation and its implications on available resources.

So as soon as possible after the accident, the potential parties are notified and encouraged to participate. For a large investigation a form of the initial group system is employed with an IIC, lead inspectors for operations, engineering and recorded data and group chairs assigned for each of these general areas. However, there is no defined set of groups and the assignment of groups comes about as the factual

information begins to be known and to do this requires a certain amount of analysis of early factual information.

It is usually known within a few hours what the basic facts of the flight were, which provides an early indication of the likely direction of the investigation. This means the IIC can focus the resources on that area that is likely to yield the most safety benefit. This cannot be done by the investigators in isolation.

As aircraft become more complex, with systems interactions and operations now inextricably linked, as well as a preponderance for recorded data, some of which is not held on the aircraft itself. There is a need to ensure all relevant parties are engaged.

So, although there are “groups”, the information within each group needs to be shared amongst the other groups and parties. This “holistic” approach is such that everyone involved is given the opportunity to be made aware of the information that is being gathered by the investigation. Indeed, participants are encouraged to discuss the investigation openly and provide their point of view.

This approach is iterative involving the gathering the facts, analysing these facts and then determining the focus of the investigation as to the continued gathering for further facts, tests or research. This “focus and scope” stage also enables the reassignment of resource to maximise the efficient collection of evidence for those areas that will produce the most safety benefit.

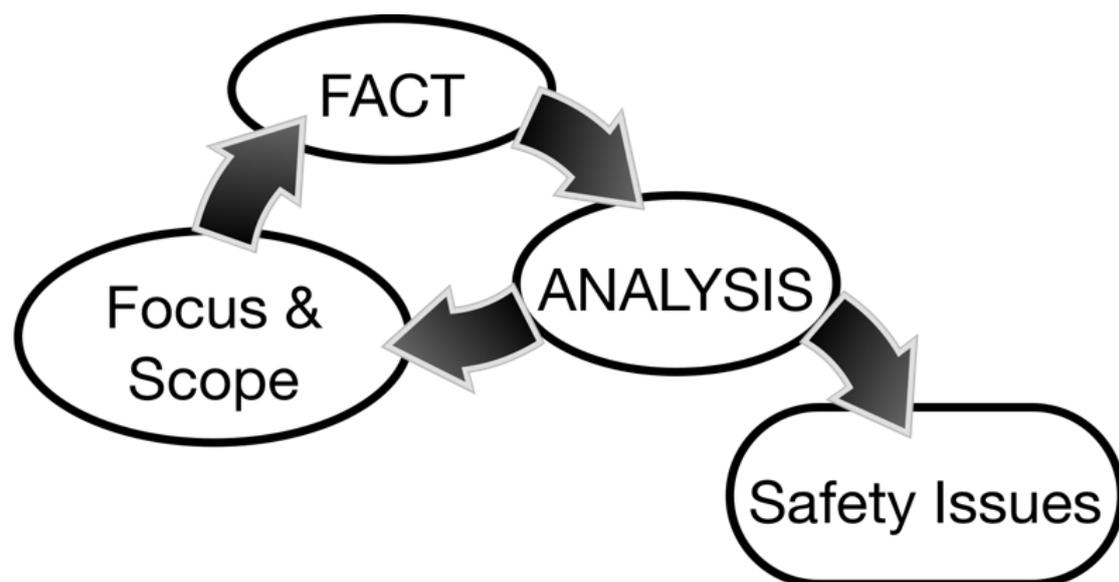


Figure 2 – Simplified diagram of the iterative process.

This system is such that there is a possibility that the investigation team may become too focused on one aspect and miss other essential factual evidence, which may later be relied. There is therefore still the need to gather factual evidence which would otherwise be destroyed and that this is identified early and suitably gathered, again early engagement with the manufacturers has shown to be valuable in identifying this evidence. Also, it is advisable to protect the evidence, even if at a later date it is no longer required by the investigation.

As the investigation progresses, the various parties will be fully aware of the gathered factual evidence and also the direction of the investigation. Their input allows for differences to be aired and for worthwhile discussions to take place across groups and advisors.

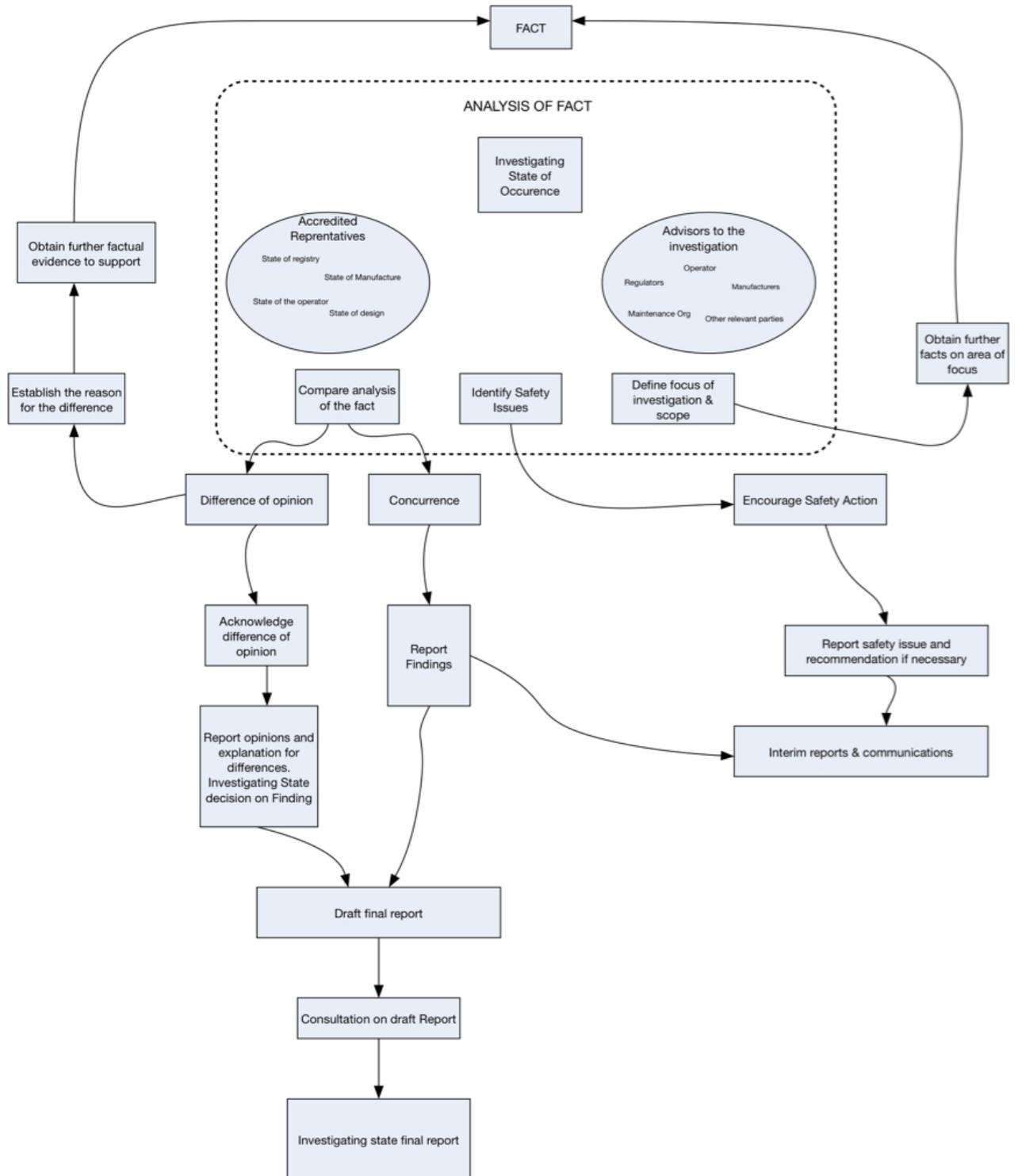


Figure 3 Holistic approach model.

From the model it is seen that the process starts as with other approaches with the gathering of facts, with groups set up to accomplish this task. Rather than a fixed set of groups, the initial groups develop as information about the accident become known, with some groups only having a short life. To maximise resource multiple groups may also be chaired by the same investigator by the SIA, and indeed

participants maybe included as part of multiple groups too. Having gathered the facts they are then analysed by the “investigation team” which includes the Accredited representatives, advisors and parties to the investigation, and not group by group – but across groups. This holistic approach is to ensure that each group is aware of the factual evidence gathered by the other groups.

During the analysis of the facts are three possible outputs:

1. The definition of the further scope and focus of the investigation, which includes the assignment of more resource, the reallocation of the existing resource, the closing down of groups that no longer serve a purpose and the release of resource for other investigations.
2. Identification of safety issues and the encouragement of safety action by the relevant participants. Indeed, it is also at this stage the possibility of reporting on the identified safety issues may be relevant, through interim reports or statements.
3. Comparison of the findings determined by the factual evidence. Concurrence indicates that the finding has been agreed and can be concluded as a finding by the investigation in the report and maybe reported in an interim report. Differences of opinion amongst the investigation team indicates either there is not enough evidence and therefore further facts, research or testing is required to substantiate or refute the position. There is also the possibility that there is some doubt about the findings from the factual evidence that has been gathered. The SIA, who are conducting the investigation, will determine the findings, to be reported to maintain the independent nature of accident investigation. However, having identified this difference of opinion, this can now be taken forward and if not resolved, may be objectively be presented in the final report.

The process is iterative, with facts being analysed as the investigation progresses.

Having completed the process and reached a stage at which the required factual evidence has been gathered. The draft final report is produced by the SIA using the agreed findings, the report will also include the findings that have been determined by the SIA but may not be full agreed on amongst the participants. However, as the report will also include these valid differences of opinion on the analysis and the reasons for these, then the report is balanced.

## **Benefits of the approach**

The main benefit of the approach is that parties to an investigation who have the power to carry out safety action are fully engaged with the investigation including not only the factual evidence as it is gathered, but also the analysis of the facts, so they become aware of the safety issues at an early stage. Indeed, the parties may also highlight safety deficiencies that require further research that may have otherwise been missed by the investigation teams. This means that regulators for example are able to issue mandatory action early and with the full agreement of the investigation team, rather than waiting for the factual evidence to be presented in a report or safety recommendation. Indeed, at the AAIB our philosophy is now moving toward encouraging proactive safety action taken when the facts are known, rather than the reactive action following a Safety Recommendation, which could be several years after the accident. This proactive approach means that rather than issuing Safety Recommendations which have no indication of whether they will be adopted or not, reporting on Safety Action that has taken place means the reader understands that safety has in fact been improved based on the factual evidence.

With a focused holistic approach, only those areas which have a safety benefit are carried forward into a full analysis for the identification of safety issues. This means the report is more focused and doesn't stray into reporting factual details on areas that had no bearing on the accident/incident. Another advantage is that there is an efficient use of the resources available to the investigation team, with the focus primarily on the main safety issues that caused or contributed to the accident.

As the parties to the investigation have been involved from the beginning, the investigating SIA becomes aware of areas of potential conflict/controversy early on. This enables the SIA to understand the reason why such a conflict/controversy exists and to acknowledge this. There will always be cases where a participant will try to influence the content of the report with conclusions which are not based on the factual evidence, this process identifies these early, such that they are dealt with at an early stage and not when the report is about to be published. The involvement of all parties during analysis discussions can mean that it remains balanced and is not biased toward one point of view, and is verified by the inclusion of the regulator and other specialists. Only those conclusions which are validated by the factual evidence should be reported, but there may be differences of opinion of the established facts. The SIA can then incorporate those valid areas of differences of opinion in the main report to balance the views of other parties. The advantage is it is then less likely that the other States to the investigation will criticise the report and request the appending

of substantiating comments to the report. The appending of comments only detracts from the aim of the investigation which is the timely promulgation of safety information.

Indeed, the holistic approach allows for full and free discussion of the issues and open dialogue following the formal consultation phase. Also, at this stage a rapport has built up amongst the investigation team and the parties, which has shown to lead to more open dialogue than would otherwise have taken place.

## **Maintaining independence**

Although the holistic approach encourages full engagement with parties to the investigation, it is still important that the investigating SIA maintains its independence from the other participants and also to remain objective.

Indeed, certain parties will have their own perspectives, cultural differences and agendas for an investigation and will attempt to influence its direction. However, the holistic approach should identify these early in the investigation as the parties are fully engaged from the start. Indeed, in our experience this approach highlights areas of contention at an early stage and allows for the investigation to deal with these during the investigation process, rather than at the end when the final report is being drafted.

It is the function of the IIC to make sure that no one party has a strong influence on the direction of the investigation and to make sure the viewpoints of all are taken into consideration. The IIC should also be able to identify when a certain party may have over stepped the mark and take necessary action, which could include expulsion from the investigation process.

The final word will always remain with the investigation SIA and they should reserve the right to exclude parties to the investigation or indeed to manage the relationships to avoid would could be destructive conflict. It is the skill of a good investigator to know when they are being misled or not being given the answers they need to further the investigation.

It always remains that the investigating SIA can produce recommendations for safety action, even if this is not in agreement with the other parties, should they feel it is necessary for continued aviation safety.

## Confidentiality

For a holistic approach it is important that the participants maintain confidentiality of the information and the analysis discussions. Care still needs to be taken with regard to the information flow, as certain information may be protected from disclosure by local regulations and may not be shared outside of the direct investigation team, and so at times advisors and observers may have to be excluded from certain discussions. However, they are likely to receive a summary of these areas, provided it is permissible within the regulations.

Should confidentiality be breached, either by leaks or by the unapproved release of investigation information the trust between the parties also breaks down. This results in the investigation participants becoming insular and the sharing of information effectively dries up or is carefully scrutinised before its release to the other parties. This then leads to further delays as the information flow disappears, and at worst the needed expertise could be removed.

The result of this is to slow down the investigation process and lead to delays in identifying the safety issues and thereby reducing the timeliness of safety action. A situation that is detrimental not only the investigation process, but the aims of the investigation not only for the investigation team but the other participants.

In the European Union, the rules on confidentiality are laid down in the EU Regulation EU 996/2010 articles 14 and 15. In addition ICAO Annex 13 lays down the following for international participants.

### *“Obligations*

#### *5.26 Accredited representatives and their advisers:*

*a) shall provide the State conducting the investigation with all relevant information available to them; and*

*b) shall not divulge information on the progress and the findings of the investigation without the express consent of the State conducting the investigation.*

*Note.— Nothing in this Standard precludes prompt release of facts when authorized by the State conducting the investigation, nor does this Standard preclude accredited representatives from reporting to their respective States in order to facilitate appropriate safety actions.”*

To ensure confidentiality, any participant to a large investigation should be bound by these confidentiality requirements and may be required to sign a statement reminding them of their entitlements as laid down by local and international protocols.

## **Communication challenges**

Good communication in an holistic investigation is key to its success and when put into practice should not result in problems of information "vacuums". These "vacuums" can, at worse, mean frustrated participants in an investigation take matters into their own hands and either leak information or produce their own interpretation of events that then finds its way into the public domain. The rules on disclosure of information is laid down in Europe under EU regulation 996/2010 and ICAO Annex 13, however this does not stop certain organisations from issuing their own "spin" – hence the need for confidentiality statements at the beginning of the investigation as mentioned previously. It is important that no information relating to the investigation should be released by participants or their organisations without the express approval of the IIC.

There are two challenges in any investigation, communication with the investigation team and parties and external communication. The holistic approach, due to its model of inclusivity, means that issues of communication can be resolved quickly.

Internal communications amongst the investigation team and participants will ensure the holistic approach works well. This is usually easy to accomplish at the accident site during the field phase, as the participants are all located in one place and a daily, or twice daily brief chaired by the IIC can take place. It is during these daily briefing/meetings that the factual evidence gathered during the day can be discussed and analysed, with decisions then made on the future direction of the investigation effort. It is also during these meetings that the parties can highlight safety issues and indeed indicate what safety action is being developed or indeed issued. In that regard, the investigation team can then coordinate their communication strategy for external release of information.

Once the field phase is complete, the internal communications become more challenging. Indeed, it is usually at this stage in a normal investigation that the "momentum" of an investigation starts to reduce as people return to their day-to-day working style. This can lead to the parties becoming insular and distanced from the investigation work.

As part of the holistic approach the IIC can maintain this “momentum”, by ensuring that all the parties continue to work closely together and share factual information and analysis. It is also at this stage that time zones can become an issue with up to 12 hours difference between locations. A compromise is to have regular daily or weekly telephone conference calls at a mutually convenient time, using web based presentation-sharing tools to assist in the sharing of the factual information.

Although conference calls work well, the ideal is to meet face to face and is an integral part of the approach. A face to face meeting not only brings the investigation team together in one place, it enables other discussions to take place amongst parties to clarify small points of dispute, which would otherwise have not taken place. It also builds rapport and enables an understanding of each parties position with good open discussion, or indeed private discussion on particular points if felt necessary. The face-to-face meetings provide a good point at which to refocus the investigation and again review the safety issues identified and areas that are either being addressed or are likely to be addressed. Again it enables discussions and co-ordination of the external communication strategies of each party.

This worked particularly well on the investigation into the accident to a Boeing 777 G-YMMM at London Heathrow, where following the field phase due to the geographical spread of the various participants. Daily and weekly telephone conference kept the momentum to a certain extent. However, bringing all the parties together routinely at face-to-face meetings was very successful in the promulgation of pertinent information. Indeed, as the value of these face-to-face meetings became evident, there were times that requests were made by parties for more frequent meetings. To reduce the impact on the work being carried out, as travelling to a meeting does take up valuable investigation time, the face-to-face meetings would sometimes be held at the location where the work was being carried out, ie fuel labs, engine test labs, research facilities, but mostly they were at neutral venues.

Indeed, this need for regular meetings is recognised in the ICAO Manual of Aircraft Accident and Incident Investigation:

*"4.5.2 It is always a challenge to ensure that the investigation continues to progress following the field phase, for the most part because the members of the investigation team are no longer centrally located, and subject matter expertise is no longer readily available. As a result, the group chairpersons and the Investigator-in-charge will have to increase their efforts to maintain communication with team members and to ensure that investigation tasks are completed on time. In this regard, the Investigator-*

*in-charge should have frequent, regularly scheduled, decision-oriented team meetings, and have additional meetings for significant issues or for issues that will require a change to the investigation plan."*

*"At frequent intervals during the investigation , the Investigator-in-Charge should hold meetings to review the progress of work and to permit free exchange of ideas and information among the groups. Very often one group will have uncovered some factor facts which will serve as a valuable lead to another group in their work. In this manner, all the relevant facts, conditions and circumstances relating to the accident are progressively developed."*

The most important stage in which communication can sometimes be lacking between participants is when the final report is being brought together. Again a face-to-face discussion is part of the holistic approach, and has proven to work well. The approach means that the SIA shares its findings with all the parties, and allows for acknowledgement and understanding of any disagreements and the presenting of their final decision. This can then be followed up by a further gathering following the formal consultation phase of the report, again to discuss any areas of particular disagreement and to clarify any points that may be lost in translation – especially with States where English is not their first language. The experience of this approach is that it means that there is less likely to be a need for comments to be appended to the final report.

As mentioned before the holistic approach also allows for coordinated communication strategies. This means that should a party wish to issue something that addresses a safety issue; the SIA can simultaneously issue an interim report with the facts and analysis presented to support the action. The other parties can then use this to prepare statements to customers and the media. The co-ordination gives the impression that the investigation is working as a cohesive team, and that the early identification of safety issues is paramount and resulting in them being addressed in a timely manner. The approach also allows for the investigation team to be aware of pressures on the parties to the investigation, so that the SIA's communication strategy can be altered accordingly. This could mean the early publication of short factual reports or the release of presentations by the IIC.

## **Summary**

In summary, the holistic approach has been shown to be an efficient way of engaging with all the parties involved in an investigation. It encourages all the investigation parties, including the manufacturer, regulator, operator etc. to work together not only

in the gathering of facts but also the analysis. The benefit of which is the timely identification of safety issues and the early engagement with those who are able to carry out safety action to prevent recurrence, without having to wait for the publication of the final report.

The AAIB have used this approach for the majority of its investigations, and it has proven to be worthwhile in the timely proactive safety action taken to prevent recurrence. This is particularly true in the investigation to the Airbus A340 G-VATL in 2004, Boeing 777 G-YMMM at Heathrow in 2008, the AS332 L2 G-REDL in 2009 and the recent ditching of the EC225 G-REDW in 2012.

However, this is not a new approach. The 1970 edition of the ICAO Manual of Aircraft Accident and Incident Investigation had the following:

*"The maintenance of a high standard of air safety is dependent amongst other things upon the appropriate corrective action being taken when faults or shortcomings in the design or maintenance of aircraft are brought to light or when unsatisfactory procedures for their operation are revealed. Since an aircraft accident represents the very antithesis of air safety, it is most important that adequate and relevant measures are taken expeditiously to prevent a recurrence arising from a similar cause..."*

*"At frequent intervals during the investigation, the Investigator-in-Charge should hold meetings to review the progress of work and to permit free exchange of ideas and information among the groups. Very often one group will have uncovered some factor facts which will serve as a valuable lead to another group in their work. In this manner, all the relevant facts, conditions and circumstances relating to the accident are progressively developed."*

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