ISSUE 93

focus

ON COMMERCIAL AVIATION SAFETY

WINTER 13

The official publication of the United Kingdom Flight Safety Committee

ISSN 1355-1523

Contents

The Official Publication of THE UNITED KINGDOM FLIGHT SAFETY COMMITTEE ISSN: 1355-1523 WINTER 2013

FOCUS is a quarterly subscription journal devoted to the promotion of best practises in aviation safety. It includes articles, either original or reprinted from other sources, related to safety issues throughout all areas of air transport operations. Besides providing information on safety related matters, **FOCUS** aims to promote debate and improve networking within the industry. It must be emphasised that **FOCUS** is not intended as a substitute for regulatory information or company publications and procedures.

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Printed by:
Woking Print & Publicity Ltd
The Print Works, St. Johns Lye, St. Johns, Woking, Surrey GU21 1RS
Tel: 01483 884884 Fax: 01483 884880
e-mail: sales@wokingprint.com
Web: www.wokingprint.com

Front Cover Picture: A350 XWB first flight, Toulouse, 14 June 2013. Photo copyright Airbus. Visit www.a350xwb.com/

Some Statistics...

by Dai Whittingham, Chief Executive UKFSC

The recent International Aviation Safety Summit run by the Flight Safety Foundation (FSF) discussed some interesting statistics. The good news is that if you are involved in commercial jet operations in the Northern hemisphere you are doing very well and, based on performance over the last 2 years, your chances of being involved in a fatal accident are a million to one or better. That is a remarkable safety achievement by any standard.

Things are not quite so clever in the business aviation sector, where there are around 10.5 accidents per year, which equates to about 0.5 per 1000 aircraft. And of the 17 fatal turboprop accidents in the last year, 7 were CFIT – consistent with the 30% CFIT average for turboprops over the last 4 years. Perhaps these statistics have something to do with the generalisation that turboprops and business aircraft tend to have the fewest protections by way of systems and automation, the least experienced crews, and fly the most difficult sectors. Please don't ask about helicopters as they didn't rate a mention at the Summit...

Other than the return of CFIT as the major killer in commercial air transport operations, another consistent theme from the statistics was the prevalence of approach and landing accidents which, over the last 10 years, have accounted for 65% of global fatal accidents. FSF research has suggested that around 83% of the ALA accidents would have been prevented had the crew opted to go-around. It follows that if crew comply with company go-around policies half of all fatal accidents could be prevented – a sobering thought. The accident figures aside, 10% of unstable approaches continue to a landing that is either long, or long and hot, or short or significantly off-centreline, which suggests that we may have an unduly optimistic view of the runway excursion risk picture as we currently understand it.

So why is the overall compliance rate for go-arounds from an unstable approach a mere 3%? Would we see the same compliance rate for a financial policy? The FSF work found that compliance rates were highest in companies where managers knew the industry and own company rates. Sadly, a survey showed that almost half the managers questioned did not know their own company compliance figures, and 2/3 were unaware of the industry rate. On the other hand, only 20% of managers thought the policies were effective, which begs the question as to what they were doing about it.

One aspect of statistics that is worthy of further thought is the problem of small samples. This can act in two ways (at least to this non-statistical brain): either the size of the sample makes the results appear more significant than they actually are, or the sample size masks or is used to dismiss arisings that are definitely more significant than they appear. My ECAST friend and colleague, Bertrand de Courville, spoke eloquently on this at the Safety Summit. He pointed out that fewer accidents – the goal of our safety work – mean that trends are often unclear, and observed that we tend to focus on the most recent events.

Learning from accidents was therefore no longer sufficient. He also reminded us that the result of low accident and incident rates was a possible erosion of awareness and commitment, ie complacency. He argued that the industry should pay more attention to global harmonisation of policies, procedures and training to better allow events to be recognised and analysed, and for lessons to be disseminated promptly. This required better sharing of information on technical and operational events. There was one other set of statistics presented last month that I found particularly illuminating. The US Department of Transportation Volpe Center has estimated the numbers of Remotely Piloted Air Systems (RPAS) it expects to be operating in the USA in 2035. The Volpe report suggests that the military will be operating 14,000 RPAS (70% of the military fleet...), and there will be another 10,000 RPAS operated by Federal Agencies (FBI etc). Add to that number another 70,000 platforms run at state and local levels, and a further 175,000 commercial applications ranging from the nano to large aircraft, and you begin to see that the US airspace environment is likely to be very different in future. The US Congress has placed the FAA under mandate to integrate these aircraft into controlled airspace, with a target of July 2016 for Class A.

The technology is not new, it is in daily use and it is not going away. There will be issues with regard to sense and avoid, but the straight fact is that you can expect to be mixing it with RPAS within 3 years in the USA. Europe will take a bit longer, but RPAS will eventually operate in non-segregated airspace here whether we like it or not. The big question will be the ability of the regulators to keep pace with the technology and react appropriately to commercial and political pressure.

As a final statistic for you, I probably manage to annoy someone in one of these editorials on 25% of all my approaches to the keyboard. If one of those is you, I apologise! I try to use snippets of information to push out points to ponder, especially as most people no longer have the luxury of a crewroom or roster that makes discussion easy. If my ramblings prompt discussion between any of us, I see that as a good thing. For example, in my last piece I used an incident of a crew shutting down an engine stuck at 1.5 EPR to reinforce a question about simulator training and where it might be leading us. In fact the crew had worked out they would be unable to achieve a stable approach with the stuck engine still running and that they stood a good chance of a runway excursion. They also considered that they were ETOPS certified, so loss of an engine was not an immediate drama, but they still delayed shutting down the engine until the last sensible moment. The additional information puts an entirely different spin on things – it was a complex emergency, well handled. My comment about shutting down a running engine is valid for many other circumstances, albeit not this one, which is why you didn't get more of the facts. And now, back to Bertrand's point about learning from isolated events...!

CAP1036, an insight

by Capt Chris Brady, easyJet

I was fortunate enough to be invited onto the panel of the CAAs annual Accident Analysis Group last month. The panel consisted of various figures in the CAA with responsibility for flight operations, flight test, airworthiness, airspace, aerodromes, ATS and aeromedical; plus external representatives from the UK Airprox Board, AAIB, NATS and EASA.

The group meet annually to analyse both the interim and final accident reports from all known worldwide commercial aircraft fatal accidents. They then identify the causal and circumstantial factors from these reports and use the data to compile CAP1036 Global Fatal Accident Review.

The experience was a sobering one. Like most readers of FOCUS I read accident reports as and when they are published and occasionally I look up old reports when I need some information from them but I have never gone through so many reports in so much detail in one day. The result, apart from a feeling of depression, was that trends could be seen very easily.

Without wishing to pre-empt the next edition of CAP1036, the main thing that struck me was the high number of fatal runway excursions following long landings. It would be very easy to say that long landings are avoidable – if it looks like you are landing long then simply go-around, end of story. Or is it? Let us consider how and why long landings occur.

The main causes of long landings are unstable (i.e. high energy) approaches and/or incorrect landing technique, often exacerbated by bad weather such as a tailwind, turbulence or heavy rain.

Unstable approaches are a fact of life in aviation; as long as you have tailwinds on approach or landing, published final approach paths in excess of 3 degrees, ATC shortcuts or speed control, airspace restrictions and commercial pressures, you will have the ingredients for an unstable approach. As pilots we face these almost daily and we usually sort them out in a timely manner with energy management techniques and various drag devices ranging from speedbrakes and the landing gear to flaps and extendable landing lights! Over the last 15 years most operators have greatly reduced the number of unstable approaches that continue to land and this is due to a continued awareness and education process amongst pilots and air traffic controllers, CRM training, SOPs which have stable approach criteria and of course a well-managed Flight Data Monitoring program.

Years ago, in some circles it was considered a sign of skill and good judgement to "expedite your approach" and be able to glide your airliner in at high speed only spooling up over the threshold. But now you would be regarded with distain in much the same way that drink-driving was more common 40 years ago but is now socially unacceptable.

So, assuming that intentional unstable approaches are a thing of the past but the factors for unstable approaches will always be present, what else can cause a long landing?

Bad weather was a contributory factor in many of the long landing events. Tailwinds and turbulence can make spotting your landing difficult but there are other effects, such as the sudden onset of heavy rain on short finals which can create an illusion of sinking thereby causing pilots to go above the profile. This was believed to be a contributory factor in the Air France A340 overrun at Toronto.

The other factor is landing technique. Long landings can even follow stable approaches in benign conditions if the flare is misjudged. Don't be afraid to throw away a landing even from the flare, most aircraft types will permit a go-around up until the point at which reverse thrust is selected. Ensure that you are happy with the baulked landing procedure as prescribed in your company manuals.

Once you have passed the TDZ markings it may be very difficult to know how far down the runway you will touchdown and more importantly what the remaining LDA is and if it is greater than LDR. You are into the realm of "eyeballing" landing performance which might work… or it might not. Standard industry guidance is: If you have not landed in the TDZ or first third of the runway, go-around.

The go-around is your "get out of jail free" card, literally so in some countries. However there are some common reasons why they are not always done:

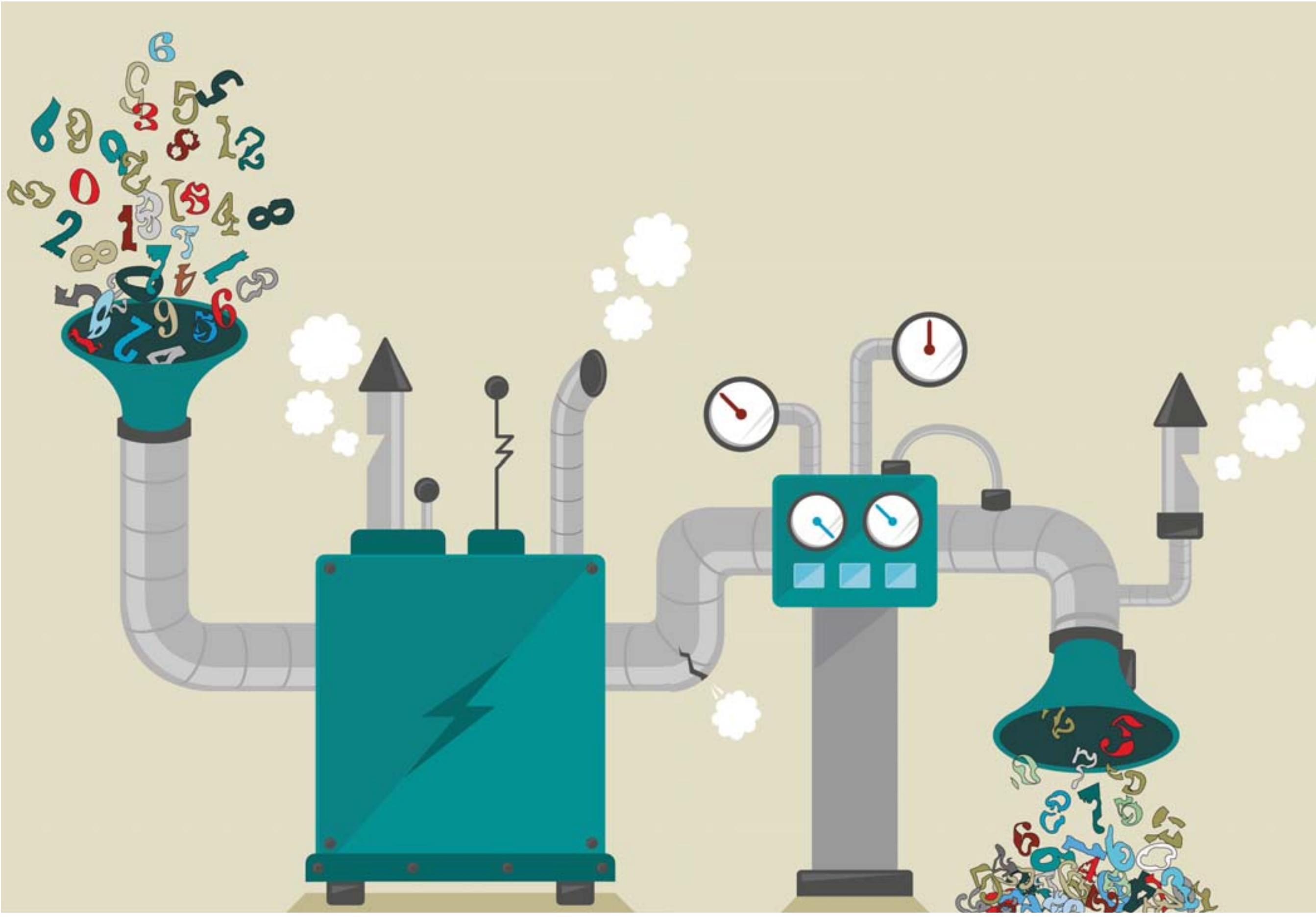
- Loss of face – These days this should not be an issue but we know that it is. However compare the loss of face of a go-around versus the loss of face from the subsequent incident.
- Go-arounds are difficult – True, they are demanding and when combined with the startle factor of having to perform one it can be a challenge. Again the solution is training and confidence with your manual handling skills. Know precisely what the sequence of actions is for a go-around and consider reviewing it as part of your approach briefing.
- A go-around would be less safe than continuing the approach – I have heard this many times during crew debriefings. All I would say to this is that you should never let yourself get so boxed into a corner where this might be the case. You would never make an approach in which ATC would forbid you from going around, so why would you impose the same restriction on yourself?

In summary, please don't get yourself a mention in CAP1036 because you didn't go around. It makes for very sad reading.

www.caa.co.uk/cap1036

Data Delirium

By Robert I. Baron



Data are important to safety, but their quality and quantity must be managed with care

Recommendations on safety management systems (SMS) typically address the requirements of implementation but less often the challenges associated with data collection. Inadequate quality of data – "garbage in, garbage out" (GIGO) – can be a problem, as well as too many – or too few – data – which can yield the same net effect, the inability to adequately analyze, understand and act on the organization's safety deficiencies and objectives.

An organization's SMS can be thought of as a data hub, with programs that feed into the SMS as data spokes. Hub-and-spoke data can be derived from a multitude of sources such as flight operational quality assurance, a fatigue risk management system, an aviation safety action program, a line operations safety audit (LOSA), and the analytical results generated by an SMS.

Sometimes all these data become so difficult to manage that their intended benefit is never fully realized. A number of problems may manifest during data collection. The first, GIGO, later can make data interpretation problematic because of a low or undetermined level of confidence.

Second, an overabundance of data in relation to the time and tools available can place a severe burden on a safety manager trying to sort through it all and have it make any sense. Effectively, there is so much information that the safety manager may suffer from what I call "data delirium." Conversely, the third problem – a scarcity of data – may not allow management to make actionable decisions because it is unclear whether the data represent reality. This article will address each of these potential problems and offer practical solutions.

Data Basics

Data can be obtained quantitatively (by focusing on raw numbers), qualitatively (by interpreting text in narrative reports) or a combination of both. Quantitative data are relatively easy to analyze using descriptive and inferential statistics. An example of descriptive analysis of quantitative data is dividing total accidents by a number representing risk exposure (such as total departures) to determine, for example, the accident rate per 100,000 departures in a particular geographic region. This type of data provides useful metrics for comparisons but does not tell us much about the actual accidents.

Qualitative analysis of texts, though more unwieldy, time-consuming and potentially subjective, can provide a much more robust understanding of a construct within the accidents under study. An example of qualitative data use is a brainstorming session directed at identifying airside hazards (e.g., producing a preliminary hazard list). A combination of both methods will offer a much more complete picture of the construct(s) under study.

One data collection instrument that incorporates both methods is the survey. Surveys often use short statements that collect data quantitatively through the use of a Likert scale (a scale typically ranging from 1 to 5, each number representing the strength of the respondent's opinion or attitude toward the corresponding statement). For each statement, there also may be a text area where qualitative data can be collected. This allows the respondent not only to provide the numerical score for an opinion or attitude about each statement, but also to expound on each numerical response with a short explanation. Regardless of how data are collected, the GIGO principle must be considered for quality control. One of the biggest challenges of collecting data is assuring that the data are valid (measuring what they purport to be measuring) and reliable (consistent when measuring the same thing). Scientific research methodology applied to aviation safety shares theories, statistical concepts and specialized terminology with other fields. Plenty of courses, websites and college textbooks offer further explanations.

Here are a few examples of how GIGO might affect your data. In the first example, let us say an airline conducts a LOSA (a spoke in the SMS hub). LOSA data collection consists of trained observers, riding in the cockpit jumpseat, who fill out quantitative and qualitative checklists related to observed crew performance. Although an observation of every single flight would be highly beneficial, it would obviously not be very practical.

Thus, LOSA observations require a series of flights as a sample of the entire flight operation. A sample should, in theory, very closely resemble the overall flight operation including the flights not observed. But what if the sample has been designed incorrectly and therefore does not truly represent the entire flight operation, for example, if the sample is too small? What if the observers are not properly trained or calibrated – calibration meaning they have standardized criteria so that there is inter-rater reliability among observers when recording threats, errors and undesired aircraft states. What if the observations are heavily skewed toward one particular fleet or route?

Once the LOSA is completed, does the airline have a valid and reliable picture of the entire operation? Probably not.

LOSA data, like any kind of data with safety implications, may require a significant allocation of financial and human resources. If management does not believe your data, it is unlikely that you will be approved for those resources.

For the second example, let us use a survey to understand the GIGO principle. The safety manager at a major airport wants to measure employee morale. Morale can have a very significant impact on safety, because employees with low morale may not be motivated to work as safely as possible.

So the safety manager creates a survey using statements that she feels would adequately measure employee attitudes about morale. The survey presents five statements and incorporates a Likert scale (1 – strongly agree, 2 – agree, 3 – neutral, 4 – disagree, 5 – strongly disagree). The statements are worded as follows:

1. *Management is never on the same sheet of paper.*
2. *Low morale seems to be the norm around here.*
3. *I think low morale is correlated with low self-esteem.*
4. *Everyone I work with is unhappy most of the time.*
5. *They don't pay me enough to motivate me*.

The safety manager emails a survey link to all airport employees, including contractors (approximately 1,200 total people) and makes the survey available online for 14 days. Upon completion of the data collection period, there are 100 responses and the safety manager emphatically declares that the results are conclusive: Employees are suffering from low morale. But could the results have been affected by the GIGO principle? Yes, and here are a few reasons why:

Although short surveys are well received, these five statements do not adequately address the full dimensions of a construct such as morale. The statements are not based on an accepted definition of the construct being studied, but are based on the safety manager's own definition of morale. A review of the extant research literature should be conducted to operationally define the research constructs (or variables).

The statements include a *neutral* point. There are mixed opinions about the use of a neutral point. The problem is that respondents use the neutral point as a "safe zone" if they are uncomfortable expressing their genuine feelings, even anonymously. Too many of these neutral answers can work against the purpose of the survey, which is to measure attitudes and opinions about the construct being studied. Some argue that everyone really has an opinion, even if he or she would prefer not to reveal it to the researcher.

All of the statements are negatively worded. When all statements have a positive or negative value, it can influence respondents to choose the same response for each. This is called the "straight-line effect."

The actual wording of some of the statements is problematic:

- **Management is never on the same sheet of paper.** Ambiguous. Does this mean lack of agreement or coordination among management personnel, or between management and line employees? Do all respondents understand the expression "on the same sheet of paper"?

- **I think low morale is correlated with low self-esteem.** Confusing. The respondent may not know how to define

low morale and low self-esteem. Additionally, some respondents may not understand the definition of *correlated*. This can become more problematic when English is not the respondent's first language.

- **Everyone I work with is unhappy most of the time.** Double-barrel statement involving two criteria. One could be true, the other not. The two problematic words are *everyone* and *most*.

- **They don't pay me enough to motivate me.** A leading question that could suggest a particular answer. Also, this statement has a strong bias, and the word *they* can be ambiguous.

There are problems with the methodology, including:

- **The inclusion of contractors.** Contractors may not be airport employees and thus may come from a very different culture at their own organizations. Contractor responses can skew the results of the resident airport's own personnel.

- **The time allocated for data collection.** Two weeks is insufficient to collect a large number of responses. A better collection period would have been four weeks. After two weeks, a reminder email should have been sent out.

- **Low response rate.** Although response rates for surveys are typically low (in the 20–30 percent range), 8 percent was exceptionally low. This response rate can have implications for the sample, as was discussed earlier. Does this sample adequately represent the other 92 percent of the airport population? Was there something different about the employees who participated in the survey compared with those who did not? Are the results statistically significant (i.e., capable of being extrapolated to the larger population)? Would the results have been different if all 1,200 people had answered the survey?

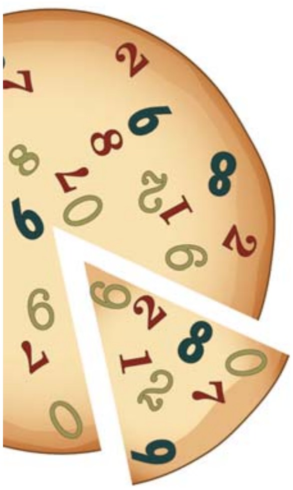
This was not a very well developed survey and its distribution was problematic (garbage in). Thus, the safety manager may have come to a false conclusion based on the results (garbage out). It would be hard to sell to management on allocating resources to the problem.

Data Excess

An overabundance of data can become so burdensome that the safety manager may suffer from data delirium. Some safety managers have complained that, while their SMS is a welcome hub for their company's safety processes, paradoxically, sometimes they do not know what to do with all their data. The problem may not be poor data management, but rather a shortage of human resources. Or perhaps the staffing is adequate, but there is so much irrelevant data that it is tying up those limited resources. Whatever the case, I offer the following recommendations.

If the problem is a shortage of human resources, the obvious solution would be to hire more people to assist with data analysis. That may not be feasible these days, where lean is the corporate modus operandi. If there is a legitimate need for additional help, consider a temporary service or a college student intern. Interns are invaluable resources, especially if their study has included research methods and data analysis.

If the staffing is sufficient, but an overabundance of irrelevant data is the issue, then it would be worth taking a look at all the data sources and considering the use of data filters. Which incoming data are relevant and which are not? Prioritize the most-need-to-know data. This does not mean that the other data are irrelevant or useless, just that they will be lower priority.



Are you simply collecting too much data? As a qualitative example, there was a safety manager at an airline who insisted on posting on a bulletin board U.S. National Transportation Safety Board (NTSB) accident reports for operationally similar airlines and environments. That seemed a great idea. However, what he posted was the entire accident report (sometimes hundreds of pages). Pilots are busy. You cannot expect them to read through a complete accident report. This is a case of too much data. A better approach would be to post the NTSB accident summary, a "Causal Factors" story from AeroSafety World or, if those are not available, only the most important points, especially causal factors.

Data overload also can be quantitative or qualitative. For example, as part of its new SMS, an airline began collecting narrative hazard reports from its large workforce. Before the SMS existed, there were few, if any, reports submitted. For the first year of the SMS, the airline received only 26 hazard reports. Due to the low reporting, the airline, in the second year, decided to put much more emphasis on hazard reporting. In the second year, there was a precipitous spike in reports (267). The safety manger was overwhelmed and was not able to process all the reports, and a large percentage of those reports contained "sneak peek" information – an inside look at the hazards. In this example, the quantitative data were the number of reports received (measurable and comparable), while the qualitative data were the sneak peeks (textual descriptions of hazards). Because of this data overload, reporters quickly lost trust in the system because their reports were not acknowledged. Hence, managing hazard reports should be given high priority.

Data Shortage

Many times, safety managers and upper management do not see eye to eye about safety expenditures. It is frustrating when upper management disapproves requests to spend financial resources for a safety improvement that you know is needed. This may be due, in part, to the safety manager not having cost-benefit justification for requests. It happens all the time, and because of this, safety may have to be thought of as a "case" or "argument," to persuade management to approve the allocation. You are misled if you think you will be able to walk into the CEO's office and get a quick sign-off on your new safety equipment request simply because you are a good salesperson. The question, then, is why might an astute safety manager lack the necessary data to present a logical case to management?

First, it may be the result of simply not knowing how to mine data. Choosing the right methodology to collect and analyze data (while avoiding GIGO) is imperative. To start, you must ask yourself what type of data you need to collect. Will they be numbers (quantitative), words (qualitative), or both? Will you be collecting data from the entire workforce or a sample? What types of data collection instrument will be used (questionnaires, surveys, test scores, interviews, focus groups, etc.)?

Once the data are collected, how will they be analyzed? Will your quantitative analysis use basic descriptive statistics (which represent a specific study group only) or inferential statistics (which can be generalized to the broader population)? What type of software will you use for the analysis? A standard spreadsheet program will work fine in most cases, but for more complex statistical analyses, you may need a program with more specialized functions.

For qualitative data, how will you sort through the hundreds or thousands of pages of text? Some software programs simplify this process by categorizing responses with keywords. Data collection is a structured process that requires good planning, a proven methodology and effective time management to yield valid results.

Second, the safety manager may not think that data need to be mined. Quite often, people use unstructured, personal observations as data sources. They develop a hunch about something and then try to sell it to management as a verified issue. While this method makes data collection simple, it has little value.

For example, the other day, a ramp worker at a major airport passed by a large paper cup on the apron. He noticed it but did not pick it up. Is that conclusive evidence that lack of foreign object debris awareness or a prevention problem prevails among all or many ramp personnel? Certainly not. But it does lend itself to a hypothesis, which can be tested, and for which the results can be presented to management as a basis for any interventions that might be required.

Third, good data may exist, but the safety manager chooses to ignore them. For example, an airport safety manager is collecting bird strike data as part of a new wildlife risk mitigation program. The manager is comparing bird strike data from before the implementation of the mitigation program (pre-measure) with data from after the implementation (post-measure). However, the data are not incorporated with study results (or data) from other, similar airports that have implemented a similar program. External data are very important not only for reference and comparison but also for benchmarking purposes. Think of it in two ways, "How are we doing?" and "How are we doing compared with other airports?" Use safety metrics to set objectives, goals and targets. Do not ignore relevant, easily obtainable data.

Data delirium can be treated, and the treatment is usually successful!

Robert I. Baron, Ph.D., is president and chief consultant of The Aviation Consulting Group. He has more than 25 years of experience in the aviation industry. His specializations include human factors, SMS, crew resource management and LOSA training/program development for aviation organizations worldwide.

Reprinted from AeroSafety World Magazine October 2013.

The broader use of AAIB accident investigation reports

By Mark Gammon, Senior Legal Executive, Holman Fenwick Willan LLP

The admissibility of an accident report published by the Air Accidents Investigation Branch of the UK Department for Transport ("the AAIB") in civil proceedings in England and Wales has long been a grey area, but until recently there was no reported decision, on any contested issue, giving any direction one way or the other. For those who represent aircraft operators and other organisations in the aviation industry, there has traditionally been an acceptance that accident investigation reports are not admissible in civil proceedings, although, unlike in the United States, there is no legislation or regulation which prohibits this use. Why, therefore, have the courts not been troubled previously with the argument that such a report is inadmissible?

The background lies in the legal framework which grants the AAIB the power to investigate accidents and incidents and the remit of this function. The AAIB's powers are set out in the Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996, which implement the EU obligations of the UK under Council Directive 94/56/EC (now superseded) to carry out Annex 13 to the Convention on International Civil Aviation (the 'Chicago Convention'). EU Regulation No 996/2010 contains the provisions for air accident investigations which operate in Member States.

The role of the AAIB is to investigate the cause of aircraft accidents from a safety perspective. Importantly, its role is not to apportion blame or liability. With that remit in mind, it is perhaps unsurprising that the AAIB's investigators must have access to the aircraft, its components and wreckage after a reported accident or incident and, importantly, an ability to take statements from witnesses, without impediment, as part of the gathering of evidence to determine the cause. What use then can subsequently be made of this factual enquiry, by a party seeking to rely on the published accident report in civil proceedings in England and Wales?

This question arose in a recent application before the High Court of Justice fin Rogers v Hoyle [2013] EWHC 1409, where the Court considered whether an AAIB report, published in relation to a fatal aircraft accident on 15 May 2011, constituted inadmissible opinion evidence. That opinion evidence was argued to extend to all findings of fact in the AAIB report and, as such, it was argued that the report should be excluded from the proceedings before the Court on the substantive dispute between the parties.

In an interesting and, perhaps, controversial decision, the Court concluded that the AAIB report was admissible as evidence in civil proceedings, and that it is for the Court to determine what weight should be given to the contents of the report. It did so having considered the relevance of the evidence contained in the AAIB report and, in particular, the evidence of the pilot and the eye witnesses in relation to the manner in which the aircraft was seen to be flown before it entered a spin, and the evidence of the AAIB's investigators on technical aspects. The Court was persuaded that statements made to experienced AAIB accident investigators during the course of their investigations had the advantage of immediacy and so could be regarded as more reliable than a recollection at trial, which may not take place until several years after the accident.

That is difficult to dispute, but where the AAIB report does not identify the person to whom any factual statement is attributed and, where the report is in a form to draw attention to particular issues and recommendations for safety purposes, it necessarily comprises analysis and discretion from the AAIB's perspective as to what is relevant for the accident report. The view taken by the Court is that evidential interrogation lends itself to the question of weight rather than admissibility, which reflects the position that it is for the Court hearing the evidence at trial to determine whether the evidence is persuasive and should be taken into account. The Court can accept or ignore that evidence, but the concern is that evidence which cannot be tested, for example by cross-examining the witness, will be accepted without further scrutiny.

There is a distinction between expert evidence, where the person giving evidence has specialist skill and knowledge of particular facts on which to give an opinion, and an opinion of a person who is not placed to give such evidence. The general rule is that opinion evidence is not admissible. What then is the status of the evidence in relation to issues of fact contained in the AAIB report, where those facts are derived from interviews of eye witnesses and others?

It was argued that findings of fact in the AAIB report are statements of opinion. However the Court was not persuaded that evidence of fact in the AAIB report should be excluded because it could not be considered reliable or capable of being tested. While the Court accepted that the AAIB report contains conclusions on the basis of inferences drawn from facts made available to the investigators, with such inferences falling into the category of opinion evidence, the AAIB was recognised as having a particular role that any expressions of opinion were informed and based on knowledge and experience. As such, the Court considered the AAIB report to be admissible and it was for the trial judge to determine what weight to give to the evidence in the report.

This is a departure from the way in which the role of the AAIB and the AAIB reports tend to be regarded by the aviation community and their legal advisers, and this decision potentially challenges the landscape hitherto understood and respected. One potential consequence of this decision is that the AAIB may now have one eye on their reports having a broader purpose.

The Secretary of State for transport is currently appealing this decision on behalf of the AAIB.

Follow the Fuel

Rick Adams investigates training for offshore helicopter operations

There's a new dynamic driving helicopter pilot training, and a new geography of locations with names you've probably never heard before. The Santos Basin off the coast of Brazil, the Kizomba field in the Atlantic Ocean east of Angola, the KG-D6 block in India's Bay of Bengal. Jansz, Sleipner, Tamar, Walker Ridge, Gumusut-Kakap, Dunquin Prospect.

These are deepwater or ultra-deepwater sites where energy companies are drilling for oil and natural gas deposits. Seismic engineers casually toss around terms like "Turonian stratigraphic" and "turbidites" that mean nothing to aviators but everything to companies such as ExxonMobil, Shell, BP, Chevron, Total, Anadarko, Hess and others who bet billions on drilling rigs, pipelines, regulatory filings, political risks, environmental challenges, and services contracts such as ferrying workers to the platforms at sea.

In recent years, deepwater (defined generally as more than 400 metres depth) has become the predominant source of new oil and liquid natural gas discoveries. It's less than 10% of production currently, but nearly two-thirds of discovered deepwater reserves are yet to be exploited. And the average hydrocarbon discovery is considerably larger beyond the continental shelf. That suggests a great deal of deepwater activity in the coming decades. And the activity is literally everywhere around the globe: South America (about one-quarter of current capital expenditures), the Falkland Islands, East Africa, the North Atlantic near Ireland, the North Sea between Scotland and Norway, the Mediterranean near Libya and Israel, Australasia, even the inland Caspian Sea. Industry datakeeper Infield keeps tabs on more than 900 offshore fields.

The S92 recently passed 500,000 hours in service, more than 90% of that in the offshore configuration. Image credit: CHC Helicopter.

Long-Range Requirements

With oil and gas rigs moving further offshore, it is also changing the requirements for the helicopters which are the primary means of shuttling rig workers to and from the production platforms. Some newer deepwater rigs are more than 200 nautical miles out, and there's no alternate landing field in between. If the rig helideck is fouled for any reason, the helicopter must be able to return to shore on whatever fuel is left in the tanks. And with as many as 150 workers rotating on and off each rig regularly, it makes economic sense to transport as many as possible with each trip. So energy company flight departments and helicopter services operators are building up their fleets of longer-range rotorcraft with capacities to carry 15-20 passengers.

That means new-generation helicopters such as Sikorsky's S92, which can traverse up to 430 nm fully loaded with 19 passengers, or the Eurocopter EC225 Super Puma, also good for 19 passengers up to 452 nm. Other helicopters such as Sikorsky's S76 or AgustaWestland's new AW189 may reach the furthest rigs but not necessarily with as large a passenger load. The Sikorsky S61 can seat 21 but is more limited in range.

The 13-tonne heavy-lift S92 recently passed 500,000 hours in service, more than 90% of that in the offshore configuration and 54% of that currently in the North Sea. It is part of the fleets of the industry's largest operators, including Avincus/Bond (two in service, 14 on order), Bristow (49 aircraft with 18 on order and options for 16 more), CHC (37), Cougar, ERA Group, Lider Aviacao in Brazil, PHI (24), and China Southern Airlines.

Eurocopter has deployed more than 900 of the 11-tonne EC225 Super Pumas across 52 countries and logged more than four million hours. However, a pair of ditching incidents last May and October led to grounding of the fleet by Bristow, CHC and Bond. In April, Eurocopter announced an interim fix for the main gearbox issue that should have the EC225s flying again by this fall.

One telltale sign of the future promise of offshore helicopter demand: high-profile investors Michael Dell (Dell Computers) and George Soros (Quantum Strategic Partners) have pumped millions into Waypoint, a helicopter leasing venture launched two years ago by former ERA Helicopter executive Ed Washecka. Waypoint plans to build a fleet of 65 aircraft, "aimed at meeting fast-growing demand for helicopters to ferry workers to and from offshore oil and gas platforms," according to the Financial Times.

Safety Quest Status

Seven years ago, the global helicopter industry set an ambitious goal of reducing rotorcraft accidents by 80 percent by 2016. The results thus far are a mixed bag. The 2011 trendline (the most recent available) of 5.7 accidents per 100,000 flight hours is better than the 2001-2005 baseline of 9.4, but still well short of the 1.9 target. Commercial airlines by comparison are far less than 1 percent, and the Flight Safety Foundation reported 2012 was the safest airline year since 1945.

According to the International Helicopter Safety Team (IHST), North America (from 9.3 to 3.7), Europe (from 7.1 to 4.8), Africa (from 12.9 to 2.0) and Middle East (from 3.2 to 1.5) helicopter statistics are improving; South America (from 9.7 to 12.8), Asia (from 9.4 to 10.4) and Oceania (from 17.5 to 18.0) are regressing.

One technical improvement which has enhanced safety in the US is Automatic Dependent Surveillance Broadcast (ADS-B), introduced in the Gulf of Mexico in late 2009. Prior to ADS-B, in the absence of offshore radar, air traffic controllers could not see helicopters transiting to oil and gas rigs. They had to rely on estimated positions from relayed reports. The Gulf was divided into 20-mile grids, and only one helicopter at a time was permitted in each grid.

ADS-B uses global positioning satellites (GPS) to provide precise positions both to controllers and other aircraft. Separation minimums have been reduced to five miles between aircraft. Most important, pilots can receive upto- date weather information for their destination platform.

Not only were there no weatherrelated US offshore helicopter crashes from 2009-2012, the improved navigation capability of ADS-B will enable quicker evacuation in the event of rig emergencies.

Sikorsky has just received FAA approval for a new automated "rig approach" option for S92 helicopters which is said to reduce the pilot cockpit workload by 60 percent and allows safer instrument approach operations in challenging weather conditions.

Worldwide, there are an estimated 1,700 helicopters serving the oil and gas market. In the Gulf of Mexico alone there are between 5,000 and 10,000 helicopter flights a day to nearly 4,000 platforms.

Training/instruction is traditionally one of the highest categories of helicopter accidents. In Europe, from 2007 to 2011, 18 percent of accidents occurred during flight training, according to the European Helicopter Safety Team (EHEST). This is similar to percentages in North America in analyses conducted in 2000. Nearly half (44 percent) of the training accidents are during the approach and landing phases with the main causes identified as dynamic roll over and autorotations.

In March, EHEST issued a new "Risk Management in Training" guide which focuses on top safety issues, and features a safety risk matrix and the ICAO SHELL model (Software, Hardware, Environment and Liveware) with an engine off landing (autorotation) example.

One reason instruction/training continues to rank high on the accident list is because the majority of helicopter training is conducted in an aircraft, particularly in single-engine helicopters. If the same training were conducted in the complete safety of a flight simulator, those accidents would be eliminated. However, since there are no regulatory type-rating requirements for light helicopter simulators, their availability and use in student training is limited.

Flight training devices (FTDs) and flight navigation and procedures trainers (FNPT) for helicopters such as the Robinson R-22 or Bell 206 are available from several manufacturers, most notably Frasca International and Flyit in the US and QinetiQ's cueSim and Helicopter Simulators Limited in the UK. Many of the current devices include relatively sophisticated visual systems, thus replicating everything except the helicopter's motion and vibration.

New-Gen Helo Sim Expansion

Helicopter training providers have been gearing up to meet the heavy-lift demand. FlightSafety International (FSI) has S92 full flight simulators (FFSs) in operation at their Farnborough, UK; West Palm Beach, Florida, US; and Lafayette, Louisiana, US centres. In March, Sikorsky and FSI announced orders for four more S92 FFSs – to be positioned in Lafayette, Brazil, Norway and Southeast Asia.

FSIs Steve Phillips, VP Communications, said the VITAL X visual system on the simulators includes scenes for offshore operations, as well as a comprehensive model of New York City for executive transport missions and imagery for emergency medical scenarios. "The visual system is optimized for training low-level flight operations, offers increased scene content, vastly improved weather features, and enhanced levels of detail for optimum cueing."

FlightSafety has implemented glass mirror displays following their 2009 acquisition of Glass Mountain Optics. "Glass mirror displays provide superior optical performance, sharper image clarity, long term reliability, and are night-vision capable. The true collimated images they present are free of visible distortions and artifacts out to mirror edge and 'ground rush' distortion in the bottom field of view," Phillips stated.

CAE announced early last year that it will deploy S92 training in Stavanger, Norway and Sao Paulo, Brazil, and Eurocopter EC-225 training in Sao Paulo by early 2014. The CAE 3000 Series S-92 / EC-225 simulator in Sao Paulo will incorporate a "mothership" with interchangeable cockpits. CAE will offer Simfinity e-learning solutions for both aircraft types, optimising student time at the training centre.

CAE's new helicopter simulator uses a direct projection display. "The main training advantages of direct projection are greatly improved height and speed cues in close to the surface ground and water operations," said Rob Lewis, CAE's Vice President and General Manager, Business Aviation, Helicopter and Maintenance Training. "Maneuvers requiring a high degree of visual accuracy, such as helideck and ship landings, ditching scenarios, and touchdown autorotations can be trained with

Sikorsky and Flightsafety International will deploy new S92 flight simulators in Norway, Brazil, Southeast Asia and the US Gulf Coast. Image credit: FlightSafety International.

Frasca-built S76 flight simulator. Image credit: Frasca International.

greater fidelity by direct projection visuals. CAE came to the conclusion that a large FOV would be a key element to providing enhanced helicopter flight training, and we designed our new 3000 Series helicopter flight simulator with a dome display to meet this need."

Eurocopter offers an EC225 FFS, built by Thales (now part of L-3 Link Simulation & Training), at its Helisim Training Academy adjacent to the Marseille-Provence International Airport on France's southern coast. The Level D device features a 200-degree horizontal by 60-degree vertical field of view visual.

In Aberdeen, Scotland, home to Europe's busiest heliport, Eurocopter has an EC225 FFS with a 210-degree by +30/-50 display. The database includes key offshore operating locations such as the North Sea's Andrew and Miller platforms, along with the CSSO Wellservicer diving support ship. Installed in 2011, the simulator is certified by UK, Canadian, Brazilian and Malaysian authorities.

Eurocopter's Malaysia Training Centre recently installed the first EC225 FFS in Southeast Asia.

Helicópteros do Brasil S.A., or Helibras, a Brazil-based, Eurocopter-owned helicopter manufacturer, announced in April they will build a new training centre in Rio de Janeiro with a combination simulator for the civil EC225 and military EC725 variants.

Frasca International has delivered two Level B EC225 simulators to Bristow in Aberdeen, as well as an S92 device. The Frasca TruVision visual provides a 220 x 60 field of view.

Counting all high-end flight simulators serving the civil helicopter market, the number of training devices available has risen from about a dozen only three to five years ago to more than 60 expected by next year. Other popular models replicated include AgustaWestland's AW139, Bell Helicopter's 412, Eurocopter's AS350 and EC135, and Sikorsky's S61 and S76.

De Facto Training Standards

With so much investment at stake, the International Oil & Gas Producers Association (known as OGP) has been driving the safety standards for pilot training – much more so than government regulators – and has become the de facto global standard bearer.

The OGP is well familiar with the benefits of simulation, applying "digital oilfield" physics-based engineering models to improve processes, monitor operations, manage assets, and even integrate advanced sensors into drilling and production to provide real-time data. They also use simulated training for maritime support vessels and undersea robotics.

No surprise, then, that the OGP aviation safety subcommittee are strong advocates for flight simulators. They conducted a landmark safety review in 2000, as well as annual industry safety performance audits. And the committee's aviation operations management guidelines, first published in 2008 and updated in 2011, recommend, "Flight crew training should be conducted in a synthetic training device (STD) that replicates the model of aircraft being flown as closely as possible. It is preferred that the device be full motion with a visual screen that provides forward and peripheral imaging." Recurrent training for pilots is suggested at least every 24 months, and every 12 months is preferred, with an emphasis on cockpit resource management (CRM).

The OGP has also provided members with the Aviation Safety Assessment Mechanism used by airlines, encouraging operators to routinely collect data and apply the scoring formula as a best practice.

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Cargo security benefits derived from e-freight

by Frederic Leger, Head of Cargo Business Process & Standards at IATA

The International Air Transport Association (IATA) has a long history of developing standards for the air transport industry in order to improve safety, security and efficiency. IATA worked closely with ICAO in the late 1970s to develop the initial Technical Instructions for the Safe Transport of Dangerous Goods by Air, which drew from the contents of the IATA Restricted Articles Regulations. Today, IATA standards cover the security, safety, operational and technical aspects of transporting cargo, as well as the carriage of special cargoes such as live animals, perishables and temperature-controlled shipments.

One of the flagship projects of IATA over the last few years has been e-freight, which aims to remove the paper from the air freight supply chain from origin to destination in order to improve both efficiency and security. Increasing numbers of regulators are requesting electronic data so that they can assess the risk related to cargo and identify consignments that may be classified as high risk.

They are also looking to provide an audit trail of who secures what cargo how and when, as all cargo loaded on-board an aircraft must be screened by secure operators. e-freight can offer significant advantages in these areas.

However, e-freight is an extremely complex set of interconnecting tools and processes, requiring close cooperation between a diverse set of industry stakeholders. Implementing e-freight is proving a significant challenge. New momentum has been achieved, however, by the endorsement by the Global Air Cargo Advisory Group (GACAG) of a threepillar action plan for e-freight for the next three years. To date, e-freight is already implemented in 47 countries and at 462 airports, translating into 4,275 trade lanes. The commitment is to have e-freight fully implemented by the end of 2015.

The first pillar is to ensure that States ratify the international treaty "Montreal Convention 99" which allows for regulators of all States to support the processing of a cargo shipment without the need to produce paper for each and every shipment. Of course, paper can be requested by the regulators, e.g. in the event of an examination, but in such cases, regulators should accept a print-out of the electronic record. Under this pillar, industry and States, as well as international organizations such as ICAO, the World Customs Organization (WCO) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), need to work closely together in order to find the most appropriate solutions following international standards (e.g. ICAO Annex 17 – Security and Annex 9 – Facilitation, WCO Revised Kyoto Convention, WCO Safe Framework).

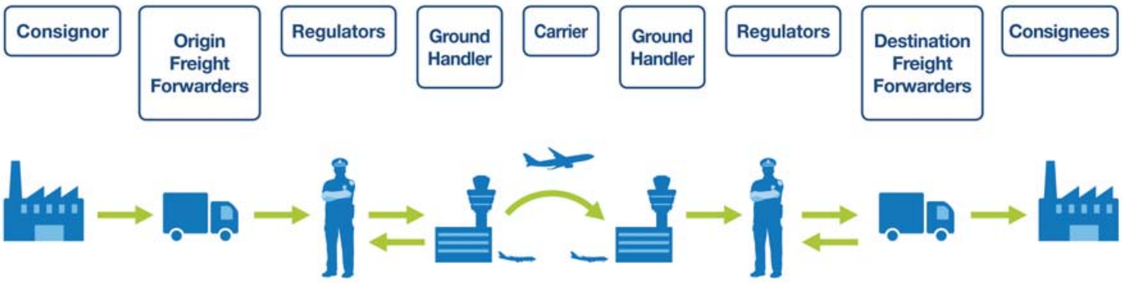
e-freight aims to remove the paper from the air freight supply chain from origin to destination in order to improve both efficiency and security.

The second pillar is to ensure that industry stakeholders remove the core transportation documents at source and replace them with electronic messages following internal standards such as Cargo-IMP (Interchange Message Procedures) or Cargo-XML (extensible Markup Language).

Of course, the most critical document is the air waybill (AWB), which is the contract of carriage between the carrier and the shipper, where the freight forwarder very often acts as a shipper. The electronic AWB (e-AWB) is equivalent to the paper AWB that has been used by the industry for many years. IATA and its airline members, as well as the International Federation of Freight Forwarders Associations (FIATA), are committed to introducing the e-AWB as the first step toward the e-freight vision, with the goal of achieving 100 per cent implementation by the end of 2015.

The House Manifest is also a critical document to be removed as it contains detailed information for each and every house waybill, which is included in a master air waybill, and such information is very often used by the carriers to file advance electronic information to the regulators.

Finally, the paper Consignment Security Declaration (CSD) that ascertains the cargo was secured prior to being loaded onto an aircraft is also a critical document. Today, each airline in every country asks freight forwarders



Building and implementing an end-to-end paperless transportation process where air cargo paper documents are replaced with the exchange of electronic data.

to complete a specific template of the paper Security Declaration, which introduces the risk of errors, non-compliance and fraud, as well as inefficiencies. An electronic version of the Consignment Security Declaration falls within the scope of the second pillar of the e-freight project.

The third pillar focuses on the removal of commercial documents, for example, the invoice or packing list, which are delivered to the airlines in a pouch, i.e. a sealed envelope that accompanies the shipment from origin to destination. The information in these paper documents is critical for proper risk assessment, as the contents information therein comes from the seller of the goods. It therefore contains detailed data from the source, including the buyer and seller, as well as descriptions of the products sold and transported. Under e-freight, the goal is that information will be submitted electronically from the source and then shared in a secured manner between the stakeholders along the supply chain, avoiding manual data entry and re-keying of information based on paper photocopies, which may introduce errors.

Why are the electronic air waybill and electronic House Manifest important for security?

The air waybill and the House Manifest are not primarily security-related documents. However, the e-AWB and e-House Manifest initiatives support and enhance security.

The data on these paper documents is very often used to support risk assessment and the information from these documents serves as the basis of the transmission of advance electronic information to regulators.

When data is transmitted electronically the information becomes available much earlier in the transportation process, as the e-AWB data can be available before the cargo arrives or, in some cases, even before cargo leaves the origin airport.

Furthermore, these are considered as supporting documents in the event that an examination is required and paper documents can be printed from electronic records, when requested.

The more industry stakeholders who submit data electronically as part of e-freight, the better it is for the regulators who are performing the risk assessment.

Why is the electronic Consignment Security Declaration important for security?

Many regulators request that air cargo stakeholders provide an audit trail of who secured what consignment, as well as how and when it was secured.

In the paper world, this is managed by additional security information that can be documented on the paper AWB, including the use of codes indicating the security status of the consignment.

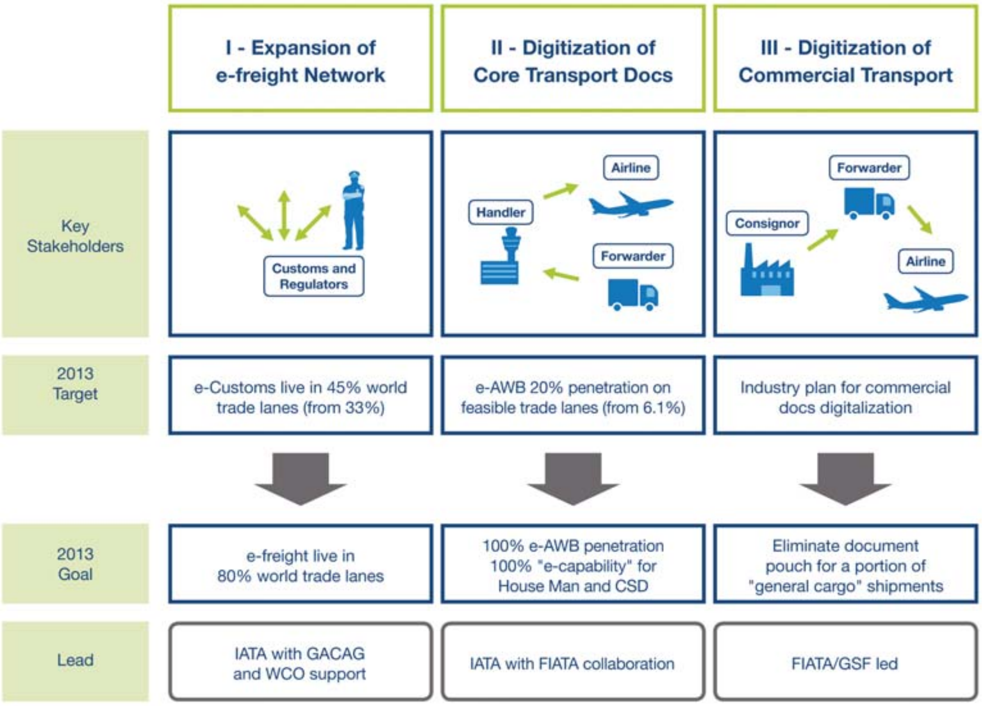
There is already a lot of information included in the AWB, and including additional security information in a document that is not standardized for that purpose is not the best practice.

In some other cases, airlines may request freight forwarders to provide their own version of the paper Cargo Security Declaration, which may increase the risk of non-compliance and impact the efficiency of air transport.

To transmit the security information in a standard manner, as part of the e-freight initiative, IATA, together with industry and regulators, developed the standard electronic Consignment Security Declaration (e-CSD). This provides an audit trail of the security information contained in a typical supply chain movement. It assures that security measures have been applied through a harmonized mechanism of data, and a standard CSD layout in case regulators require it to be printed.

This standard CSD was developed in cooperation with airlines, freight forwarders, ground handling agents, regulators and international organizations.

Recently, the ICAO Working Group on Air Cargo Security (WGACS) agreed on an enhanced standard layout for the CSD that includes additional security information (e.g. origin and destination) which is critical for security-risk assessment. At the same time, IATA and ICAO aligned their CSD forms and agreed on a format that can be used electronically. ICAO also updated its Aviation Security Manual (ICAO Doc 8973—Restricted), which guides States on implementing ICAO Annex 17 - Security, by incorporating the security declaration layout and instructions on how to complete the form.



The e-freight three pillar roadmap.

The standard e-CSD is an integral part of the e-freight programme. However, in various countries, it is increasingly implemented as a stand-alone solution.

Electronic consignment security declaration (e-CSD) proofs of concept have been successfully completed in the U.K., the Netherlands, Germany and Switzerland, involving freight forwarders, ground handlers, airlines, IT service providers and regulators.

Other proofs of concept have been launched in a number of countries worldwide, such as France, Luxembourg, Canada, Singapore and South Africa.

As a result, many airlines are planning to roll out the e-CSD in the coming months.

Several parties have made the choice to implement both e-AWB and e-CSD under their own e-freight project, which is advantageous because their data can be processed automatically. Compliance is improved through harmonization and by avoiding the inefficiencies of archiving paper documents.

Why is the Message Improvement Programme (MIP) Important for Security?

e-freight is a common agenda item on which regulators and industry need to collaborate for mutual benefit. The increasing number of stakeholders that are joining e-freight will certainly serve the interest of regulators to receive high-quality data on a systematic basis, at the level of detail they require to perform appropriate risk assessment in order to improve security. This critical objective is also shared by the entire air cargo industry.

The quality of the data received from the freight forwarders is therefore pivotal in achieving the required outcomes, as accurate information will avoid unnecessary shipment delays and impact cargo risk assessments. IATA has a programme whereby quality of data is being monitored and the Organization works with the air cargo community to address data error issues at their source.

More information can be found at:

www.iata.org/cargosecurity,
www.iata.org/e-awb
www.iata.org/e-freight and
www.iata.org/mip

Questions can be addressed to:
cargo@iata.org

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Modelling the atmosphere

by Dr Helen Wells

The Met Office works across all areas of the aviation industry to help ensure safe and efficient operations. Dr Helen Wells, Manager of the Aviation Meteorology Research and Development Team at the Met Office, provides an overview of the services provided.

The Met Office provides a wide range of services which include specialist websites, forecaster telephone and on-site consultancy and high-resolution data services to name just a few. These services are tailored to meet the needs of various users so that they have the most accurate information relevant to supporting their weather-dependant decision making, and adding further value by simplifying the interpretation of meteorological conditions and their impact on airport, aircraft and air traffic management operations.

To provide accurate forecasts we first need quality observations from around the world which can be fed into our supercomputers using a Numerical Weather Prediction (NWP) model. This uses well established physical equations to produce a forecast for our atmosphere for up to 30 days ahead.

Around 500,000 observations from all over the world are received at our headquarters in Exeter, UK every day from land observation stations, including airfields, ocean drifters and buoys, aircraft themselves, satellites and radar. This data is the starting point from which the Met Office is able to produce the detailed forecasts that our numerous customers rely on.

Accurate forecasting

The Met Office uses an IBM Supercomputer to assimilate all the incoming data and provide a range of forecasts. The supercomputer was upgraded in 2012 and is now capable of 1,200 trillion calculations per second. This means that we can look at NWP output at increasing resolutions and shorter timescales.

One of the major advances in the last year has been the operational use of the UKV model, which is a version of the Met Office Unified Model that uses a resolution of 1.5km. This gives improved forecasts of small scale weather phenomenon, such as fog filling valleys, enhanced rain over mountains and higher temperatures in cities. However, the main benefit is that we can better resolve convective showers or storms which, in extreme cases, can give rise to major flooding events or disruptive snow in winter.

All the processes, from data collection to modelling and then the production of several forecasts, operate 24 hours a day, 365 days a year and must be produced, quality controlled and issued across a wide range of channels to many different users. In addition, in many cases the forecasts must be delivered in accordance with strict deadlines. So despite the complexities, the production of the forecast is really just the start of a much broader process.

Products and services

Forecasts for the aviation industry are used in many areas and include the Met Office's international responsibilities as one of only two World Area Forecast Centres providing international forecasting services to meet Annex 3 of the ICAO Convention on Civil Aviation. This means we have to deliver global forecasts of upper-winds and temperatures for all flights throughout the world. This specialised information includes distributing global upper-wind and temperature data four times a day, along with significant weather data (SIGWX) charts for FL250 and above as well as operational meteorology (OPMET) TAFs, METARs and SIGMETs and enables operators to optimise safety and fuel consumption for their aircraft.

Also, in our role as the London Volcanic Ash Advisory Centre, the Met Office aids flight safety by providing reports and forecasts for the movement of volcanic ash plumes within our area of responsibility – the north east Atlantic.

In the UK, the Met Office also provides expert advice and guidance to the Civil Aviation Authority and NATS (the National Air Traffic Control Centre), including: gridded winds and temperatures for the assignment of Atlantic tracks, offshore helicopter forecasts, UK low-level weather charts up to FL100 and UK spot wind charts up to FL240 - all updated four times a day.

So what about our latest products and innovative services? To follow is a summary of the Met Office's unique products:

De-icing service

Our De-icing Service offers forecasts of aircraft icing conditions for airports worldwide.

The service also offers a tailored guide to holdover times and proactive alerts to ground staff to enable improved planning of de-icing operations and reduced departure delays. This provides a significant financial benefit (every minute of delay costs £50 according to the industry average), and ensures the safety of passengers and airport staff.

ClearFlight®

This online briefing service is designed for flight operators and dispatchers and helps to optimise operations through efficient planning and anticipation of weather-related delays at airports anywhere in the world up to five days ahead. Using clear global map viewing, ClearFlight® offers intuitive monitoring of current and forecast weather conditions around the world, allowing users to instantly highlight any potential problems and enabling them to plan operations and resources accordingly.

OpenRunway®

Similar to ClearFlight®, OpenRunway® is a onestop shop which provides essential aviation weather information, but designed especially for airport airside operations. It alerts users to current and forthcoming weather conditions at their airport, up to five days ahead, which enables operations teams to plan ahead to maximise operational efficiency and to help avoid weather-related delays.

The Clearflight® tracking service allows people to view their fleet and overlay current and forecast weather conditions

The Clearflight® tracking service with a temperature overlay

WeatherWindows

In recent years it has been established that, for many types of weather event, probabilistic forecasts can offer the most skilful forecast, rather than a more traditional 'yes/no' deterministic forecast. However, it can be difficult for the user to understand how to make decisions based on a selection of forecasts, especially when used to support a more deterministic approach.

The clearest way to understand a probabilistic approach is by the use of an ensemble forecast. Instead of running just a single forecast, the NWP computer model is run a number of times from slightly different starting conditions. The complete set of forecasts is referred to as the 'ensemble', and individual forecasts within it as 'ensemble members'. The output from the ensemble systems allows the uncertainty of the forecast to be quantified, and the risk of a particular weather event occurring can be assessed. This can aid decision-making for those who are sensitive to the occurrence of certain weather events, as it enables forecast guidance to be closely aligned to operating thresholds.

The Met Office's WeatherWindows service makes full use of ensemble forecasting, helping users to make confident weather-sensitive planning decisions up to 15 days ahead. It has been designed to build confidence into decision-making by using a risk-based approach. WeatherWindows automatically displays the best time periods for tasks to be carried out; allowing resources such as staff, materials and contractors to be scheduled effectively.

Airport Collaborative Decision Making (A-CDM)

The use of probabilistic (ensemble) forecasting has a particularly important role

Three-panel view of the OpenRunway® service. Customers are given a viewing preference for each panel

to play when coping with adverse weather conditions within an A-CDM environment.

Critical to the success of A-CDM is that airlines, ground handlers, airport airside operations, air traffic management agencies such as NATS and EUROCONTROL, and emergency responders are able to access the same data creating a 'single view of reality' This is a situation that can be very different at airports that have not adopted A-CDM, where many parties base decisions on multiple sources of information.

As adverse weather is one of the most significant threats to performance across the aviation industry, providing shared weather information is key to achieving a common situational awareness in order that airports are more resilient to severe weather, a reliable

message is delivered to passengers and the media, and that the efficiency and safety of airports and airlines is as high as possible.

Although A-CDM benefits can be realised by sharing a deterministic forecast, a real step change in efficiency and cost saving can be achieved by embedding probabilistic forecasts as triggers within airports' A-CDM operational framework. This approach has real potential to maximise capacity at the airport while reducing costs and the impact on the environment.

Forecaster involvement

The Met Office provides all of its core services from its Exeter headquarters, including expert consultancy to ensure that the information provided is tailored to the customers' needs and that as much detail and value can be added to make the best possible forecast.

While we can provide these tailored services remotely, the ultimate service is to work on site, side-by-side with operational staff. This could be to support a specific event, on a seasonal basis, or (as at Heathrow Airport) around the clock, every day of the year. Having an on-site presence means we can quickly gain a deep understanding of the customer's operations and thresholds, which would be much more difficult to achieve if working from a separate location.

At Heathrow Airport, staff can call to ask forecasters for the latest information. They can discuss aspects which are most important to them, see the graphics that we use to forecast and discuss the probabilities attached to any risk. Alongside this increased accessible consultancy, the Met Office participates in operational (Webex) conference calls at least four times a day, or more depending on the weather. All airport stakeholders can listen in and hear how weather will impact the airport overthe next 24 hours.

The Met Office has had forecasters on-site at Heathrow Airport since the 2011 winter season, and more recently with easyJet at Luton Airport. The spread of expertise into an airline is showing how successful and fundamental the on-site support can be to the aviation industry. Using this method of forecasting, the Met Office can help all stakeholders have one clear and consistent message about the weather.

Ultimately, at the Met Office we understand that delivering weather services for aviation is a matter of partnership and inter-dependence - the forecast is dependent on the technology and the science, the delivery and usability of the forecast is dependent on our understanding of customer's requirements, and customers are dependent on receiving timely, accurate and easily understood forecasts and advice.

Dr Helen Wells BSc PhD FRMetS joined the Met Office in 2002 working as a Research Scientist on Mountain Meteorology. She has a degree in Geophysics and while working at the Met Office completed a PhD in Mountain Meteorology with the University of Leeds. In 2011, Helen became Manager of the Aviation Meteorology Research and Development Team at the Met Office. Helen is also a Fellow of the Royal Meteorological Society.

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Reversion – the other side of automation

by Captain Ed Pooley

Most of us recognise that the arrival of high levels of commercial aircraft automation and their major effects on the precision with which aircraft performance can be delivered has had a huge impact on the ATM world.

In conjunction with related improvements in the same direction in ATM, more aircraft navigational precision has enabled increased efficiency, flexibility and capacity all at the existing or an enhanced level of safety. For automated aircraft, the likelihood that acceptance of an en-route clearance will be followed by delivery exactly as accepted is greater than in former times – and the controller's scope for clearance issue is also greater. But poor pilot use of automation in a fast-moving aircraft can quickly lead to problems exacerbated by the expectation of usually more reliable outcomes that have allowed more aeroplanes to use the same skies. And anyway, the skies are full of a complex mix of aircraft with a range of performance capabilities even before you add in the pilot factor!

Of course, apart from such occasional misuse of automation, the everyday issue if it is functioning properly – and it is very reliable – is twofold. Firstly, how well do pilots understand its capabilities? and secondly, if it or the inputs on which it depends malfunction, how well do pilots cope with reversion to 'less automation'?

Quite some years ago, but a long time after flight with auto pilots and auto throttles became routine even for approaches, almost all the simulator time spent on training and checking pilots on their task competence was conducted without the use of the autopilot. The 'excuse' was that to allow it to be used reduced the workload which could be imposed upon pilots to see if they could 'survive' under high pressure. Such pressure was equated at that time with the pressure that might arise if unspecified abnormalities arose. Eventually, as this early level of automation moved into the era of the Flight Management System, directives changed to a requirement to use the autopilot most of the time. However, since the required minimum simulator time stayed the same, operating the aircraft with autopilot out became something to do in the aircraft on a nice day line flying. Back in the simulator, with the exception of a few key (memorised) emergency task competencies[1], the focus in the era of increasingly complex (but also increasingly reliable) automation moved to a combination of the everyday and the **anticipated** departures from it. Because there were now so many SOPs for loss of automation scenarios, it was tacitly assumed that there would be one for most situations provided that (when using a QRH in book form in pre ECAM/EICAS days) you could correctly identify it!

Joe… does the emergency NAV kit work or should I call MAYDAY?

But this understandable focus on mitigating the 'regular' causes of accidents led to far less attention being paid to the wide range of infrequently encountered (for any particular pilot) abnormal events, for which a procedural response was (entirely understandably) not specified or only partially specified. What seems to have been overlooked is that what used to be called 'thinking on your feet', an essential process for situations where no specific procedural response exists, often demands rapid recall of acquired and retained technical knowledge, both generic to all aircraft flight and specific to the aircraft type involved. Such a background goes well beyond how to get the best out of the SMS and how to optimise aircraft performance in 'normal' operations. But how widespread is this 'competency' nowadays?

Could there be a parallel in ATM as systems are increasingly automated to make sure that ATM performance continues to match modern aircraft performance? I think so. Performance of any system which depends on high levels of automation to deliver efficiency, flexibility and capacity with no reduction in safety also demands an ability to cope with reversion to a lower level of system performance. Crucially, just as for pilots, this includes both reversion to expected or anticipated conditions, which can be addressed by prescribed responses and the infrequent, perhaps very infrequent, unexpected and unanticipated conditions. Here again, the ability to respond effectively is, as for pilots, is likely to be dependent on acquired and retained knowledge which will only very rarely be needed.

These 'reversions' may be internal to the ATM system or a consequence of changes to the automation status of an aircraft being handled. Has ATM training risen to this challenge? I suspect that, just as in pilot training, in the areas of background knowledge it has not yet caught up with the rapid arrival of reliable automation in both ATM systems and on the flight deck. If I am right, it is time to ensure that expensive recurrency simulator time for controllers is preceded by classroom preparation for infrequent reversions of all sorts which goes beyond 'learned responses' for the expected and presents 'unpredictable' or 'unexpected' scenarios. For such scenarios, there will not be just one particular and prescribed correct response but several equally acceptable ones. Of course, such background training for the unexpected will undoubtedly also provide a deeper understanding of performance issues in the everyday world.

Captain Ed Pooley is an experienced airline pilot who for many years also held the post of Head of Safety for a large short haul airline operation. He now works as an independent air safety adviser for a range of clients and is currently acting as Validation Manager for SKYbrary.

1- Such as engine failure on take-off, emergency descents and responses to activation of the Stall Protection System, the TAWS and the TCAS

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Automation, workload and safety

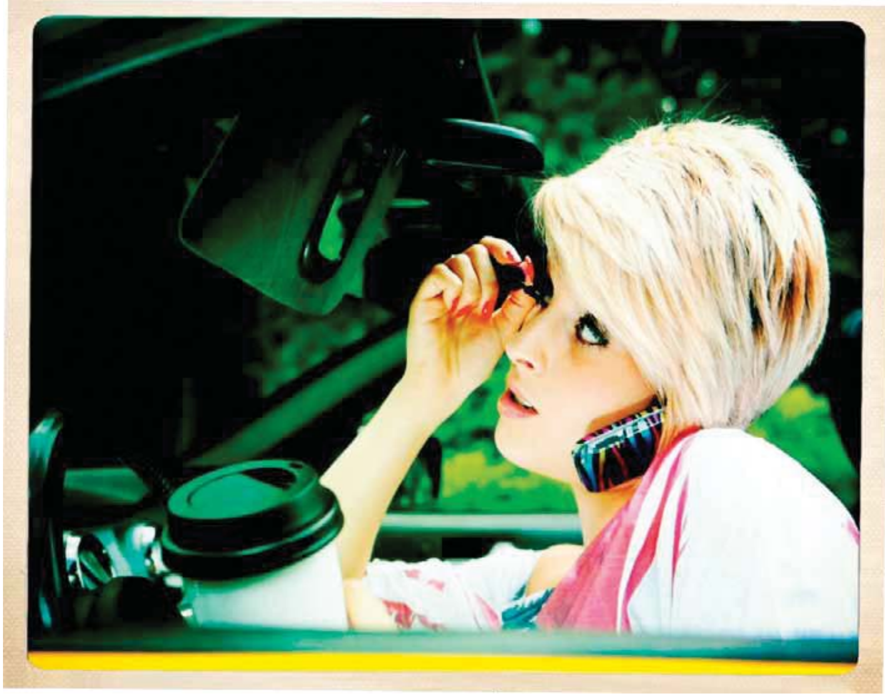
by Captain Harry Nelson

During my first period as a test pilot I worked at the Blind Landing Experimental Unit (BLEU) at the Royal Aircraft Establishment, Bedford in England. One of the research topics that was very high on our work agenda was workload.

The research was led by Dr Allan Roscoe, who was well ahead of the times in his thinking and work. What it meant for us pilots was that we were heart rated on every flight and every task, some of which were very demanding indeed. We also used eye marker tools to "see" what we were looking at. We coupled this to skin acidity measurements and we also rated each task in terms of workload. In fact we used a workload rating scale to assess our level of workload. It was developed from the famous Cooper-Harper rating scales for aircraft handling qualities. For those interested, a quick look on the internet will provide many details on these interesting areas of research.

In brief, I learned a lot about workload, which was to stand me in good stead over the rest of my test flying career. I also believe that there are real parallels with workload in the air traffic environment and I thank Hindsight for giving me an opportunity to share some of what I have learnt.

If we look at the aviation definition of automation, it is "something that is designed to decrease workload". Oh, that it were so simple! If we take the autopilot, we have seen the progression from basic attitude hold systems through to modern day, very sophisticated auto flight path control systems which are perfectly capable of controlling an aircraft from just after take-off through to touch-down. The day of the auto take-off is, I suspect not too far away as more and more experience is gained through RPV types of aircraft and then who knows what may come next?



Certainly the autopilots of today do reduce workload and they are extremely successful at doing it. This, coupled to the greater reliability of modern jet transport aircraft can lead to pretty low general arousal states for the crew. Most flights are completed in a very easy and low workload state. But what happens when things do not go as expected?

For most pilots of my era, the natural tendency is to immediately take control manually, sort out whatever has happened and then, when happy with the flight path, energy situation and technical configuration, select the autopilot back on again. However, an increasing trend is for pilots to use up significant workload capacity in getting the automatics to do what they want, sometimes at the expense of accurate flight path control. Exceptionally, this can lead to situations where the safety of the aircraft may be put in question.

Ok, so I have introduced a new term, workload capacity. We all know what that is or we all have an idea of what it is about. Let us look at it in a bit more detail.

It may be helpful for all controllers (and pilots) to consider that at any moment you have a given workload capacity and it changes with many variables. Your health, your fitness level, your degree of stress, your training level, your experience, your fatigue level, your age, and your circadian rhythm are just some of the many factors affecting your capacity for work when examined on an instantaneous basis. You will notice from even this list that some of these are under your control and others are not.

For ease of understanding I will group mental workload together with what I call motor function workload or physical workload. When a pilot takes control from the autopilot, his motor function workload takes a step change upwards and immediately demands the use of more of his spare workload capacity. If he was using this capacity for mental tasks like trying to resolve an issue with the aircraft or communicate on a detailed route change, then he potentially may have a problem. As workload gets closer and closer to his capacity limit, several unfortunate effects start to become evident.

Firstly he sheds tasks by priority. It may be that one of the first to go is the longer-view monitoring of his situation. He stops "tracking mentally ahead of the aircraft or at least he may not look so far ahead in terms of threats and things to avoid. Later, with a further increase, he focuses only on what is happening inside the flight deck and finally he may tend to "fixate" on an issue or a parameter or a course of action at the expense of others which may be more important or more helpful. His hearing may well be affected. He hears sound but maybe does not register the content of the communication in a normal way. If he hears it then he may not be able to resolve what he is being told and messages may have to be repeated several times before they "get through". Of course this tendency will also cut across the potentially helpful Crew Resource Management (CRM) behaviours that all airline pilots are aware of today and effectively isolates that crew member in his "close to becoming overloaded" state. As the overload condition takes its full grip, he may well be focusing on only one instrument or even one parameter.

A simple analogy may be useful here. Imagine you are driving an older generation car and you want to change the radio channel. On an autoroute, motorway or autobahn it is easy. On a two lane road with traffic coming towards you, albeit separated by a white line, you need to take some care because more of your capacity is being used in ensuring the trajectory of your car remains on your side of the road. And finally, if it is night and you are driving along narrow country lanes it becomes a task not without risk and you may either switch the radio off or develop a new technique to do it. You reach for the knob without looking and then verify with a quick glance that you have the right one. Then you tune by ear using minimum eye movements as you carefully steer the car along the difficult bendy road. During this action it is quite possible that you would not hear a passenger in the car talking to you or letting you know that you had just passed the intended turn off point. You can build up this workload scenario by imagining that you are driving on a route unknown to you so as well as the motor function efforts needed to steer, accelerate etc you are also thinking hard about the route.

Add a crying child in the back of the car and things can go critical as many husbands and wives will testify – and hopefully laugh about it later.

Learning to recognize your personal symptoms as you reach your workload limit is something I would commend to everyone but you must go further and also decide before you get into such a situation, what you will do about it as you see those symptoms starting to impact your performance. You need to formulate an action plan. One of the best action plans before you hit the "black hole" as I call it, is to call for help. Inform someone immediately as soon as you feel that capacity is becoming limited. Ask the other pilot to take over control. Leave it and it may become too late.

Looking from afar I know that much work has been done on this subject in the world of ATC regarding the number of aircraft a given controller can handle during "normal flow" and also how many if the situation changes, let us say by one aircraft declaring an emergency. I am also sure that ATC supervisors try to be aware of the capabilities and workload capacities of their individual team members so that they can keep the whole operations safe but we also know from the real world that occasionally expediency rules and "there is simply no one else". The same applies to pilots. Once again, I must put some of the responsibility onto the shoulders of each pilot and ATC controller. Only you know how you feel right at this moment. Only you know whether the new baby kept you awake all last night and you are feeling really tired. Instead of being "macho" about it, recognize your potentially degraded workload capacity state and inform the other pilot, the supervisor, or the controllers operating the adjacent sectors. They can help and all will have experienced similar situations.

We know from our Human factors studies that there is an optimum arousal and activity state in terms of workload. Too little and our battle is with boredom and inattention and all that can follow from that. Too much and we can hit the black hole. We work best when working within our capacity in an alert and active manner. That must be the target of each one of us as we go about our business in this safety-driven industry.

The mechanisms I have learnt to help me through those potentially very high workload periods include the following:

(1) In general I try to shed unnecessary workload so as to maintain a greater level of spare capacity.

(2) If it is quiet and low arousal that is the threat, imagine an emergency and run through it in your mind what you would do in detail. If you have forgotten something go and check the books.

(3) If it is busy, I try to be a bit schizophrenic by fulfilling my primary task for sure but also trying to stand outside myself and "observe" my own behaviour as if I am in one of those video car racing games where the car is ahead of you. This way it becomes possible to see some potentially risky behaviours before they happen.

(4) As soon as I sense the early warning signs of a significantly building workload situation, I ensure that the other pilot is aware and get him to take more of the non flying tasks, leaving me free to concentrate on flight path and energy control. If he gets overloaded it may slow down communication or delay a procedure but if I, the flying pilot, get overloaded the situation would be much more serious. It was interesting to note that Captain Sullenberger, in the Hudson accident, left his co-pilot to deal almost completely with the drills and attempts to relight while he focused on the water landing.

(5) Of course the doctors are also right. It is important to stay fit and to ensure the right amount of rest and food. In the RAF years ago it was a punishable offence not to take breakfast. So it became normal to do so, a routine that still works and frankly for me, it remains the most important meal of the day.

(6) Finally, a word about the "black hole". The hole is like a whirlpool in that you tend to get drawn progressively into it without the apparent strength to get out again. If one finds oneself at the very edge of the black hole, the only mechanisms I know for a recovery are to take a mental seat in the video game viewing place and take a fresh look at what is going on and to force oneself to examine all the instruments, starting with the attitude indicator, to seek out those instruments that are giving good information. I would guess that the corresponding situation for controllers is fixation on one "tricky" aircraft at the expense of others that may become threats to the overall safe situation. Releasing the thing or parameter that you have fixated on in favour of good parameters is not easy. We all have the desire to make the facts fit the belief or decision that has already been made. Even when faced with overriding evidence that the initial assumption was wrong, we still cling to it and try to get a "fit" from the other parameters. It is vital to re-examine the data in front of you in a fresh way.

In conclusion

Pilots and controllers can help each other in this workload issue. It is reasonably easy for an experienced pilot to judge how hard a controller is working and I am sure that the reverse is true. Why is it then that I hear pilots putting even more pressure on controllers who are dealing with, for example, a low visibility operations situation. Complaints about holding times, expected approach times and the rest do not help anyone. They add to the overall "noise" and cause irritation to all real professionals. What both the pilots and the controllers need is clear minimized information. From the pilots, the controllers need to know if there is a real fuel shortage or any other operational constraint so that the right prioritization can be made. From the controllers, the pilots need to know the changing weather situation, when they can expect to start the approach so that their passengers and company can be informed, fuel can be managed and maybe in exceptional circumstances, the aircraft can be diverted or an emergency declared. The rule has to be the greater the workload – the greater the assistance we need to be giving each other.

Harry Nelson has had a flying career spanning some 46 years which has focussed on flying training and test flying as the two main activities. A graduate of the Central Flying School and the Empire Test Pilots School he has operated in all parts of the world and worked at 5 flight test centres throughout Europe ending up in Airbus where he now holds the post of Executive Operational Advisor to Product Safety. He has over 10000 flight hours on over 76 types of aircraft.

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A330 - Loss of control of both engines

by Dai Whittingham, Chief Executive UKFSC

Cathay Pacific Airways Limited flight number CPA780, an Airbus A330 powered by two Rolls Royce Trent 700 engines, was scheduled to operate from Surabaya, Indonesia (WARR) to Hong Kong on 13 April 2010. The crew completed normal pre-flight preparation and took off at 0124 hrs with the co-pilot as Pilot Flying (PF) and the Commander as Pilot Monitoring (PM). The departure was uneventful but during the climb the crew noticed some abnormal Engine Pressure Ratio (EPR) fluctuations on No. 2 engine, with a range of approximately ± 0.015 around EPR target. No. 1 engine also had abnormal EPR fluctuations but within a narrower range.

At 0158 hrs, and shortly after levelling off at FL390 (i.e. 39,000 ft AMSL at standard atmosphere conditions), the Electronic Centralised Aircraft Monitoring (ECAM) showed "ENG 2 CTL SYS FAULT" and (information) "ENG 2 SLOW RESPONSE". The crew contacted the CPA Integrated Operations Centre (IOC)) for technical advice. After discussion and FCOM review the crew were advised to maintain the engine control at "EPR" mode and that IOC would continue to monitor the flight. As all engine parameters were considered normal other than the EPR fluctuations, the flight crew elected to continue the flight to Hong Kong.

Just over an hour later, ECAM message "ENG 2 CTL SYS FAULT" reappeared, this time the information "AVOID RAPID THR CHANGES" was also displayed in addition to the "ENG 2 SLOW RESPONSE". Engine anti-ice for both engines was selected "ON" but had no effect on the now slightly increased EPR fluctuations. From the IOC, the maintenance engineer considered that No. 1 engine was functioning properly and that No. 1 engine EPR instability might be caused by the Full Authority Digital Engine Control system (FADEC) in using No. 1 engine to compensate for the EPR fluctuation of No. 2 engine, and that the "AVOID RAPID THR CHANGES" was related to the Variable Stator Vane (VSV) System; the Fuel Metering Unit (FMU) in No. 2 engine would be replaced upon arriving at VHHH. The crew accepted the explanation and continued the flight to Hong Kong.

The runway in use at VHHH was 07L. Wind was from 160 degrees at nine kt with wind direction varying between 100 degrees and 230 degrees. Visibility was 10 km with few clouds at 600 ft and scattered clouds at 1,800 ft. Temperature was 29 degrees C, dew point 24 degrees C and QNH 1013 hPa. Significant windshear was forecasted for both runways 07L and 07R. The crew carried out the arrival and approach briefing, planning for a standard SABNO 2A arrival for 07L and completed the descent checklist. "CONFIG FULL" (i.e. full flap setting) was maintained as the default setting in the Multipurpose Control and Display Unit (MCDU); autobrake system was set to LO.

During the descent to FL230, ECAM messages "ENG 1 CTL SYS FAULT" and "ENG 2 STALL" were annunciated within a short period of time; a light "pop" sound was heard and some "ozone" and "burning" smell being detected shortly before the ECAM message "ENG 2 STALL". CPA780 was then at about 110 nautical miles (nm) southeast of VHHH, descending through FL300 at 295 kt. Vertical mode "Open Descent" was selected and the crew completed the ECAM actions, setting No. 2 thrust lever to IDLE.

"ENG 1 SLOW RESPONSE" and "AVOID RAPID THRUST CHANGES" were then also displayed. No. 1 thrust lever was advanced to MCT per the QRH guidance. However No. 1 engine N1 only temporary increased to about 57% N1 before dropping back to about 37% N1. The crew declared a PAN, advising that No. 2 engine was operating at idle thrust, before briefing the oneengine-inoperative approach and missed approach procedures. "CONFIG 3" (i.e. flap setting no. 3) was re-selected in the MCDU. The crew also requested a shortened track for a priority landing.

The Commander contacted the In-flight Service Manager (ISM) and advised her that there was a problem on No. 2 engine and a priority landing would be accorded by the ATC. The ISM was asked to prepare the cabin for landing and to report to him if there were any abnormal signs in the cabin or at No. 2 engine. He then took control of the aircraft as the PF in accordance with company SOPs.

With the aircraft approximately 45 nm southeast from VHHH and about to level off at 8,000 ft AMSL, ECAM message "ENG 1 STALL" was annunciated. ECAM actions were carried out, putting the No. 1 thrust lever to IDLE. Autothrust (A/THR) was disengaged, both engine master switches remaining "ON".

With both thrust levers at IDLE position, the Commander then tested the controllability of the engines by moving the thrust levers one at a time. There were no thrust changes corresponding to the engine lever movements initially but "ENG 1 STALL" reappeared.

The crew upgraded the PAN to MAYDAY and advised Hong Kong Approach of the double engine stall situation. CPA780 was then cleared to descend to 3,000 ft AMSL. The aircraft was still in IMC at 230 kt, reducing towards a Green Dot Speed (i.e. engine-out operating speed in clean configuration) of 202 kt. The Commander disconnected the Autopilot and the Flight Directors (FD) and flew the aircraft manually; Flight Path Vector was selected and VMC was gained soon after.

Thrust levers were moved to check the engine control but there was no direct response from the engines. The No. 1 engine speed eventually increased to about 74% N1 with the No. 1 thrust lever in the CLB (climb) detent position. The No. 2 engine speed remained at sub-idle about 17% N1, with the No. 2 thrust lever at the IDLE position. The "ENG ALL ENG FLAMEOUT - FUEL REMAINING" checklist was carried out for the No. 2 engine in an attempt to clear the thrust control fault but the engine remained at a sub-idle speed of 17% N1.

At 5,524 ft AMSL and 219 kt, and at 9 nm from VHHH, the Commander tried to decrease the speed by retarding the No. 1 thrust lever. However, there was no corresponding decrease in No. 1 engine speed. Eventually, No. 1 thrust lever was left at the IDLE position and No. 1 engine speed remained at 74% N1. Cleared for a visual approach for Runway 07L the crew deployed the speedbrakes when the aircraft was at 5,216 ft AMSL descending with a CAS of 234 kt at around 8 nm from VHHH, the landing gear being selected down shortly afterwards.

The Commander aimed to fly the aircraft at a CAS as close as possible to the Minimum Selectable Speed (VLS), which was 158 kt at that time. The aircraft went through the runway extended centreline and recaptured the centreline from the north in order to manage altitude and airspeed. Landing checklist was actioned. With the Maximum Allowable Speed (Vmax) at 240 kt and actual CAS at 244 kt, an overspeed warning was generated by the onboard system. A short while later Hong Kong Approach cleared CPA780 to land on Runway 07L and advised that the current surface wind was 150 degrees at 13 kt. The crew stowed the speedbrakes when the aircraft was at 984 ft AMSL and armed the ground spoilers at 816 ft AMSL.

At about two nm to touchdown, the aircraft was still at flap CONF 1, with a CAS of 227 kt and a vertical speed of 1,216 ft per min at an altitude of 732 ft AMSL; at this stage the "Too Low Terrain" warning was generated by the EGPWS. Flap CONF 2 was selected at around one nm to touchdown with a CAS of 234 kt and at an altitude of 548 ft AMSL. A flashing "F RELIEF" message was displayed at Engine Warning Display (EWD) as the TE flap was extended to 8-degree position instead of the commanded 14-degree position. With a Vmax of 205 kt, another overspeed warning was generated shortly after Flap 2 selection. The "Too Low Terrain" warning changed to "Pull Up" warning briefly at 176 ft AMSL and back to "Too Low Terrain" within a very short timeframe. The EGPWS warning stopped at 24 ft above the ground.

During the final approach, No. 1 engine speed decreased to about 70% N1 at touchdown, with the No. 1 thrust lever at IDLE position. No. 2 engine speed remained at about 17% N1 throughout the final approach and landing.

CPA780 touched down on Runway 07L some 680 metres (m) from the beginning of the runway threshold at a ground speed of 231 kt. The landing weight was approximately 173,600 kg. Immediately after both main gears touched down on the runway, the right main gear bounced and the aircraft became airborne again briefly. The aircraft then rolled left seven degrees and pitched down to -2.5 degrees at the second touchdown during which, the lower cowling of No. 1 engine contacted the runway surface. Spoilers deployed automatically.

Both engine thrust reversers were selected by the Commander. Only No. 1 engine thrust reverser was deployed successfully and ECAM message "ENG 2 REV FAULT" was annunciated. Maximum manual braking was applied. As required by SOPs, the co-pilot called out "no spoilers, no REV green, no DECEL" during the landing roll.

The aircraft came to a complete stop on the runway at a position just passed Taxiway A10,

with its nose wheel at about 309m from the end of Runway 07L. The total distance for stopping the aircraft from the initial touchdown was approximately 2,630m.

After the parking brake was set to ON, the Commander made a PA to request the passengers to remain seated. No. 1 engine was still running at76-79% N1, with No. 1 thrust lever at IDLE. The flight crew shut down both engines by selecting No. 1 and No. 2 engine MASTER switches to "OFF". The brake temperatures were monitored and discussed between the Commander and the co-pilot. The brake temperatures reached the top of the scale at 995 degrees C in the cockpit display. The Commander made another PA advising the passengers that the flight crew was evaluating the situation and the passengers were requested once again to remain seated and to follow the cabin crew's instructions.

Unable to contact the attending fire crews, the Commander called for the emergency evacuation checklist and actions up to "EVACUATION" were completed. "Cabin crew to stations" was PA broadcasted and the fire pushbuttons for both engines were pushed. The Commander eventually established communication with the Rescue Leader, who confirmed that brakes on left and right gears were hot and that he could see "smoke and small fire"; the thermal relief plugs had deflated three of the left main gear tyres and two of the right main gear tyres. The Rescue Leader further advised the flight crews that water was applied to cool down the hot brakes. The Commander then ordered an emergency evacuation and shut down the APU by using the APU fire pushbutton as per the emergency evacuation checklist.

All eight emergency exits doors were used after the cabin crew had confirmed the absence of fire or smoke outside the exits. Exit doors L1, R1 and R4 were each attended by two cabin crew members, and the remaining five exit doors were each attended by one cabin crew member. Some passengers took their cabin bags along and did not follow the cabin crews' instruction to leave their bags behind before jumping onto the slides. The whole evacuation was completed in about two mins and 15 seconds. The Commander, the co-pilot and the ISM walked through the cabin to make sure there was no one left inside the aircraft before they left.

The subsequent investigation revealed that the cause of the incident was contamination of the fuel uplifted at WARR. The contaminant was spheres of a super-absorbent polymer used in the filter monitors at the bulk fuel installation. These SAP spheres had migrated into the Fuel Metering Unit of both engines and had generated stiction and eventual seizure of the sleeve of the Main Metering Valve.

Other than safety action taken by Airbus to expand the handling advice for crews suspecting fuel contamination, all other safety actions (7) and recommendations (4) concentrated on fuel supply, storage and quality issues.

Civil Aviation Department, Government of Hong Kong – Report on the accident to Airbus A330-342 B-HLL operated by Cathay Pacific Airways at Hong Kong International Airport on 13 April 2010. Accessed from SKYbrary at www.skybrary.aero/bookshelf/books/2467.pdf

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