ISASI FORUM

"Air Safety Through Investigation"

JULY–SEPTEMBER 2005

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ABOUT THE COVER

On Aug. 12, 1999, a Raytheon Beech 1900 crashed while on approach to a Canadian airport at night. At the time of the approach, the reported ceiling and visibility were well below the minima published on the approach chart. The accident resulted in a TSB Canada recommendation that "the Department of Transport expedite the approach ban regulations prohibiting pilots from conducting approaches in visibility conditions that are not adequate for the approach to be conducted safely." (TSB Recommendation A02-01) Photo courtesy TSB Canada.

ISASI FORUM

"Air Safety Through Investigation"

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AIR SAFETY INVESTIGATORS
INCORPORATED AUGUST 31, 1964

ISASI View of NTSB Member Role

By Frank Del Gandio, President

Our Society has a long history of partnership with the National Transportation Safety Board. When we couple that with our fundamental belief that safety is a cornerstone of the international transportation system, we come to believe that the Society holds a unique and credible perspective on what the role of an NTSB Board Member should be, and by extension, what experience a nominee should possess.

In our view, the role of Members is critical to the success of the overall NTSB mission, and, therefore, to the safety of the traveling pubic. Clearly, the most qualified candidate will be the most effective Board Member and, thus, best serve the nation's interests. Although aviation safety issues tend to be the most visible, we are acutely aware of the Board's responsibility to road, rail, marine, and pipeline safety, as well as to transportation disaster assistance. Thus, Board Members must possess expertise and experience in safety issues that deal with as many of these facets of the Board's mission as possible. Since few candidates will have "hands on" experience in every aspect of the agency's interest, potential members must have a record of accomplishment that demonstrates his or her ability to rapidly and effectively adapt to new challenges in the transportation industry.

We, as an organization, are acutely aware that the safety of this and every other nation's transportation system, regardless

We, as an organization, are acutely aware that the safety of this and every other nation's transportation system, regardless of mode, has become global in scope. The Board's jurisdiction may be limited to the United States, but its safety interest cannot be.

of mode, has become global in scope. The Board's jurisdiction may be limited to the United States, but its safety interest cannot be. Accordingly, to be considered for a Board Member position, an individual should have demonstrated the ability to function in the international arena. Ideally, this ability would include experience in interacting with regulators and governmental safety agencies worldwide.

One of the leading roles of an NTSB Member is assisting the Chairman in setting the course for the agency. Another is to challenge the NTSB staff to excel in following the set course. A candidate who has experience in an organization dedicated to safety management and/or investigating safety

There soon will be a vacant seat on the NTSB. Candidates are even now stepping forward, vying to fill the position. We urge the nominating committee to bolster the fine performance of existing Members by nominating a candidate with an established record of superior performance in a major transportation field, complemented by expertise in other modes.

issues would appear to be ideally suited to fill these rolls.

In a similar vein, we firmly believe that, although the NTSB staff employees are charged with the technical operations of the Board, the Board Members themselves must have a background that includes a degree of technical skill. As things stand, the Board's most visible presence is in a reactive approach to hazards—for instance, investigating accidents and incidents. However, we believe the Board must also have a proactive role in ensuring transportation safety.

Applying knowledge gained through investigation, and supplementing that knowledge with a data-driven approach to hazard identification and mitigation, can enable the NTSB to fulfill its role as a true safety agency, not simply as an investigative body. Thus, Board Members should have not only safety investigator experience, but also experience with proactive disciplines such as safety management systems and the effective use of safety data as tools to identity and mitigate hazards.

There soon will be a vacant seat on the NTSB. Candidates are even now stepping forward, vying to fill the position. We urge the nominating committee to bolster the fine performance of existing Members by nominating a candidate with an established record of superior performance in a major transportation field, complemented by expertise in other modes. Ideally, the nominee will have a technical background in accident investigation, intimate knowledge of the NTSB processes, and experience operating with industry and government organizations in the international arena. To effectively use the knowledge gained through investigations, the nominee should have experience with programs that are designed to use such information in proactive safety programs that develop mitigation strategies to cope with identified hazards. To continue to develop the Board's role in dealing with the human toll of accidents, any nominee should have experience with programs that respond to the stresses imposed by critical incidents such as transportation disasters. ◆

Do Safe Skies Cause Rusty Skills?

By Ron Schleede, Vice-President

Is it possible that the excellent and improving aircraft accident record could diminish the quality of future investigations because there are fewer accidents?

Two press releases in March 2005 caught my interest and prompted me to compose this message. The first, by the International Air Transport Association (IATA), headlined *"2004—The Safest Ever for Air Transport."* The second, by the NTSB, headlined *"NTSB Reports Decrease in Aviation Accidents in 2004."* According to IATA's release, more than 1.8 billion people traveled safely worldwide in 2004, with the deaths of 428 persons in commercial aircraft accidents. The release compared these data to 1945, when the number of fatalities was very similar, yet the number of passengers carried by commercial airlines was only 9 million. For 2004, the U.S. had only one fatal commercial airline accident and that one resulted in 13 fatalities. Compare these data to those from 1985, when there were just more than 2,000 deaths or to 1996, when there were just more than 1,800 deaths worldwide in commercial airline accidents.

This is an admirable achievement, considering that traffic volume continues to increase. All aviation safety professionals should be proud, including air safety investigators who are members of ISASI.

Why do I bring up these numbers? I began to wonder if the improving air safety record indirectly might have an adverse effect on the quality of future investigations because air safety investigators might not get enough "practice" to maintain their skills. I have addressed the issue of investigator training in the past and this message is related.

It is well known that key persons involved in aircraft operations, such as pilots, flight attendants, mechanics, and air traffic controllers, must meet certain training and experience requirements. Deficiencies in training and experience of such personnel have been found during many past accident investigations and have been reported as causal or contributing factors. How about investigators? Persons whose tasks require complex skills will lose proficiency if they don't practice and maintain currency.

Is this a concern? I believe it is, unless certain steps are taken to hone the skills of air safety investigators, who may not get much practice because accidents are so rare that several months or years may pass without a major accident. I recall from my experience at the NTSB that we had some "lean" years and our skills definitely diminished. How do we get the practice? Certainly not by having more accidents!

An excellent means to maintain currency is to conduct exercises, both small and large scale. There are requirements for airports to conduct disaster exercises, and many airlines stage exercises of their required emergency preparedness plans. One way we were able to "practice" at the NTSB was to participate in airport or airline exercises. During one lean period at the NTSB, we held a 2-day meeting of investigators and managers at which we reviewed go-team investigation procedures and exercised our aviation accident program in a "tabletop" exercise.

I am aware that some investigation agencies conduct periodic exercises to prepare for a future accident. However, it is not a requirement and not necessarily a widespread practice. Consequently, I suggest that government and industry organizations conduct periodic exercises, including the use of case studies, to enable air safety investigators to be prepared for the rare but complex investigation that follows an accident. ◆

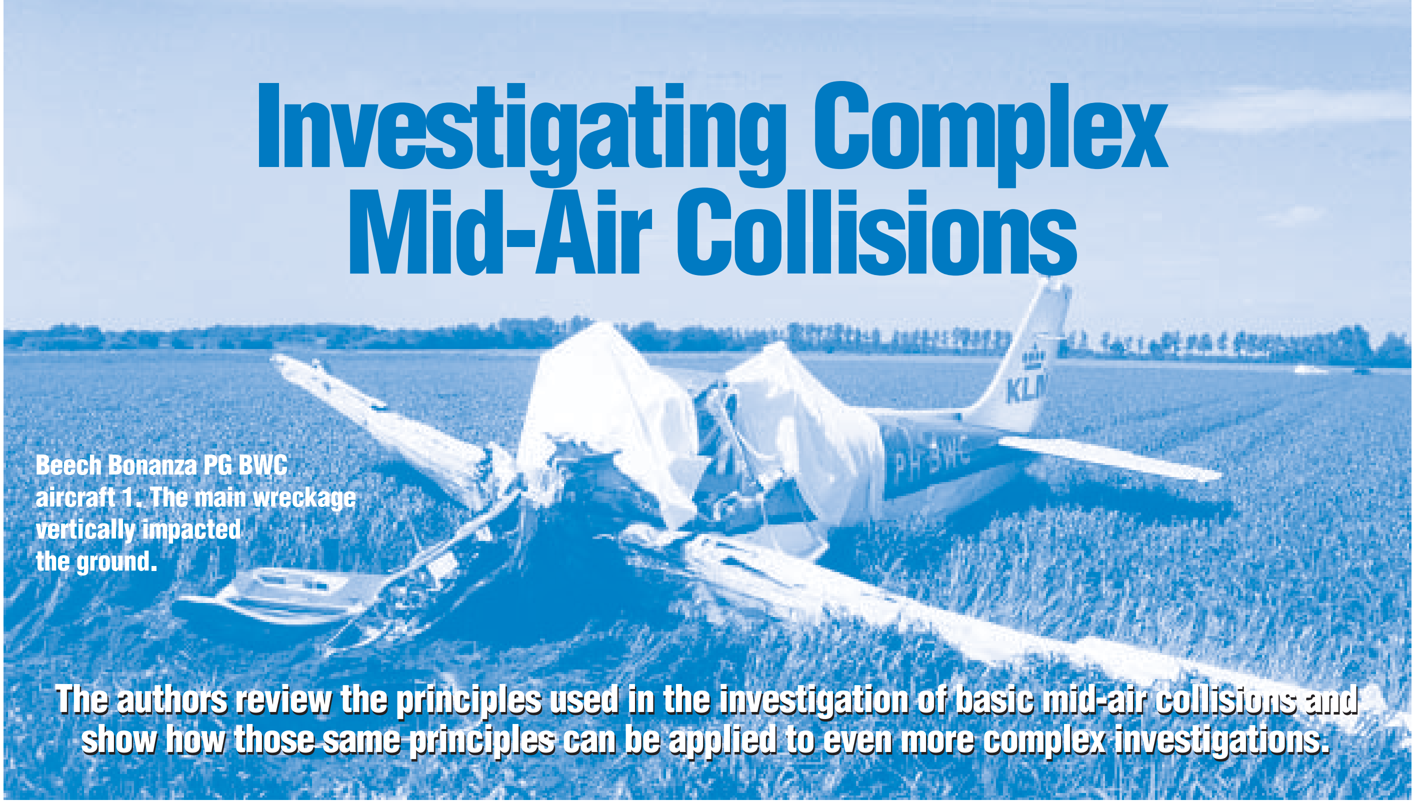
Useful Websites

Government Investigation Agencies
Australia—Transport Safety Bureau www.atsb.gov.au
Brazil—CENIPA www.dac.gov.br/principalIng
Canada—Transportation Safety Board www.tsb.gc.ca
Czech Republic—Air Accident Investigation Institute www.uzpln.cz
Denmark—Accident Investigation Board www.hcl.dk
Finland—Accident Investigation Board www.onnettomuustutkinta.fi
France—Bureau of Investigations and Analysis (BEA) www.bea-fr.org
Germany—Federal Bureau of Aircraft Accidents Investigation www.bfu-web.de
Hong Kong—Civil Aviation Department www.info.gov.hk/cad/english
Iceland—Aircraft Accident Investigation Board www.rnf.is
Ireland—Air Accident Investigation Unit www.aaiu.ie
Italy—National Agency for the Emergency of the Flight (ANSV) www.ansv.it
Japan—Aircraft and Railway Accident Investigation Commission www.mlit.go.jp/araic
Korea—Aircraft-Accident Investigation Board www.kaib.go.kr
Netherlands—Dutch Transport Safety Board www.rvtv.nl
New Zealand—Transport Accident Investigation Commission www.taic.org.nz
Norway—Accident Investigation Board www.aibn.no
Singapore—Aircraft Accident Investigation Board www.mot.gov.sg
Sweden—Accident Investigation Board www.havkom.se
Switzerland—Aircraft Accident Investigation Bureau www.bfu.admin.ch
Taiwan—Aviation Safety Council www.asc.gov.tw
United Kingdom—Air Accidents Investigation Branch www.aaib.dft.gov.uk
United States—National Transportation Safety Board www.ntsb.gov

Accident Databases, Statistics, Reports, And Current and Historical Materials
Aircraft Crashes Records Office—www.baaa-acro.com
Air Data Research—www.airsafety.com
AirDisaster.com—www.airdisaster.com
Airline Safety.com—www.airlinesafety.com
AirSafe.com—www.airsafe.com
Aviation Safety Network—www.aviation-safety.net
AvWeb—www.avweb.com
FindLaw *(US only)*—www.findlaw.com
Flight Safety Information *(FSINFO)*—www.fsinfo.org
Flightscape—www.flightscape.com
JACDEC, Jet Airliner Crash Data Evaluation Center—www.jacdec.de
National Aviation Reporting Center on Anomalous Phenomena—www.narcap.org
The Aero-News Network—www.aero-news.net

Regional and International Associations and Organizations
European Aviation Safety Agency—www.easa.eu.int
European Civil Aviation Conference—www.ecac-ceac.org
European Co-ordination Centre for Aviation Incident Reporting Systems—http://Eccairs-www.jrc.it
European Organization for the Safety of Air Navigation (EUROCONTROL)—www.eurocontrol.be
Flight Safety Foundation—www.flightsafety.org
Global Aviation Information Network—www.gainweb.org
International Air Transport Association—www.iata.org
International Civil Aviation Organization—www.icao.org
International Federation of Air Line Pilots Associations—www.ifalpa.org
International Transportation Safety Association—www.itsasafety.org
Joint Airworthiness Authority (*being phased into the EASA)*—www.jaa.nl
The Latin American Aeronautical Association—www.ala-internet.com/ala2 ◆

Investigating Complex Mid-Air Collisions



Beech Bonanza PG BWC aircraft 1. The main wreckage vertically impacted the ground.

The authors review the principles used in the investigation of basic mid-air collisions and show how those same principles can be applied to even more complex investigations.

(This article was adapted, with permission, from the authors' presentation entitled Using Physical Evidence from More Complex Mid-Air Collisions *presented at the ISASI 2004 seminar held in Australia's Gold Coast region Aug. 30 to Sept. 2, 2004, which carried the theme "Investigate, Communicate, and Educate." The full presentation including cited references index is on the ISASI website at www.isasi.org.—Editor)*

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Keith McGuire *is the director of the National Transportation Safety Board's Northwest Regional Office. A former pilot with the U.S. Air Force, he has a B.A. in physics, an M.A. in counseling psychology, and has completed the Senior Executive Fellows Program at Harvard University.*

By Gijsbert Vogelaar (CP0186), Dutch Safety Board, the Netherlands and Keith McGuire (M02416), the National Transportation Safety Board, USA

Introduction

Mid-air collision investigations are one of the most interesting investigations faced by the professional air safety investigator. While increasing technology has reduced the number of mid-air collisions, they continue to happen and present the investigator with some unique challenges. This article is a review of the principles used in the investigation of basic mid-air collisions and how those same principles can be applied to even more complex investigations. The basic principles of a mid-air collision investigation have been examined in several sources, but the discussion here will be limited to the (1) ICAO *Manual of Aircraft Accident Investigation* and (2) the simplified approach to using the ICAO procedures previously outlined in the *ISASI Forum* by one of the authors titled *Using Physical Evidence From a Mid-Air Collision*.

The investigator may be able to use flight recorder information, radar data, and even witness statements to assist in the investigation. However, these sources of information may not be available on all accidents and in some cases are not as accurate as the physical evidence. The physical evidence left from a mid-air collision can tell you precisely the relative headings of the two aircraft involved at the time of the collision. Combined with other data like radar, the investigator will end up with a more complete picture of the collision sequence. Of course there will also be situations where the physical evidence is the only data available. In that case, the analysis of the scratch marks will be the only basis for determining the collision angle.

The techniques discussed here vary somewhat from Appendix 11 of the fourth edition of the ICAO *Manual of Aircraft Accident Investigation.* The ICAO Manual, for example, refers to 19 "rules of thumb" that provide guidance for analyzing scratch marks. While these rules of thumb are valuable, we use a simpler approach to the analysis of scratch marks that is easier for the investigator to remember and use while at an accident scene. By adding the concept of convergence angles onto the ICAO approach, the investigator is able to more quickly determine what the visibility was from each cockpit (see Figure 1, page 6). If there is a scratch mark on an aircraft that is going from the leading edge to the trailing edge of the wing forming a 20-degree angle with the longitudinal axis, we know that the convergence angle of the second aircraft was also 20 degrees from the 12 o'clock position at the moment of impact.

Convergence angles have to be based on heading rather than track in order to establish a valid visual perspective for each pilot. Once these angles are established, the investigator can replicate the visibility from a cockpit with fairly good accuracy. A visibility study can be done with a computer to provide a graphical plot of what the pilot(s) could have seen from the cockpit. The pilot's visibility can also be assessed manually by reconstructing the pilot's seated height and seat location in a similar aircraft and then determining what is at the convergence angle.

Using scratch marks to determine the collision angle always gives a relative angle between the two aircraft headings rather than the actual compass headings of the aircraft. This is actually a very helpful result in that the relative headings of the two aircraft are needed to determine each crew's visibility of the other aircraft. However, while the scratch marks can reveal the relative attitude of one aircraft compared to the other, they will not provide the absolute heading of either aircraft. Likewise, the scratch marks may reveal the relative attitudes of the aircraft to each other, but the attitude of either aircraft in reference to the horizon will remain unknown.

The techniques discussed in this article have been limited to determining horizontal angles of convergence and collision. However, the same techniques will work to establish the vertical angles of convergence by using scratch marks from vertical surfaces rather than the horizontal surfaces. The ICAO Manual uses eight pages to explain how to calculate the collision angle when there is both horizontal and vertical motion involved. While this material is excellent, there is an alternative approach that is less time consuming. Simply solving for the horizontal angle and the vertical angle separately and then combining the results at the end will give the same result as the ICAO approach.

Calculating a collision angle

A common mistake made in evaluating a mid-air collision is for the new investigator to assume that the scratch mark (or structure deformation) is synonymous with the track of the other aircraft. Investigators will sometimes find themselves sighting down the scratch mark as though that represents the flightpath of the other aircraft. Occasionally, even experienced investigators can be seen placing a part of an aircraft wreckage into matching damage on the second aircraft as though that was the way the two aircraft collided. In reality, a scratch mark is a combination of the movement of two different bodies in motion. (See Figure 2.) Only when one of the aircraft is not moving or the second aircraft is approaching from the 12 o'clock or 6 o'clock positions will the scratch marks show the direction of travel for that aircraft.

When both aircraft have reliable scratch marks, solving for the collision angle is a fairly simple process. Since the scratch marks are the same as the respective convergence angles, it is simply a matter of subtracting the two scratch mark angles from 180 degrees to get the collision angle.

When only one aircraft has a reliable scratch mark, it is necessary to have the speeds of the two aircraft in order to solve for the collision angle. While any estimate introduces some error into the final results, a range of probable speeds can be used and the resulting range of probable collision angles will provide useful information to the investigation. The variation in one general aviation accident was only about four degrees. While it's desirable to have more precise calculations, this range can still be very useful for a visibility study.

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Figure 1

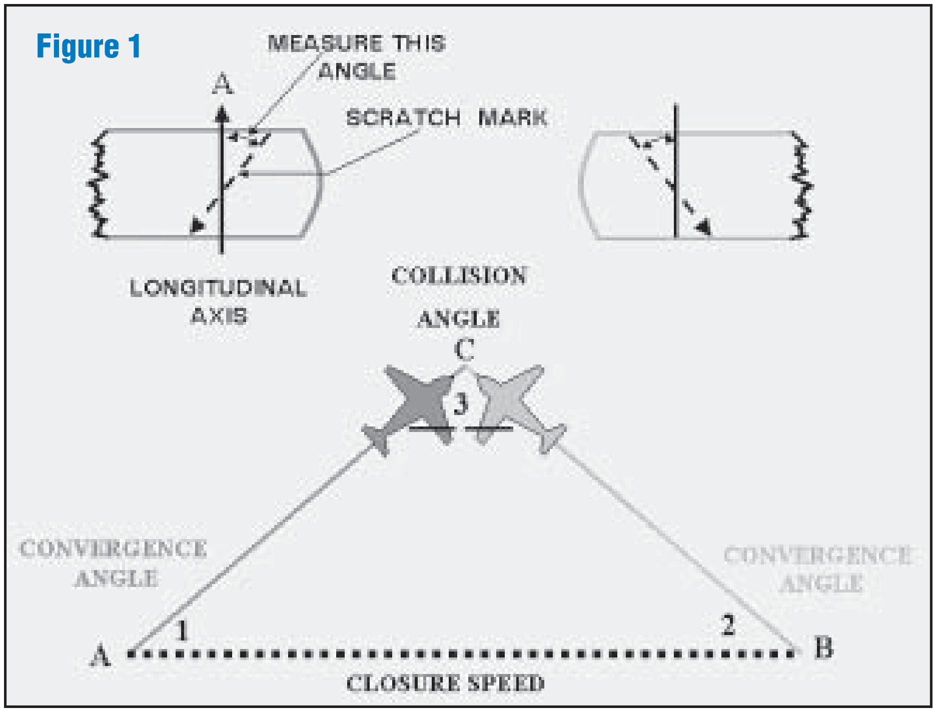
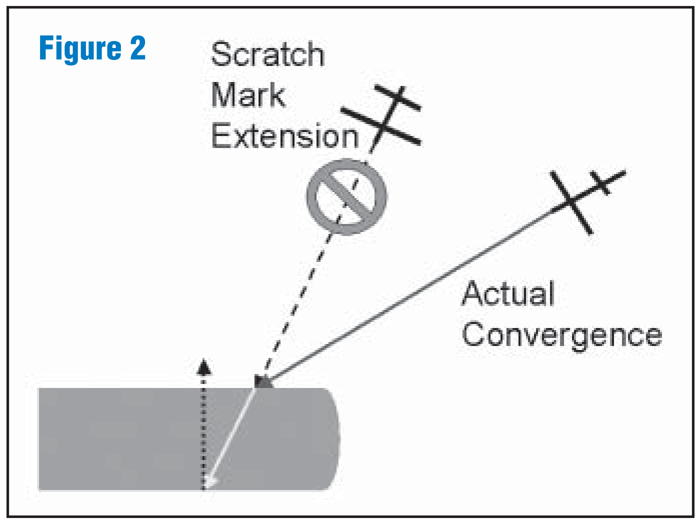


Figure 2



Aircraft 2 was found in a meadow. From the track in the meadow, it could be determined that a rather smooth gear-up landing was executed. The cockpit roof was heavily damaged and scratched, and the left upper wing was dented.

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Propeller slashes

Using the exact same physics as in the basic approach, the techniques can be expanded to more complex accidents. For example, when there are propeller slashes left on an aircraft, an investigator can calculate the "collision angle" between the propeller blade and the aircraft with the slash marks. Working backwards, he or she can then calculate the collision angle between the two aircraft.

A propeller tip moving through space is the combination of the propeller blade motion and the aircraft motion. Since propeller blades are a fixed dimension and rotate within certain expected RPM ranges, the speed of a prop tip for any given RPM can be calculated. Obviously, constant-speed propellers and aircraft with known power settings will give more accurate results, but a range can be used to calculate a collision angle range much like what is done when only the speed of one aircraft is known.

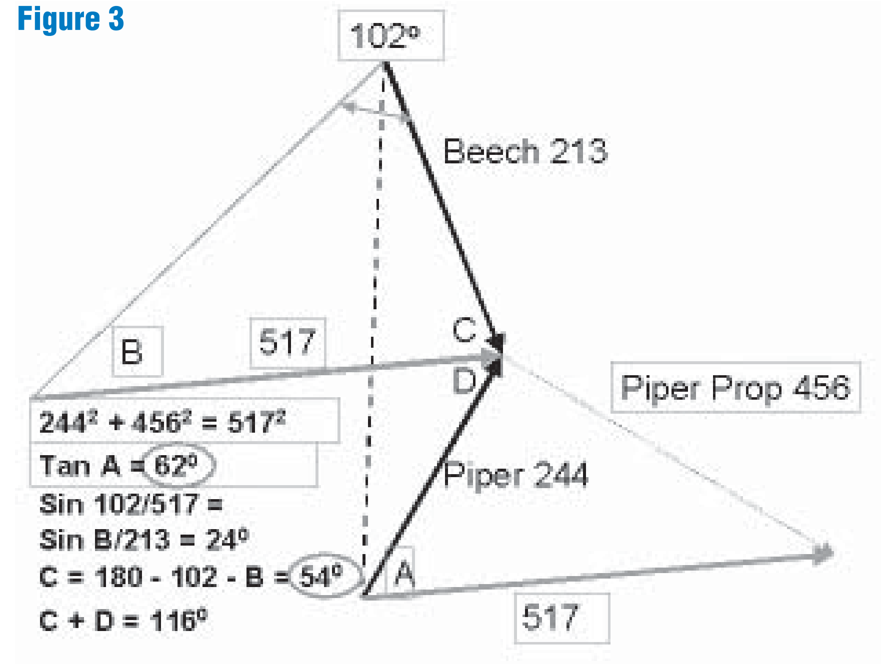
By using the diameter of the propeller, direction of rotation for the propeller, and the RPM of the propeller, a calculation for the prop tip speed can be established using standard trigonometric functions. (See Figure 3.) Since the prop is always providing thrust at a 90-degree angle with the longitudinal axis of the aircraft, the square of the prop vector and the square of the aircraft vector can be used to get the square of the combined vector, which represents the prop tip moving through space. Combining this prop tip moving through space with the movement of the second aircraft allows the investigator to solve for the collision angle between the prop tip and the second aircraft. Then, using basic geometry, the collision angle between the two aircraft can be determined.

Case studies

Beech King Air/Piper Navajo collision with only one prop slash—A Beech King Air collided with a Piper Navajo near a VOR while both airplanes were in cruise flight in VFR conditions. Both aircraft were substantially damaged but landed safely. Interviews with the crews revealed that they were not aware of the other aircraft until just before the collision. The only reliable scratch mark was a prop slash on the underside of the right wing of the King Air. The angle between the prop slash and the longitudinal axis of the Beech was 102 degrees.

The Piper prop tip speed was calculated at 456 knots using the diameter of the propeller and the RPM of the propeller. This was then combined with the 244-knot speed of the Piper aircraft to produce a resultant 517-knot vector. Since this is the vector that actually produced the slash on the Beech, we can combine the prop tip vector with the Beech vector to calculate a collision angle of 54 degrees between the Piper prop tip and the Beech. (Angle C in Figure 3.) While

Figure 3



interesting, this number in itself is only part of the collision angle between the two aircraft and useless to the investigator by itself since interest is not centered on the collision angle between the prop tip and the aircraft. What ultimately needs to be determined is the collision angle between the two aircraft themselves.

To determine the second part of the collision angle, one first needs to use basic trig functions to calculate the angle between the final prop tip vector and Piper aircraft vector. While this number once again is not a particularly useful number, it does allow the calculation of the remaining angle of Angle D in Figure 3 to find the collision angle between the two aircraft. Basic geometry allows that when a straight line intersects two parallel lines, the opposite interior angles are equal. This allows us to substitute the angle between the resultant prop tip vector and the Piper (Angle A in Figure 3) for the remaining part of our collision angle (Angle D in Figure 3) with a resulting collision angle of 116 degrees.

For many of the calculations in the midair collision diagram, the law of sines is the best equation to use. However, there is one significant exception when it comes to solving for the closure speed when using only a single prop slash. In this case it is necessary to use the law of cosines.

Mid-air collision between two Beech Bonanzas—In the afternoon of June 8, 2000, an accident with a Beech Bonanza of the KLM flight academy (KFA) was reported. The aircraft (registered PH-BWC, Aircraft No. 1) had crashed in a field. The instructor and two students were fatally injured.

The other aircraft that was involved was from the same school and was also a Beech Bonanza (PH-BWD, Aircraft No. 2). The instructor had made a successful emergency landing and was uninjured. The two students who were on board this aircraft suffered back injuries.

The accident happened during a sunny day in uncontrolled airspace south of Groningen Airport Eelde CTR, the home base of the KLM flight academy. The KFA uses this area frequently for training flights. The wreckages of the two aircraft were found approximately 1.7 nautical miles from each other.

Aircraft 1 was found with the nose section (engine, propeller, and nose gear) separated from the aircraft. The distance between the main wreckage and the nose section was approximately 50 meters (165 feet). The main wreckage (wing leading edge) showed traces of an almost vertical impact. The tail section was undamaged.

Aircraft 2 was found in a meadow. From the track in the meadow it could be determined that a rather smooth gear-up landing was executed. The cockpit roof was heavily damaged and scratched.

A closer look into the damage of Aircraft 2 revealed the following:

- Tail section undamaged.
- Right upper wing undamaged.
- Left upper wing: dented and partly covered with a black, greasy substance.
- Left aileron: heavily damaged, partly disappeared, and pushed in neutral position to the outer side of the wing.
- Left lower wing:

(1). Slash marks in wing and aileron corresponding with a propeller that turns to the right and passes underneath the wing (roughly speaking) from front to rear.

(2). A hole, just outside the wheel doors, that appears to have been made by a soft body. Inside there are traces of a black material, probably rubber.

By properly documenting the scratch marks created from a mid-air collision, the collision and convergence angles can be mathematically derived even in some of the more complex cases.

Analyses

The heavily damaged and scratched roof of Aircraft 2 showed clearly that there was a collision with something above the aircraft. The propeller slashes in the left lower wing pointed to a collision with an aircraft from below.

How was it possible that Aircraft 2 was heavily damaged both at the top and at the bottom? Was a third aircraft involved? Where did the big hole in the left lower wing come from?

We think the sequence of events was as follows:

- Both aircraft were flying in the same direction.
- The bottom of Aircraft 1 came in contact with the roof of Aircraft 2, probably during a pull up of Aircraft 2.
- Aircraft 1 "slid" to the left over Aircraft 2.
- The left inner wing and leading edge "supported" Aircraft 1 just behind the engine section.
- The engine and nose gear separated from Aircraft 1 due to acceleration forces during the collision, leaving dents and oil on the left upper wing of Aircraft 2.
- The nose section with the engine still running turned upside down and passed underneath the left wing of Aircraft 2.
- The propeller, still turning clockwise, made the prop slashes, damaged the left aileron, and pushed it outwards.
- Because the clockwise-turning propeller was cutting the wing, the engine itself was forced to turn anti-clockwise (action = reaction).
- During this process, the nose gear came out of the bay and was slammed against the bottom of the wing, causing the hole.

Later when the radar data and witness statements were available, the following came to light:

- The two aircraft were flying in formation.
- Both instructors had come up with the idea to use their instruction slots for a birthday greeting for another KFA instructor, who was the father of the instructor who survived the accident. Aircraft 1 crashed a few hundred meters from his home.
- The aircraft passed the house two times at low altitude (below 300 ft). During the second pass, the collision occurred.
- During the second flyby, there is no transponder signal from Aircraft 1.

Beside the investigation into the direct cause of the accident, the Dutch Safety Board performed an investigation into the safety culture of the academy, which was state owned until 1990. Also the role of KLM as owner of the flying school and the CAA-NL as former "owner" and as the organization responsible for the oversight was investigated.

Investigation findings

- Neither one of the instructors was trained in formation flying.
- The formation flight was not authorized and not reported to operations or ATC.
- Because of their position, the two instructors should have set the example and should not have even considered this flight, especially not with students on board.
- At the time of the accident, the KFA did not have a head of training nor a flight safety officer.
- The KFA board did not take "adequate measures" to keep the quality of the group of instructors on the recommended level.
- The KFA board did not implement and maintain a good working safety management system and did not create the conditions for the proper safety culture. This was one of the reasons that important positions were vacant.
- KLM, as the owner of the academy, developed fewer activities to enhance safety, the safety management system, and the safety culture than can be expected from an owner of a flying school (especially when the owner is an airline and has the necessary knowledge to enhance a safe operation).
- The oversight of CAA-NL was insufficient.

Causal factors

- The insufficient overview by CAA-NL.
- Absence of a just safety culture as a result of a lack of adequate measures by KFA management.
- The absence of adequate activities of the owner of the academy.

Recommendations

To the KLM flight academy

- Develop an adequate safety management system and incorporate a non-punitive safety reporting system with feedback to all participants and encourage instructors and students to report occurrences.

To KLM

- As owner of the KFA, set requirements in relation to safety, the safety management system, and the safety culture. Keep oversight by requiring reports and performing audits.

To CAA-NL

- As civil aviation inspectorate of the KFA, set requirements in relation to safety, the safety management system, and the safety culture. Keep oversight over implementation and execution by requiring reports and performing audits.
- Investigate the possibility of requiring limited registration of flight data for aircraft operated by approved flying schools, for example, by flight data recording.

Remark: Shortly after the accident, a number of safety actions were taken by the KLM flight academy.

Summary

The aircraft wreckage from a mid-air collision can provide valuable information to the investigation process. The techniques in this paper provide a framework for expanding the basic mid-air collision investigation principles to more complex accidents. By properly documenting the scratch marks created from a mid-air collision, the collision and convergence angles can be mathematically derived even in some of the more complex cases. *[The views expressed in this paper are those of the authors and not necessarily the views of the NTSB.]* ◆

The (R)Evolution Of Human Factors in Transport Safety Investigation

Learn why the Swiss cheese model sometimes is not as applicable as has been thought and that it can be misapplied in some cases as a prescriptive investigation technique, rather than a theoretical model.

By M.S. Young (Brunel University, U.K.), S.T. Shorrock, J.P.E. Faulkner (University of New South Wales, Australia), and G.R. Braithwaite (Cranfield University, U.K.)

(This article was adapted, with permission, from the authors' paper and presentation entitled Who Moved My (Swiss) Cheese? The (R)Evolution of Human Factors in Transport Safety Investigation *presented at the ISASI 2004 seminar held in Australia's Gold Coast region Aug. 30 to Sept. 2, 2004, which carried the theme "Investigate, Communicate, and Educate." The full presentation including cited references index is on the ISASI website at www.isasi.org.—Editor)*

When it comes to incidents and accidents, the popular template adopted for human factors investigations has been James Reason's "Swiss cheese" model as expressed in his *Human Error,* 1990 and *Managing the Risk of Organizational Accidents,* 1997. One of the implications of this has been the sometimes-blinkered search for latent conditions leading up to the incident. Overzealous implementation of the theoretical model has sometimes led to an illusion of management responsibility for *all* errors. While this may often be appropriate for major accidents, in many cases the retrofit seems contrived and untenable.

This article reviews a variety of case studies to explore the role of human action at the sharp end. A critique of Reason's organizational accident model is presented, with a focus on the problem of identifying latent conditions in hindsight. We, the authors, believe that the focus on latent factors such as management and regulation has gone too far, and perhaps we should redress some of our efforts back to the human in control.

The evolution of accident causation

Transport disasters, such as the Tenerife runway collision in 1977 or the Ladbrook Grove rail crash (U.K.) in 1999, are mercifully rare. However, public concern over such events is inversely proportional to their frequency and probability of harm, as noted by W.T. Singleton in his *The Mind At Work: Psychological Ergonomics,* 1989. Oft-quoted statistics reveal that more than two-thirds of these accidents involve "human error" by pilots, air traffic controllers, ground personnel, and mechanics as a major contributory factor. Many other commentators and researchers put this quotient closer to 90 percent.

Data such as these have been instrumental in raising the profile of human factors, within training, research, and investigations (e.g., the laudable movement toward crew resource management, or CRM, and its offshoots). In response, ergonomists and psychologists have been driven to determine why humans are so fallible, and the discipline of human factors has grown from modeling individual cognitive failure to investigating the organizational contribution to accidents. The popularization of this way of thinking is largely thanks to the work of James Reason, whose Swiss cheese model of accident causation is now adopted as a model for investigation in many industries. Indeed, in aviation, the model has been adopted by organizations such as the Australian Transport Safety Bureau (ATSB) as the basis of its standard methodology and is endorsed by the International Civil Aviation Organization (ICAO).

Reason made a key distinction between active, operational errors (often using the unfortunate term "unsafe acts") and latent, organizational conditions. Reason stated, "systems accidents have their primary origins in the fallible decisions made by designers and high-level (corporate or plant) managerial decision-makers." (1990, p. 203) Ac-

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tive errors were seen as symptoms or tokens of a defective system. It apparently became the duty of incident investigators and researchers to examine the psychopathology of organizations in the search for clues.

Has the pendulum swung too far?

Organizational accident theory and the Swiss cheese model occupy a curious position in accident research and commentary in that *they are never challenged*. While these developments were clearly landmarks in accident investigation research, this unquestioning stance is an unhealthy state of affairs in science. We believe that there are flaws in the prescriptive implementation of a theoretical approach. While the importance of analyzing human factors throughout the accident sequence is not in question, the dogmatic insistence on identifying the latent conditions could and should be challenged in cases where active errors have played the major part.

Ironically, it seems that the only person to question the use of Reason's Swiss cheese model is Reason himself. In his 1997 book *Managing the Risks of Organizational Accidents*, Reason warned that "the pendulum may have swung too far in our present attempts to track down possible errors and accident contributions that are widely separated in both time and place from the events themselves." Subsequently, at the 2003 Australian Aviation Psychology conference held in Sydney, he reiterated his concern that "maybe we are reaching the point of diminishing returns with regard to prevention." Reason stated some concerns with the ever-widening search for the upstream or "remote factors" in safety investigation. The main points were as follows:

- They have little causal specificity.
- They are outside the control of system managers and mostly intractable.
- Their impact is shared by many systems.
- The more exhaustive the inquiry, the more likely it is to identify remote factors.
- Their presence does not discriminate between normal states and accidents; only more proximal factors do that.

Significantly, Reason stated, "*perhaps we should revisit the individual* (the heroic as well as the hazardous acts). History shows we did that rather well." (emphasis added)

In this article, we take this statement as licence to pass a critical eye over the application of Reason's (1990, 1997) organizational model to incident investigations. When viewed in this light, textbook case studies display a continuum of latent and active failures. We ask the question whether the focus on latent errors has become too strong and whether efforts should be redressed back to the human at the sharp end. It should be made clear at the outset that this shift is in no way an effort to reapportion blame or shift the ultimate goal of accident investigation (i.e., to prevent future accidents). Rather, it is in direct keeping with such philosophy that all of the relevant causes of an accident should be elucidated. Let's now examine a recent aviation incident in order to demonstrate the significance of the front-line operator.

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Bangkok—the lost error

On Sept. 23, 1999, a Boeing 747 aircraft overran a runway while landing at Bangkok International Airport in Thailand. The ATSB investigation report 199904538, 2001 (page v, xii) said: "The overrun occurred after the aircraft landed long and aquaplaned on a runway which was affected by water following very heavy rain. The aircraft sustained substantial damage during the overrun, but none of the three flight crew, 16 cabin crew, or 391 passengers reported any serious injuries.… These events and conditions can be described in many different ways, the most common being the model of organizational accidents as outlined by James Reason and others."

Although this investigation was conducted in accordance with standard practice by adopting the "Reason" organizational model, it is our contention that the report did not sufficiently acknowledge the contribution of an active error, thus distorting the rest of the findings. The most critical event in the accident sequence was, arguably, an active error. Because this was not sufficiently acknowledged in the investigation report, the rest of the findings were distorted.

The critical event referred to is the captain's late and incorrectly handled cancellation of the go-around. Due to an unstable final approach, the aircraft was just about to land when the captain instructed the first officer to go around. This was a perfectly normal decision and corresponds with required flight procedures. The next action by the captain, though, seemed to have no basis in standard training. Some 4 seconds later, the captain retarded the thrust levers (in fact only three of the four) "because he decided to continue the landing rather than go around. The captain gave no verbal indication of this action or of his intentions and did not take control of the aircraft from the first officer," noted the report (page 9).

In the sparse discussion of this decision, the report states: "It is very widely accepted that a decision to conduct a go-around should not be reversed.… The captain's rejection of the go-around appeared to be a considered but rapid response to a unique situation." It is not clear why the report concluded that the captain's actions were "considered," and the situation only became unique when the aircraft ran off the end of the runway onto a golf course.

That there were latent conditions at work is not in question. The ATSB investigation report identified deficiencies in company procedures and training for landing on water-logged runways. However, the lack of discussion of such a critical part of the incident sequence seems to illustrate the dramatic shift toward the "latent" end of the Swiss cheese, as well as our lack of understanding of such errors. Furthermore, the latent conditions would have little direct relevance if it were not for the events at the sharp end. The question of why the captain acted as he did in canceling the go-around is a mystery. Every organization can be investigated, and there will always be organizational issues to address. However, establishing clear cause-effect relationships between these and any subsequent incident is another matter. In the case of QF1, while the identification of latent conditions undoubtedly served to improve the safety health of the airline, it is hard to see how these conditions had a significant causal influence on the ultimate active error.

Pathogens in the railways

In addition to aviation and nuclear power, the Reason model has been adopted in railway industries around the world as a template for incident investigations. While we maintain that such use of the model could still fall prey to an excessive focus on latent conditions, a review of major railway accidents reveals that this industry may exemplify the organizational model better than any other. The key systemic deficiencies contributing to railway accidents would appear to lie in design and maintenance. Some of the most high-profile fatal accidents in the U.K. of recent years have been a result of inadequate track or signal maintenance (e.g., Clapham Junction, Hatfield, Potters Bar).

The most recent major fatal rail accident in Australia can also be attributed to latent failures, this time in the design of the train protection systems. The Waterfall inquiry, as noted in the Ministry of Transport 2003 report, found the design of the deadman system to be deficient, in that the weight of the driver's legs was sufficient to maintain the footpedal in the suppressed position. Further evidence uncovered at the inquiry revealed that some drivers (although not the driver of the Waterfall train) had been deliberately circumventing the system by forcing a handsignaller's flagpole into the footwell, thereby keeping the pedal suppressed. This suggests that the design was not only deficient in failing to achieve its intended purpose, but also in being a hindrance to drivers such that they felt the need to commit a "necessary" violation.

Although these brief case studies have focused on the most pertinent latent conditions involved, there were undoubtedly further organizational failings underlying the errors in each case. However, the point is that there was nothing that the drivers of any of the trains involved could have done to prevent the accidents. That is, in terms of occurring in close temporal and spatial proximity to the event, there were no identifiable active errors.

Not all rail crashes fall into this category either, though. The increased public and media concern with SPADs lately has inevitably been the result of fatal accidents caused by trains passing signals at danger. In the U.K., the collisions at Southall in 1997 and at Ladbroke Grove 2 years later were both the result of drivers passing a red light. Again, there were clear organizational problems in each case—most notably concerning the train protection systems and driver training—resulting in an extensive set of recommendations from the joint inquiry of Professor Uff and Lord Cullen. The accident at Glenbrook in 1999 was partly the result of verbal communication failures when the signaller (correctly) authorized the driver to pass a failed red light.

Clearly, SPADs are another category of accidents for which active errors are a necessary and sufficient component in the accident chain. This is not to say that there were no organizational failures at Southall, Ladbroke Grove, or Glenbrook, nor that any of the drivers were necessarily "at fault," but that key errors on the front line were essential to complete the accident chain.

The Swiss cheese model has been applied or misapplied to lead to the conclusion that the roots of all errors and accidents stem from the organization's management. This is not the case. Many errors are simply a by-product of normal, adaptive cognitive processes. "Inadequate defenses" would make the errors more dangerous, but even then some errors would overcome even well-planned and maintained defenses.

Cutting the Swiss cheese

In light of the above cases, let's examine whether the organizational accident model is still valid for describing, investigating, and preventing accidents or whether the approach to safety investigation needs to evolve further rather than revolve.

An ultimate and necessary (though not always singly sufficient) cause of all technological disasters relates to human actions. Reason (e.g., in Maurino et al. in *Beyond Aviation Human Factors—Safety in High Technology Systems*, 1995) contends that an error can comprise mostly latent conditions, mostly active failures, or a combination of both. As argued through the various case studies above, though, the accident without a significant contribution from active failures is a relatively rare event (*Challenger* being one such example, and the rail industry providing other exceptions). Accidents occur due to varying proportions of predisposing factors and precipitating events, and many require an active "trigger" to keep the window of accident opportunity open. The Swiss cheese model has been applied or misapplied to lead to the conclusion that the roots of all errors and accidents stem from the organization's management. This is not the case. Many errors are simply a by-product of normal, adaptive cognitive processes. "Inadequate defenses" would make the errors more dangerous, but even then some errors would overcome even well-planned and maintained defenses.

Investigations of "near misses" seem to find far fewer organizational contributions. In an analysis of 3 years of U.K. enroute air traffic control (ATC) airprox incidents by one of the authors of this article, it was found that very few organizational factors were mentioned in the published incident investigation reports. In ATC, it would appear that active errors and human performance at the sharp end are currently the major factors contributing to incidents. Are accidents and near misses really so different in causality? Or is the line between in-depth investigations and safety audits becoming increasingly blurred?

The Swiss cheese model and the top-down nature of associated investigation raise the concern of "hindsight bias," where we overestimate what we knew or would have known before an event. Reason seems to show some susceptibility to hindsight bias in some of the case studies he presents. While accident investigators do apply certain tests to these links, these tests are not part of the Swiss cheese model, and indeed the tests may be more subjective than we wish to believe. In the analysis of the BAC 1-11 windscreen accident (Maurino et al., 1995), the authors cite a series of latent failings—such as insufficient stocks and poor labeling of stock drawers—that formed the accident chain. While these may well be organizational failings, the establishment of causality is only really evident in hindsight at best, as noted in S. Dekker's *The Field Guide to Human Error Investigations*, 2002, and even then subject to interpretation.

Top-down investigations (as advocated by Maurino et al., 1995 and Reason, 1997), working retrospectively from the event outcome, are easily influenced by knowledge of the consequences. Latent conditions are often present semi-permanently anyway, and it is only the unfortunate occurrence that reveals their pathogenic status. A bottom-up approach, investigating the contextual factors and working forward along the time line toward the event (cf. Dekker, 2002), might give a more unbiased view of the relevant factors. Many of these factors would doubtless seem insignificant to the actors, or even the industry regulators, and it is therefore harsh to judge them as latent failures *post mortem*.

The "human" in human factors

The point here is not that Reason's Swiss cheese model is irrelevant or outdated—indeed, the model has clearly revolutionized incident and accident investigations worldwide and put human factors firmly on the map. However, the case may now be that industries and organizations have latched on to the model in a far-too-rigid and dogmatic fashion. As a consequence, investigations are continually searching for those hidden latent conditions when, in some cases, more attention should perhaps be focused on the human—both cognitive and emotional aspects.

For instance, many major accidents are rife with so-called "errors of commission," including Three Mile Island and the go-around cancellation in QF1. These decision errors involving "extraneous actions" were brought into focus in the early 1990s but did not receive the kind of attention they deserve, except at surface level. Barry Kirwan in *A Guide to Practical Human Reliability Assessment,* 1994 notes that the problem with such errors is twofold. First, extraneous actions are difficult to predict, being rooted in misconceptions, knowledge inadequacies, or misleading indications. Predicting what people could fail to do (errors of omission) based on a task analysis is much easier than identifying what *else* people could do. Second, such errors can have a dramatic impact. Reason, in *Human Error,* noted the difficulties faced in detecting mistakes. The person making the error can often only detect it from the adverse consequences, since before that point everything is going according to plan, which happens to be faulty.

Perhaps we can also look more closely at the emotive influences on behavior. "Emotion," however, is hardly a word in the human factors nomenclature. Indeed, many models often used in the study of human performance make no mention of emotional factors. It may be that emotion is simply seen as uncontrollable, unpredictable, and unfathomable. References to emotion in accident and incident reports are rare. Try to find references to "panic" in NTSB reports. You will come up with little. But surely emotional responses must play a role sometimes. The QF1 captain must have been under stress. He was almost certainly fatigued, having been awake for almost 21 hours. Could his cancellation of the go-around have been influenced by emotion? This very human side of behavior needs to be better understood.

Without wanting to return to the Dark Ages of "human error" being the company scapegoat for all accidents, there is a balance to be redressed in accounting for the role of active errors. Latent conditions are often significant, but occasionally people really do just slip up.

Closing thoughts

The position in this article is not that Reason's Swiss cheese model should be discarded as a philosophy for accident investigations, despite the seemingly negative tone. Our argument is simply that the organizational approach is not as universally applicable as has been thought and that the Swiss cheese model can be misapplied as a prescriptive investigation technique rather than a theoretical model.

The fixation on latent conditions can result in the sidelining of active errors, which may have more direct implications for the outcome in many cases.

Ironically, it can also shift the "blame" ever backward from front-line operators to designers and managers and so on. However, the search for latent conditions has resulted in recommendations that undoubtedly improve the safety health of the organizations concerned, despite these conditions arguably having only tenuous connections to the actual event.

Our aim has not been to criticize James Reason, or to throw his Swiss cheese to the mice. We would just like to see an increased awareness among investigators of the spirit of the model, rather than following the letter of Reason's "bibles" so dogmatically. Without wanting to return to the Dark Ages of "human error" being the company scapegoat for all accidents, there is a balance to be redressed in accounting for the role of active errors. Latent conditions are often significant, but occasionally people really do just slip up. ◆

Underwater Recovery At 3,300 Feet

Discover the strategies used for wreckage mapping and search and recovery of the flight recorders and airplane parts of the B-737-300 crash into the Red Sea off Sharm el-Sheikh, Egypt.

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On Jan. 3, 2004, Flash Airlines Flight FSH604, a Boeing 737-300 registered as SU-ZCF, operating as a chartered flight from Sharm el-Sheikh, Egypt, to Paris, France, crashed into the Red Sea approximately 6 nautical miles southwest of the airport. Egypt and France jointly carried out underwater recovery operations from Jan. 3 to Feb. 5, 2004. The initial search for possible survivors and the recovery of bodies were priorities for the rescue and investigation teams.

The accident triggered a lot of emotion in France because of the large number of French victims (134 of 148). The complex international situation and the rather mysterious nature of the accident raised many questions. Speculation on safety (airworthiness of the airplane) and on security (possible terrorist attack) led to intense media coverage while the initial results of the technical investigation were awaited.

The investigation of a civil aviation accident comes within the framework of the Chicago Convention, to which both Egypt and France are signatories. Annex 13 to this Convention details the responsibilities of the different States involved in the occurrence. The technical investigation, carried out by the Egyptian Investigation Commission, with the participation of the United States (the NTSB) and France (the BEA), was charged with finding answers as to why this accident occurred. The investigation team was composed of specialists from the Egyptian CAA, Flash Airlines, the NTSB, the FAA, Boeing, SNECMA, and the BEA.

The salvage operation was the first step in the investigation. Egyptian and French Navy ships and equipment undertook the underwater recovery operations. To this end, the French Navy mobilized considerable resources, both human and material. Four ships, the frigate *Le Tourville* and the fleet support *La Somme* and two salvage ships (*Ile de Batz, Janus II*) equipped with underwater robots became involved and completed the operation. A great deal of coordination was required between the various parties to provide rapid answers to the many questions raised by the disaster.

Preparatory work

Before committing the naval resources, it was essential to get more information on the wreckage site. Parts that were found floating on the surface and the initial witness statements that were collected were not sufficiently precise to allow the wreckage of the plane to be located. Moreover, the seafloor was not thoroughly charted and varied in depth between 100 meters (330 feet) and 1,420 meters (4,686 feet) over relatively short distances.

A flight recorder immersed under water can be located by the signals (1 bip/second with 37.5 kHz (±1 kHz)) transmitted by the beacon (pinger) attached to the recorder. This pinger starts as soon as it is in contact with water and is designed to transmit this signal for at least 30 days. Recovery teams used equipment from the BEA and the French Navy. The BEA's portable equipment, consisting of a directional hydrophone, could not pick up any signals. But success came with the French Navy's acoustic detector assembled on a pole called "Helle," which tracks signals on frequencies ranging from 7 to 50 kHz. This detector has two reception antennae, one omnidirectional and the other directional. The detector was connected to an audio system that controlled the frequencies and was coupled with a global positioning system.

FDR, CVR search

The first stage in the search consisted of checking signal transmissions and defining a general area using the omnidirectional antenna. Because the seafloor was uncharted, locating the beacons (pingers) was

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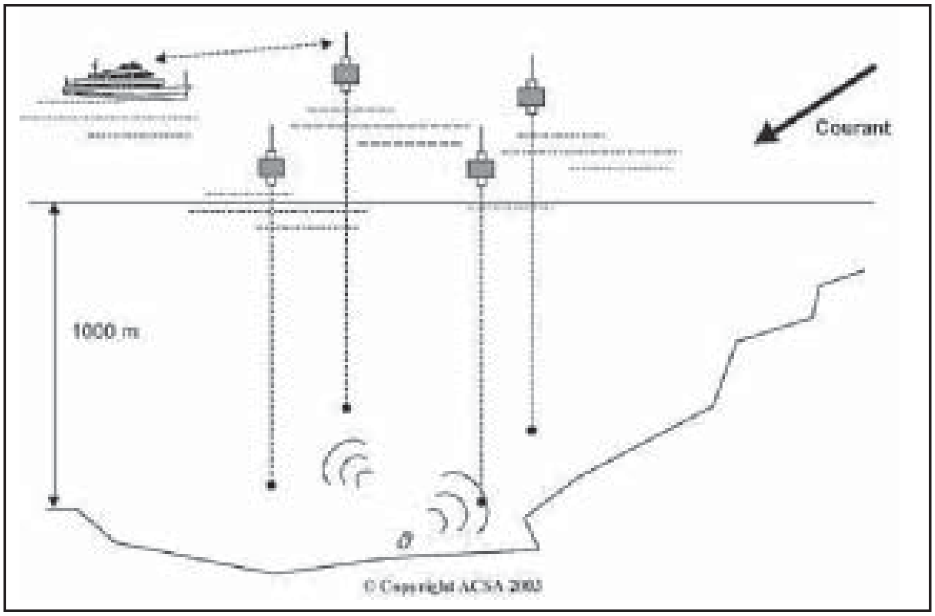


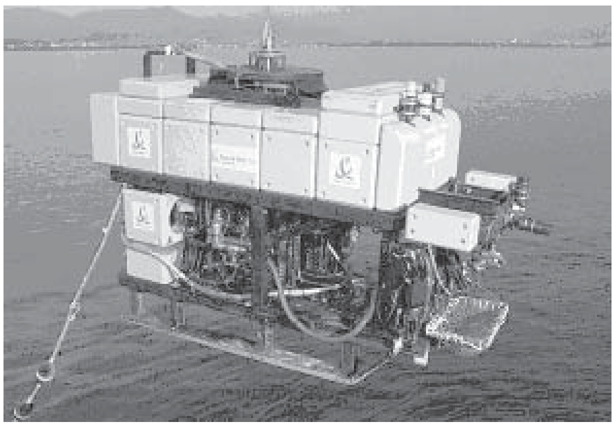


Figure 1 (above): GIB system.
Figure 2 (left): Scorpio ROV operated from *Ile de Batz.*

complicated by possible reflections from the transmitted sound waves and possible secondary echoes. The next stage consisted of taking successive bearings using the directional antenna to get a more precise fix.

This acoustic search determined two possible positions for the flight recorder beacons: one to the south with a position considered as nominal since it could be picked up from all bearings, but which was transmitting more weakly than the one identified further north. The measurements and calculations performed gave an estimated depth of around 1,000 meters (3,300 feet).

To confirm these results, the USBL (ultra short base line—acoustic positioning) of the *Ile de Batz* (the first recovery ship on site) was temporarily modified (in coordination with its manufacturer, Sonardyne) and adapted to the reception of the signals transmitted by the southern pinger. These results confirmed the presence of a transmission source beneath the *Ile de Batz* that had been positioned directly above the estimated position.

Use of a GIB system—To narrow the pinger position search area, the French Navy contracted ACSA (Advanced Concept and System Architecture) to supply a GIB system (GPS intelligent buoys). Contracting officials adapted a network of four acoustic receivers to conduct a search at a depth of around 1,000 (3,330 feet) meters.

The hydrophones, immersed 450 meters (1,485 feet) down around the initial identified pinger position, drifted with the current while continuously transmitting their position and any signals received (Figure 1). An algorithm integrated all data to determine the recorder's fixed position.

Through the use of a GIB system, the FDR was ultimately found in the area defined by the Navy, just 12 meters (39.6 feet) from the position computed by ACSA. The GIB system proved essential in this search, because the ROV (remotely operated vehicle) used only visual means to search for the recorders and could not be guided by acoustic information to home in directly on the beacons.

Assets and other search tactics—The French Navy sent the oceanographic hydrography ship, the *Beautemps-Beaupré*, to carry out multi-beam sonar bathymetry of the accident area. It drew up a chart of the seafloor with a 50-meter isobath. This knowledge of the topography facilitated ROV operations on the seafloor.

The *Ile de Batz*, owned by Alcatel (LDA), was designed to lay and maintain submarine communication cables and is ideally suited for this type of search mission. This powerful ship is equipped with dynamic positioning II (DP II), enabling it to maintain its position at a given point in spite of adverse weather conditions. The *Ile de Batz* is approximately 140 meters (462 feet) long and can operate at great depths. The Scorpio ROV (work class, see Figure 2), provided by France Télécom Marine (FTM), was installed with its 50 tons of equipment on the ship's main deck.

The *Janus II*, owned by Comex, is a 30-meter (99 feet) aluminum semi-swath catamaran equipped with dynamic positioning. This ship can be used to support the Remora 2000, a twin-seat submarine that can operate down to 610 meters (2,013 feet), and the Super Achille ROV (observation class), which can operate down to 1,100 meters (3,630 feet).

The Super Achille is a light unit and can be remotely controlled via its lifting cable from the *Janus II*. A "garage" cage was lowered vertically from the ship by a winch located on the main deck. Once at its working depth, Super Achille exited the cage attached via a 70-meter (231 feet) floating cable, controlled by a winch at the top of the cage (tether management system). The ROV was equipped with a transponder acoustic beacon controlled through the *Janus II*'s USBL; it was also used as a DP reference and was continuously positioned on the integrated navigation system. A record could thus be kept of the ROV's movements and its position in relation to the garage, which was also equipped with a transponder. This gave the robot mobility by not hindering its movements through the drag from around 1,000 meters (3,330 feet) of connecting cable.

FDR recovery—The Scorpio robot started searching for the recorders using its cameras, based on an initial determination of the position of its beacon. Squares of 50 x 50 meters (165 by 165 feet) were systematically searched by the ROV. This position was then refined by the ACSA GIB system. That produced a theoretical position with a precision of plus or minus 10 meters over 100 meters (33 feet over 330 feet). By dividing the accuracy radius by 10, the search area was divided by 100. A square of 20 by

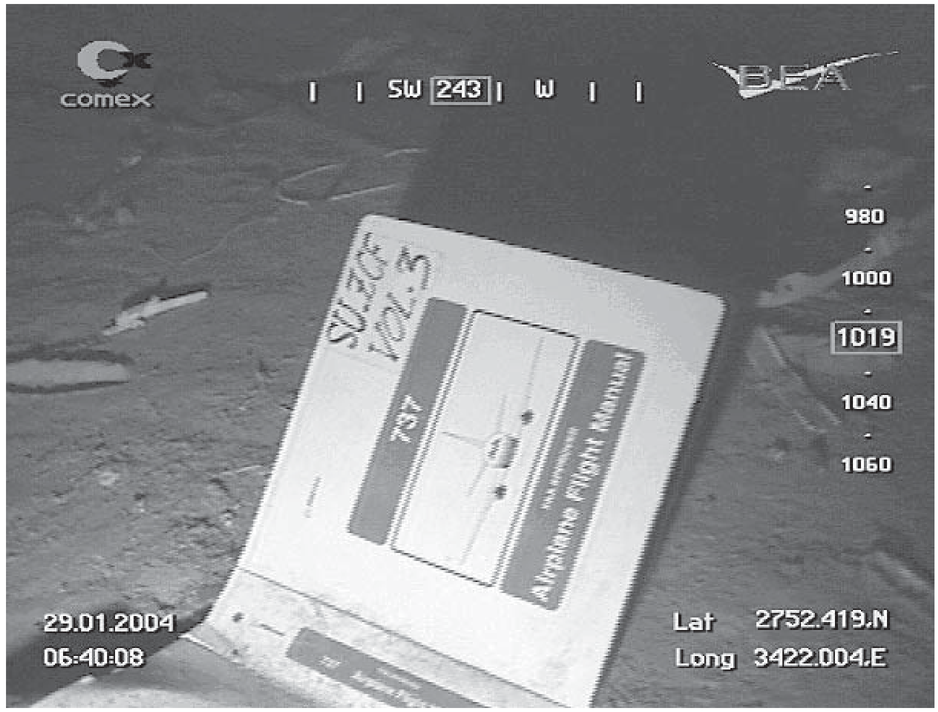
Figure 3: Investigators' workroom.

20 meters (66 by 66 feet) was then defined and searched by the ROV. While finishing one run, this visual search finally led to the discovery of the FDR, which was in fact located approximately 12 meters (39.6 feet) from the estimated position.

CVR recovery—The search for the second recorder required making some further tactical choices. From the beginning of the operations, the echo from the second beacon had appeared to be located a few hundred meters (about 660 feet) north of the initial search area. At that time, results from ACSA computations were not yet available. For accidents with high-impact forces, accelerations at the time of the collision may separate the pinger from the recorder case. This assumption was considered plausible on the basis of the initial information gathered. Two approaches were then possible (1) to wait for the absolute position of the northern echo to be determined on the basis of the ACSA computations and (2) to continue the search in the area where the FDR had been found, supposing that the pinger had been detached from the CVR.

The second approach was chosen. On the basis of the initial analysis of wreckage distribution, it was decided to define a zone to the south of the position of the FDR. The CVR was found approximately 24 hours after the discovery of the FDR just outside the search area designated by the investigators. Its case was damaged more than that of the FDR; its reference numbers and the pinger had separated.

The use of a large television screen connected to the panoramic camera helped in identifying its position, as the CVR was spotted during a 180-degree turn between search lines. The facilities on board the *Ile de Batz*, which contributed greatly to enhanced teamwork and coordination, were a key element in the rapid recovery of the recorders.



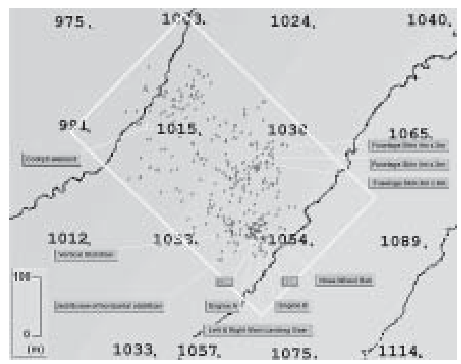


Figure 4 (above): Underwater picture taken by Super Achille.
Figure 5 (right): Wreckage distribution.

Transfer procedure

It was important to have an agreed official procedure for transferring the flight recorders from the French to the Egyptian authorities since the recorders were to be recovered from Egyptian territorial waters (Egyptian jurisdiction) via a ship flying the French flag (French jurisdiction). Moreover, since Egypt had just been equipped with a technical laboratory, the readout of the flight recorders was to be undertaken in Cairo.

It was also necessary to satisfy news media requests for images. An official photographer took photographs of the recoveries of the recorders (which in both cases happened at night). They were quickly put on line on the BEA website.

So as not to hinder salvage operations, the Egyptian Navy had secured the zone. The BEA officially delivered the recorders to the Egyptian Commission in Sharm el-Sheikh harbor in the presence of journalists. The Egyptian judicial authorities then affixed seals for their transfer to Cairo.

Wreckage mapping

Exploration of the seafloor was organized by defining rectangular zones extending outward from the central area. Each zone was then divided into grids with the side of each square being 3 to 5 meters (9.9 to 16.5 feet), depending on the ROV used and the specific objectives. During these operations, it was important to have aeronautical specialists who were able to coordinate the search and identify the debris. Each Scorpio and Super Achille ROV dive was filmed. On board the *Ile de Batz*, the workroom was equipped with a video recorder, which allowed some dives to be reviewed during ROV maintenance.

The digital video system on the Super Achille was also able to take digital stills of the airplane parts considered interesting to map and examine (see Figure 3, flight manual) with the still featuring an inset with parameters such as latitude, longitude, depth, heading, etc.

The various parts located and identified during the dives were entered in a database. Parameters such as the date, the position, a brief description, and photographic references provided useful information for the

Figure 6: Rudder recovery.

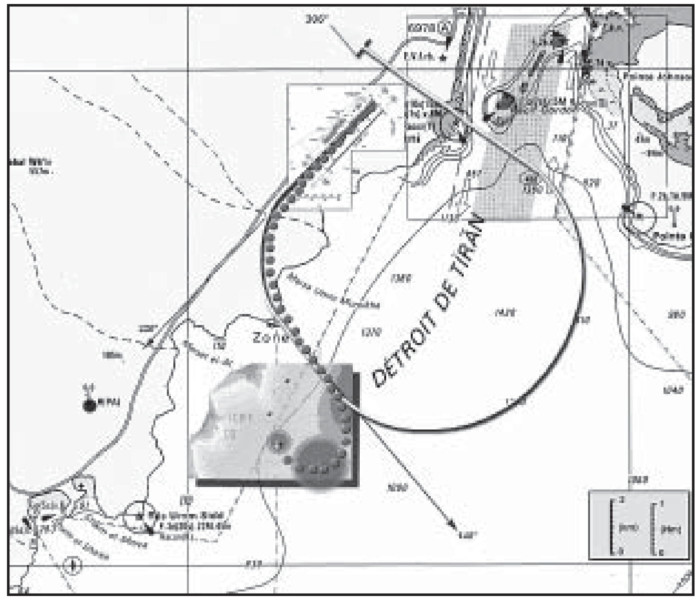


Figure 7: Combined data on one map.

investigation and could thus be easily accessed (this database contains approximately 400 located and identified wreckage parts).

Figure 5 shows the wreckage distribution and the extent of the search area (a rectangle 440 by 275 meters (1,452 by 907.5 feet). The Super Achille also traveled on the seafloor toward the location of the northern echo and searched a 100-x-100 meter (330 x 330 feet) square but did not find any pieces of wreckage nor the pinger.

The wreckage distribution is compatible with the last recorded heading (311°) and the northeast current measured by the *Beautemps-Beaupré*. The heavy parts (engines and main landing gear) were close to the point of impact whereas lighter debris drifted with the prevailing current during their 1,000-meter (3,300-feet) descent.

Airplane parts recovery

The strategy for airplane parts recovery was developed after initial flight recorder readouts undertaken in Cairo were completed. All parts related to airplane control surfaces, flight systems, and flightdeck panels were regarded as priorities. The strategy included a procedure to record the description, dimensions, and coordinates of the parts recovered by the investigators, following their first observations. A database made it possible to establish the link between these parts and the photographs taken on the ship's deck or on the seafloor.

A specific nomenclature was also adopted:

- SW (surveyed wreckage) for the debris surveyed on the seafloor.
- FW (floating wreckage) for the floating debris recovered in the first few days after the accident.
- RW (recovered wreckage) for debris recovered.
- PE (personal effects) for the personal effects.

Fifty-five items were recovered, identified, and referenced as FW, and around 50 parts were recovered from the seafloor and in turn referenced RW.

The work performed jointly by the *Janus II* and the *Ile de Batz* (both with dynamic positioning) made it possible to recover large parts such as the rudder (see Figure 6) and the elevator.

All salvaged parts were preserved in seawater until unloading at the naval port of Sharm el-Sheikh and handover to the Egyptian authorities.

Personal effects recovery

Some items of clothing were recovered. On several occasions, they jammed the propellers of both ROVs. Their slightly positive buoyancy made handling and recovery difficult. Personal effects recovered included watches, cell phones, bags, wallets, etc. Some personal effects fell out of the recovery basket during the 1,000-meter (3,300-feet) lift to the surface.

When possible, some personal effects were recovered progressively during the search operations. The majority of these personal effects were then recovered by the *Janus II*, which remained at the accident site longer for that purpose. The search covered the central zone where most of the personal effects were located. The *Janus II*'s mission at Sharm el-Sheikh ended when everything possible had been recovered.

Search/recovery conclusions

The recorders were recovered in less than 2 weeks, although they were in a relatively uncharted area about a 1,000 meters (3,300 feet) deep. Figure 7 combines a maritime map, airfield data, bathymetric data, and the airplane track from the FDR readout.

The success of the operations was mainly due to the preparatory work undertaken by the Navy, which meant that appropriate equipment and personnel could be sent to the site quickly. The investigation team was then able to define the most effective strategy to find and recover the recorders in the shortest possible time.

The logistical support was a significant part of the success of the operations. The support ships' adaptability and the hard work of their crew made the joint recovery efforts more complementary, and thus more effective. The Navy's decision to deploy the ACSA system also contributed greatly to reducing the amount of time needed for the search. The mobility, adaptability, and the image quality from the Super Achille made it possible to cover the site methodically and to recover many personal effects.

Teamwork proved to be key in the success of this operation with each contribution improving the effectiveness of this joint effort. Sharing the knowledge gained during this experience will help other investigators facing the aftermath of an occurrence similar to the Sharm el-Sheikh accident. ◆

Human Factors in Stressful

Shedding light on the domain of the individual coping with stress: changing gears from functioning in the green range to functioning in the yellow or even in the red range.

By Werner Naef, Air New Zealand

(This article was adapted, with permission, from the author's presentation entitled Human Factors in Stressful Team Situations: A View from an Operational and Training Perspective *presented at the ISASI 2004 seminar held in Australia's Gold Coast region Aug. 30 to Sept. 2, 2004, which carried the theme "Investigate, Communicate, and Educate." The full presentation including cited references index is on the ISASI website at www.isasi.org.—Editor)*

Investigation reports into occurrences, incidents, and accidents—according to the established process—start with a narrative synopsis of what happened. This usually gets supported by factual information and data retrieved from different recording sources. The subsequent analysis then looks into causal factors and the dynamics involved and puts all into context explaining links between the different factors. The findings then provide a clue as to why the mishap did occur. Finally the recommended actions propose what has to be done in order to avoid another such occurrence and thus improve the overall situation.

Applying models from researchers like James Reason or Bob Helmreich in these process steps helps investigators to systematize and thus to better understand the dynamics of the events: how defense layers have been penetrated and how well or how badly threats and errors were managed, resulting in risk levels that—according to investigations—then mostly got out of control.

From here and in order to improve, the industry and the regulators implement changes in process, in hardware, and in skill management. The results are regulations, procedures, checklists, and organizational charts being adapted or even newly designed. Also resulting is hardware improvements and skill training reinforced, adapted, or newly designed as well.

Although investigators strive for continuous improvement on all fronts, again and again the result is another mishap, occurrence, or accident. A closer look reveals that in the majority of all cases it is the well-known "human element" that plays a crucial role and thus becomes a key issue for any future improvement.

In medicine, the notion is that with further investments into medical *technology* only a tiny improvement can be achieved, but a systematic investment into *"human factors training"* would have a much greater effect and success. As a well-known research paper has disclosed, in the U.S. between 48-98,000 patients die annually due to medical malpractice in one way or another.

A microscopic look also reveals that it is not just the technical skill training and the classical "human factors" training that is needed, but yet another training domain needs our attention—the domain of the individual coping with stress, changing gears from functioning in the green range to functioning in the yellow or even in the red range.

This paper tries to shed some light onto this domain.

It's not only that an adequate training in threat and error management is badly needed in terms of developing strategies "how we would proceed if…." We need to get a step closer to the individual's reactions under stress; learn and experience individually about our own stress patterns; and develop, apply, and modify intervention techniques that can be applied to the individual and/or on other members of the team involved.

Do we really take adequately into consideration the ability of the "man" component to deal with his/her built-in, own variability?

Green range to yellow/red range

Examples of a few mishaps in different areas demonstrate the need to shape stress training:

09/11 investigation commission—Do you remember those words heard from tapes played recently to the National Commission on Terrorist Attacks Upon the United States (also known as the 9-11 Commission) when an FAA official asked some Defense Department official over the phone if they would launch fighters? The response was something like "….uhh….I don't know…. uhhh…."

The response was a completely inadequate and failed "professionalism"—but no surprise here; these people had been

Werner Naef, *a human factors investigator with Air New Zealand from 2003 until 2005, has been involved in international scientific associations/boards and is a subject matter expert in human factors with national (Swiss CAA) and international (European JAA) regulatory bodies and within the airline industry (Association of European Airlines). He led the Daimler-Benz Foundation (1998-2004) research project Group Interaction in High Risk Environment/Aviation. His career has included being an airline and Air Force pilot in Switzerland and an instructor and fleet and training manager. Recently he joined Aerospace Certifications & Training (www.safetyaudit.aero) as director and trainer.*

Team Situations

thrown from business as usual straight into top stress levels without any warning. And that's how it happens.

Management blunder—Remember the collapse of a major national flag carrier in central Europe in 2001? We saw a new CEO, former CFO of a huge corporation, taking command and asking insiders how it came that the former management—being involved in aviation and, therefore, being familiar with planning items like "alternate planning"—could have gone that far without considering any alternative course of action. Exactly the same person then, later and under increasing stress, did exactly the same—no consultation with any knowledgeable body, lonely wolf behavior, tunnel vision "how to save the company" without considering any alternative…. Stress symptoms in quantity.

Malpractice—Keen to perform, keen to fulfil expectations, keen to compensate for lack of resources—these were the drivers in a recent incident in a Swiss hospital where an 82-year-old patient had the wrong leg amputated and subsequently died. Under the magnifying glass of the investigation, all sorts of stress symptoms surfaced.

Aviation—Remember the captain of a Middle East airline—the aircraft was on fire and returned under emergency with open fire and panic in the cabin? On the CVR he was heard singing during final approach—only a closer look revealed that he was citing verses from the Koran. Under the extreme stress he reverted to old methods of dealing with stressful situations—completely inadequate with what was expected in the given situation. Stress symptoms in the most pure form.

Politics—Remember when President Nixon got under fire about Watergate? Remember those pictures on TV of him exhibiting deep stress patterns?

Common issues in all these cases:

- All key players in these examples were under stress.
- All of them had excellent training and all of them had passed the respective exams so they basically knew what and how to do it, and they all also had quite some practical experience behind them.
- The moment they passed a certain stress level their behavior became narrow-minded, narrowly focused, and one-sided. Tunnel vision took over.
- Behind their very individual stress-bound behavior (tunnel vision) was a specific driver that delivered the motivation to exactly act the way they did.
- This switch from "operating in the green range" to "operating in the yellow (or even red) range" diverted them from adequately analyzing and assessing situations and made them follow a different "dominant logic."
- The takeover of such "dominant logic"—other than the logic expected under consideration done in a cognitive-level thinking process—has to do with something else than with what we have learned, even what our experience would probably be.

By the way, isn't some of the behavior that is sometimes observed on busy highways (not our own, of course) close to what was just described above?

Backstage

Our behavior, our functioning has several sources. It is an outcome of several layers of our personality, of our skills, of our experience, of our mindset—and of the environment, of course.

Taking up a model from psychology (PCM©: Process Communication Model© by Taibi Kahler, Ph.D.) will help our understanding of some of this complex process. Here is a closer look into how our "human computer," in terms of a functioning input-output system, works.

Interestingly we can model our "computer software" also into a part that might be called "system software" while another part might be called "application software." The system software is representing our "self" while the application software represents all that we have acquired in terms of skills. The self represents, e.g., value system, self-appreciation, appreciation of others, attitude.

The difference with any technical computer: our personal, human built-in system software cannot be updated anymore once it has gone beyond a certain development stage.

Heredity, childhood experience, and other influences shape our basic personality structure that—at the age of around 7 years—has already reached the final development stage, "system software version 3.0."

Heredity, childhood experience, and other influences shape our basic personality structure that—at the age of around 7 years—has already reached the final development stage, "system software version 3.0." It's with this system software version that we will handle all of our future in terms of how we function—there is not much change to this basic structure anymore once we have passed our first 7 years of personality development. What we do change—and we do it at large—is the implementation of all kinds of application software—software we need to run an adequate professional life, to do what we like to do in our spare time, etc. But all this takes place on the foundation of that very specific, very individual system software version 3.0.

Here is a closer look at the phenomena representing specific individual behaviors—specific individual system software. Observe that we have *different modes of functioning indeed.*

Perception

• ***Perception***—Some persons perceive the world through thoughts; to do so they need facts and figures, and the ruling principle applied to deal with the world is the principle of *logic*. Other persons perceive the world through opinions; to do so they need to trust others, and the ruling principle applied to deal with the world is the principle of *value system*. Still other persons perceive the world through emotions; to do so they need relationships with others, and the ruling principle applied to deal with the world is the principle of *compassion*. And so on. Statistically there are some six such different ways to perceive the world.

Process improvement and safety enhancement should be achieved by focusing more on the functionality of the man-component under stress.

• ***Communication***—Some communicate in a directive mode ("go get me…," "tell me…") while others do it in a more nutritive way ("so nice to be here…."); there are several ways how to do it.

• ***Psychological needs***—Some strive for recognition of work and for time structure, others look for recognition of person and for sensory, others strive for action, others for solitude…. There are also several different specific psychological needs that can typically be found in specific personality structures.

Character strengths

• ***Character strengths***—Some are adaptive, persuasive, and charming; others are spontaneous, creative, and playful. Others are dedicated, observant, and conscientious. There is a range of character strengths that differs among various types of personalities.

Stress patterns

For us, the most important differentiation among various types of personality is the specific reactions of the individual to stress. These stress patterns relate to very early experiences in our own life—whether we trust ourselves or not, whether we trust others or not. We distinguish between light stress and heavy stress. The latter is characterized by stress that really has a heavy impact on us—we "really get wet." It's stress that might have to do with the fundamental threat to our life, our existence, or our self-esteem or with the lives of our loved ones.

Stress patterns have different intensities. A light stress (Level 1) might arise several times a day—anytime something has to be done that does not just satisfy basic needs or means fun. We then typically react according to a specific driver—this one linked to the specific typology we represent: "be perfect," "be nice," or "be strong" to mention some. If the stress increases to the next level, we then are submitted to attacking others, blaming others, or becoming a drooper—taking up the role of the victim. And it is not only such "inside-the-system" stuff that makes us different—specific types differ in choosing words, setting tones, gestures, postures, and facial expressions.

Back to start

Looking into occurrences—whether in medicine, in aviation, in business management, in crises management—in our investigations we come across stress-influenced behavior of key persons again and again.

Wouldn't it be wise to have such key persons, decision-makers, and opinion leaders know more about their stress patterns? How they develop, how they start to pop up, how they influence their rationale behavior? How to counteract and get the stress level down again?

Wouldn't it be wise to have others know about such stress phenomena and have those people be able to adequately intervene once a key player has been thrown into stress? Allow for stress-reducing intervention instead of stress-increasing confrontation?

Such insight into one's own stress patterns can be achieved. The mastering of a stress-reducing intervention technique can be achieved. The knowledge and the methodology are available. But in technology-focused fields like aviation, any methodology to tackle the findings of investigations is traditionally tailored along technology methodology and is less human-process-focused. And in exactly this domain—the area of the human factors—we are subjected to occurrences again and again. The following proposals will enable the start of reversals to the repetition.

• Have relevant people know about and experience not only their specific business area, but also their specific mode of operation once they get under stress.

• Have such training integrated beyond transfer of "human factors knowledge" through use of tutorials or CD-ROMs.

• Have teams trained to cope with stress symptoms typical for the individuals of that team.

Conclusion

In the complex man-machine-environment interface, the machine improves constantly—heaps of money getting involved. The environment has to be accepted as a random variable. But "man" is among the most complex of the components involved. And this component gets added to the system as newcomers again and again. And it constantly shows up as a major causal factor in mishaps in any area concerned. Do we really adequately take into consideration the ability of the "man" component to deal with his/her built-in, own variability? Process improvement and safety enhancement should be achieved by focusing more on the functionality of the man-component under stress. ◆

Benefits of Individual ISASI Membership

About You

You are an air safety professional. You may work for an airline, a manufacturer, a government, the military, an operator, or on your own. But you are a person who is dedicated to improvement of aviation safety and you joined ISASI with the expectation of enhancing the achievement of that goal.

About ISASI

ISASI is the only organization specifically for the air safety investigator. Our motto is "Air Safety Through Investigation." We are a growing, dynamic organization with a full range of membership.

Why Join? Lots of reasons—activities, education, services, and networking

- The yearly ISASI seminar has become a focal point for aviation safety professionals throughout the world. Attendance has steadily grown and the presentations are state of the art and meaningful. The 2003 seminar was held in Washington, D.C., celebrating the 100th anniversary of flight, and the 2004 seminar was held in Australia's Gold Coast region.

- The *Reachout seminar program* was instituted to provide low-cost, subject-oriented seminars in regions of the world with higher accident rates. Since the first *Reachout* held in Prague, Czech Republic, in May 2001, there have been numerous Reachout seminars, some of which were held in Lebanon, Chile, India, Sri Lanka, Tanzania, and Costa Rica. All have been an unqualified success in attendance and content. These mini-seminars provide our corporate members an opportunity to directly affect safety in those areas where it will have the greatest return.

- The ISASI publication, *Forum,* is a first-class magazine, published in color four times a year. Its editorial content emphasizes accident investigations findings, investigative techniques and experiences, regulatory issues, industry accident prevention developments, and member involvement and information. Each issue also features one of our corporate members in a full back-page "Who's Who" article.

- The annual seminar-published *Proceedings* are provided to individual members at no cost on line.

- Individual members have access to past ISASI publications, our library, and accident database.

- ISASI now has an easily accessible website, www.isasi.org, with an extensive "Members Only" information section and a limited general public area.

- Our corporate and individual members are a large and diverse group working in all facets of the industry worldwide. This presents a unique opportunity for personal and on-line networking.

ISASI is the place for those dedicated to improving aircraft accident investigation and aviation safety.

PREAPPLICATION FOR INDIVIDUAL MEMBERSHIP

(Cut and mail to the address below or otherwise contact ISASI to receive a full membership application.)

PLEASE PRINT

Name (last, first) ____________________

Date of birth ____________________

Home address ____________________

City ____________________

State, district, or province ____________________

Country ____________________

Postal zip/zone ____________________

Home telephone ____________________

Citizen of (country) ____________________

E-mail address (optional) ____________________

I AM INTERESTED IN APPLYING FOR SOCIETY MEMBERSHIP IN THE MARKED MEMBERSHIP CLASSIFICATION. PLEASE FORWARD TO ME A FULL MEMBERSHIP APPLICATION.

❑ **Member**—A professional membership class requiring at least 5 years' active experience as an air safety investigator.
❑ **Associate Member**—A professional membership class for air safety investigators who do not yet fulfill the requirements for member.
❑ **Affiliate Member**—A public, non-professional membership class for persons who support ISASI's goals and objectives.
❑ **Student Member**—A membership class for students who support ISASI's goals and objectives. (If student, list name of institution where enrolled____________________.)

Present employer ____________________

Employer's name ____________________

Address and telephone ____________________

Did your position involve aircraft accident investigation? ❑ Yes ❑ No

Your title or position: ____________________

Dates: from ____________ to ____________

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E-mail: isasi@erols.com

Society Council Selects Singapore for '07

(Adapted from minutes and notes of the International Council meeting recorded by Keith Hagy, Secretary.—Editor)

The ISASI International Council, during its May 6 meeting in Herndon, Va., USA, voted to accept the AAIB-Singapore bid to host ISASI 2007. Because there is no home ISASI society located there, the seminar will be under the auspices of the ISASI National Council as was ISASI 1998, held in Barcelona, Spain. The Singapore AAIB will coordinate and work with Barbara Dunn, chair of the ISASI seminar committee, to establish plans for a successful seminar. Dunn will make a "site visit" and arrange for ISASI headquarters to collect seminar registration fees and sponsorship donations. Tentative dates for the seminar are Aug. 27-30, 2007.

In other seminar news, Curt Lewis, in his role as president of the ISASI Dallas-Ft. Worth Chapter, which is hosting ISASI 2005, reported that planning for the upcoming seminar continues with registrations beginning to come in. The seminar website is up and active. Two tutorials are planned. The first is on helicopter accident investigation and the second on emergency response. John Goglia, former NTSB Member and long-term ISASI member, is scheduled to be the keynote speaker.

Similarly, Dunn reported that planning has begun for ISASI 2006 to be held in Cancun, Mexico. The tentative selected dates for the event: September 11 to 15. Carlos Limon from the Mexican Pilots Association and Luis Ortiz, president of the ISASI Latin American Regional Society, are involved in planning seminar events.

President Del Gandio addressed all the work done by Dunn that has reinvigorated and raised standards for seminar planning. She is very actively involved in seminars that are being hosted in locations where an ISASI group is not present, but where members create and establish an atmosphere conducive to conducting an annual seminar. In addition, Del Gandio lauded the completion of the new seminar manual and the direction it provides planners. He noted the change that there is no longer a limit on the number of non-member representatives from ISASI corporate members who may register for seminars at the member rate. In the past, the limit was two individuals.

E. MARTINEZ

Chan Wing Keong (left), director AAIB, Singapore, presents his proposal to sponsor ISASI 2007 to the Council. Listening are, left to right, Ron Chippindale and Barbara Dunn.

During President Del Gandio's far-ranging report, he encouraged discussion of any subject he addressed. Among those topics was the ISASI website. Council discussion and consensus was that the site had grown too large and was too important to the Society to be maintained on a voluntary basis. Corey Stephens, who developed, initiated, and acted as volunteer webmaster for the ISASI site, was lauded for his efforts and service to the Society. The belief is that the website's increased content is difficult to keep current, as is the membership directory, through voluntary efforts. Because of the web's direct reflection on the Society, the Council agreed with the need to hire a

2004 Annual Seminar Proceedings Now Available

Active members in good standing and corporate members may acquire, on a no-fee basis, a copy of the *Proceedings of the 35th International Seminar*, held in the Gold Coast, Queensland, Australia, Aug. 30-Sept. 2, 2004, by downloading the information from the appropriate section of the ISASI website at http://www.isasi.org. The seminar papers can be found in the "Members" section. Alternatively, active members may purchase the *Proceedings* on a CD-ROM for the nominal fee of $15, which covers postage and handling. Non-ISASI members may acquire the CD-ROM for a US$75 fee.

A limited number of paper copies of *Proceedings 2004* are available at a cost of US$150. Checks should accompany the request and be made payable to ISASI. Mail to ISASI, 107 E. Holly Ave., Suite 11, Sterling, VA USA 20164-5405.

web professional and directed that a search and hire be made.

The President also reported that he had asked the Positions Working Group to consider drafting an ISASI position on digital photography. Later in the meeting, Positions Group Chairman Ken Smart presented to the Council some draft language aimed at strengthening the Society's position on flight deck image recorders. The Council recognized the need for the Society to take a firm position on technology that would aid the investigation of an accident, but the Society also recognized the legal and privacy issues associated with image recorders. After some discussion, the Council felt that it needed more time to discuss the draft language and asked Keith Hagy to work with Smart and the Positions Working Group on some language that would strengthen the Society's position and acknowledge the associated legal and privacy issues.

In the area of membership, Del Gandio reported there are 1,456 members on the rolls from 56 different countries. Tom McCarthy, treasurer and membership chair, noted that 11 new corporate members have been recorded, which includes four by the U.K. Society and one from the New Zealand Society. General membership activity in the societies is reported as good: ESASI-127; ASASI-137; CSASI-94. While the dues delinquency rate is improving, McCarthy stressed that Council members should continue efforts to reduce the existing rate. In this regard, the President has contacted each corporate member by letter, outlining the benefits of ISASI membership. McCarthy noted that individual delinquent members are placed in an inactive status and are unable to vote in elections, do not receive copies of the *Forum*, or enjoy any of the other benefits of active members.

McCarthy, in his treasurer's role, reported that ISASI 2004, conducted in

PHOTOS: E. MARTINEZ

ABOVE: Ron Schleede asks a question of President Frank Del Gandio.
RIGHT: Lindsay Naylor makes his report to the Council.

Australia by the Australian Society, contributed $41,000 to the national ISASI treasury, helping to maintain the Society's sound financial condition. He also noted that the 2004 annual audit is under way and is being conducted by the appropriate accounting method.

National Societies/Councillors

Ken Smart, president of the European Society, noted that Dr. Graham Braithwaite from Cranfield University had expressed an interest in joining the Investigator Training and Education Working Group. Following the meeting, President Del Gandio offered Braithwaite the appointment as chairman of the group and he accepted.

Barbara Dunn, Canadian Society, reported the CSASI has joined the Canadian Aviation Executives Safety Network (CAESN). The goal of CAESN is to identify safety issues and mitigation strategies.

Ron Chippindale, New Zealand Society, raised the concern that the Reachout program was straying from its original intent of bringing accident investigation techniques to parts of the world with emerging aviation systems, but where funds are too scarce to attend annual ISASI seminars. He noted that workshops are now conducted in what might be considered "garden spots" and that the focus is on accident prevention. Further discussion declared that Reachout had many missions: to bring ISASI visibility and to teach accident investigation and accident prevention. Also, it was noted that over time ISASI Reachout has been able to partner with ICAO COSCAP and as such has to go where the ICAO members request the need. The Council accepted a suggestion that with the expanded role for Reachout, the original stated aims should be reviewed by the program chairman and broadened, if necessary.

Committee/Working Groups

Jim Stewart, chairman of the Reachout program, noted in a written report that ISASI corporate members are not as sufficiently aware of the program's successful activities as might be believed, considering the numerous articles published in the *Forum.* He suggested that a specific communications vehicle directed to corporate members would be useful in raising program awareness and increasing support. One of the first topics of the communication vehicle would be a sponsorship funding campaign to help cement the financial condition of the program.

He noted the great influence "guaranteed" sponsors, such as ALPA and Continental Airlines, have had on the program's success. A letter of special acknowledgement will be forward to appropriate senior managers of these organizations.

Other continuing supporters are ICAO and COSCAP-NA. Stewart reported that the newly appointed chief of accident investigation and prevention, Marcus Costa, has pledged continued support for the ISASI/ICAO partnership regarding Reachout.

John Guselli, Air traffic Services (ATS) co-chairman, submitted a revised terms of reference for the Working Group. The Council approved it. Among the terms of reference are that the Air Traffic Services Working Group will

- promote and facilitate the ready exchange of air safety investigation information, particularly in the field of ATS Investigation.
- provide mutual assistance in ATS-related occurrence investigation in response to any legitimate request.
- promote and facilitate mutual assistance in the training of investigators for the ATS investigation specialty.
- actively support the ISASI Reachout program in its mission of international harmonization.
- promote and facilitate liaison between safety professionals in the area of ATS-related occurrence investigation.
- provide and facilitate a resource forum for ISASI that will enable examination and discussion of new and contemporary ATS investigation techniques.

Joann Matley, Cabin Safety, reported that she had been working to provide the Working Group products to the membership through the ISASI website. In addition, the minutes from the Working Group meetings are being placed on the website.

The Council meeting adjourned following McCarthy's filing an item for new business. He asked that Council members consider the question about "equivalent experience" for new members to reach full-member status: How much investigative experience should be required? Are matters of "safety promotion" and "accident prevention" acceptable equivalent experience? Reminding the Council that the "national" societies decide on the membership category before forwarding the application to ISASI, he suggested Council members be prepared to discuss the issue at the Council meeting scheduled to be held in connection with ISASI 2005. ◆

Goglia Set to Deliver Keynote at ISASI 2005

John Goglia, senior vice-president of government and technical programs for the Professional Aviation Maintenance Association (PAMA), will ride point in opening the 2005 ISASI seminar, *Investigating New Frontiers of Safety*. The seminar, slated for September 12-16, will be held amidst the frontier heritage of Fort Worth, Tex., at the Renaissance Worthington Hotel.

Goglia is a previous Member of the National Transportation Safety Board (NTSB), serving in that position for 9 years. He is the only presidential appointee to the Board ever to hold an Airframe & Powerplant certificate. During his tenure on the Board, Goglia championed aviation safety through professional maintenance and raised awareness about the effects of poor maintenance. Also, throughout his tenure, and continuing to the present, he is an active member of ISASI.

Goglia also serves as a professor of aviation science for Saint Louis University's Parks College of Engineering, Aviation, and Technology, and directs the College's Center for Integrated Emergency Management.

Registration for the seminar has kicked off. Registration and reservations may be made by forwarding the adjacent registration form on page 25 or from the seminar's website at www.ISASI2005.com.

Registration fees for the event are $495 for members, $225 for student members, and $545 for non-members. Fees rise slightly after August 15 to $545, $250, and $595, respectively. For $95, attendees have the option of two tutorials: Helicopter Accident Investigation Basics or Family Assistance Act & Accident Preparedness.

The remainder of the seminar's

2005 ISASI Seminar Agenda

Seminar Attendees		Companions
Day 1	Choice of two tutorials (optional) Welcome reception	Free explore day
Day 2	Seminar opening Keynote address by John Goglia Paper presentations with Q & A Panel discussion ISASI Society meetings Dinner and entertainment at Billy Bob's	Visit to Fort Worth's Cultural District Visit to Fort Worth's Botanical Gardens Visit to the Fort Worth Stockyards Dinner and entertainment at Billy Bob's
Day 3	Paper presentations with Q & A Panel discussion Session on crewmember perspectives ISASI Working Group meetings	Discover historic Granbury. Lunch on board a riverboat and tour the Brazos River and Lake Granbury Shopping
Day 4	Paper presentations with Q & A Closing statements ISASI Working Group meetings Seminar banquet	 Seminar banquet
Day 5 (optional)	Tours of Dealey Plaza and museum in Dallas, plus a visit to an authentic Texas ranch, the Circle K!	

Investigating New Frontiers in Safety

September 12-16, 2005
Fort Worth, Texas USA

A professional training seminar for anyone interested in aviation safety presented by

The International Society of Air Safety Investigators

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For room reservatons call the Renaissance Worthington Hotel Fort Worth (Marriott) at 1-817-882-1600 US/Toll-Free: 1-800-468-3571. Conference rate $140/night; use Group Code SASSASA.

Please check appropriate box: ***Please note that all fees are shown in US Dollars.***

	Registration PRIOR TO 16 August 2005	Registration AFTER 15 August 2005
Full Seminar & Functions (per person)		
Member:	[ ] $495	[ ] $545
ISASI Student Member:	[ ] $225	[ ] $250
Non-member:	[ ] $545	[ ] $595
Single day with no functions (per person) (Tue/Wed/Thur):	[ ] $175	[ ] $225
Tutorials (per person)		
Emergency Response Preparedness including Family Assistance Issues	[ ] $95	[ ] $125
Helicopter accident investigation	[ ] $95	[ ] $125
Companion Program (per person)	[ ] $350	[ ] $395
Tuesday Night Party at Billy Bob's of Texas (per person) (See note below)	[ ] $35	[ ] $45

Note: The Tuesday evening, September 13. Billy Bob's Party is included in all Full-Seminar Registrations and the Companion Program.

Post Seminar Function (price per person)	[ ] $95	[ ] $95

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Cancellations made before 15 July 2005 (Dallas) will incur a $10 processing fee. Cancellations made between 15 July 2005 and 15 Auç incur a $75 administration fee. There will be no refunds for cancellations after 15 August 2005. Registrations are transferable.

technical program is currently being finalized. Once complete, the technical agenda will be updated on the website. A companion program is also available, which includes the seminar's welcome reception and banquet, an evening at Billy Bob's, an authentic Texas honky-tonk, and 2 days of experiencing Texas at its frontier best. ◆

MARC Meeting Draws Record Crowd

The ISASI Mid-Atlantic Regional Chapter (MARC) recorded more than 110 guests at its spring Chapter dinner/meeting held at the newly opened National Transportation

Safety Board Academy, at Ashburn, Va., USA, on May 5.

The meeting coincided with the spring meeting of ISASI's International Council, members of which were in attendance at the NTSB academy. In addition to opening remarks by Chapter President Ron Schleede, ISASI President Frank Del Gandio addressed the group and was followed by guest speaker NTSB Chairman Designate Ellen Engleman Conners, nominated for her second term as chairman and awaiting confirmation. The event, which included a refreshment hour, a briefing/tour of the academy, and the highly prized reconstructed fuselage of the TWA 800 teaching tool, was marked by President Schleede as, "…ideal for international aviation safety representatives to meet for the exchange of ideas and promotion of the primary goal of air safety investigators—the prevention of accidents."

Following welcoming remarks by Julie Beal, academy director, Kathy Silbaugh, acting deputy director of the academy, provided a PowerPoint briefing of the academy's mission and the TWA 800 investigation. She then led the group to the cavernous bay that houses the reconstructed fuselage of TWA 800 and provided a detailed explanation of the explosion damage and, briefed the group on the investigation methodology, findings, and how investigators disproved many of the theories concerning how the explosion occurred.

PHOTOS: E. MARTINEZ

ABOVE: NTSB Chairman Designate Engleman Conners presents "thank you" plaque to Ken Smart. LEFT: Dennis Smith and his wife, Sharon, accept door prize of free roundtrip ticket from Jean-Pierre Dagon, AirTran Airway. BELOW: Enjoying a social moment, left to right, are Richard Stone, Frank Del Gandio, and Ellen Engleman Conners.

Throughout the event, door prizes, donated by JetBlue, AirTran, Airbus Industries, Independence Air, Reynolds Technology International (rti), and others were presented to winners. Among the few who received free round-trip airfare tickets were Dennis and Sharon Smith.

In his after-dinner remarks, President Del Gandio gave the MARC members a brief update on the status of the Society. Commenting on the Society's highly successful Reachout program of training seminars, he noted that the idea for such a program was first broached by Olof Fritsch, then international councillor, in 1968. Other members have taken Reachout from a concept to a reality that is having a positive impact. He said that 769 persons, mostly accident investiga-

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tors, have been through the program. Del Gandio also urged continued promotion of the ISASI Rudolph Kapustin Memorial Scholarship, named for the former MARC long-term president. He noted that two corporate members who specialize in safety instruction have added tuition awards to the selectee(s).

Chairman Designate Engleman Conners during her presentation explained the NTSB mission as it relates to accident investigators, calling it a two-part process—first we must determine the probable cause of the accident and second, make safety recommendations that, when implemented, will help to prevent future accidents. She said both the accident report and our safety recommendations fulfill the Board's mission. "Out of tragedy, good must come." In this regard, she reported that the NTSB has aggressively pursued advocating implementation of its safety recommendations, which now number less than 800 open recommendations for the first time since 1975. She stressed that an existing critical issue that is crossing all modes of transportation is human fatigue, "and we are not doing enough about it; it is a critical area that we have to address." She noted that the NTSB academy and its training courses include this critical issue. She urged all of the Society's international membership to take advantage of the facility, whenever possible.

"People," she said, "should feel safe in whatever mode of transportation they select, and it is that expectation of safety that builds public confidence." Noting that safety is part of an investigator's personal mission, she concluded that working together, safety will remain the first and foremost goal.

Before leaving the lectern, she unexpectedly called on Ken Smart, president of the ISASI European Society and retiring chief inspector of air accidents, U.K. Air Accidents Investigation Branch (AAIB). She presented him a plaque, engraved with the comment, "To Ken Smart, a good friend of the NTSB, for contributions to aviation safety." ◆

ISASI Reachout Proves Popular in Asia

The ISASI Reachout program has become very popular in Asia. On May 10 and 11, a 2-day Reachout workshop on safety management systems (SMS) was held at the EVA Airline training facility in Taiwan. Participants came from EVA Airlines, China Airlines, Flight Safety Foundation, Taiwan, Republic of China Air Traffic Controller's Association, the Taiwan Civil Aeronautics Administration, Air Line Pilots Association (ALPA), Korea, and representatives of the Taiwan Accident Investigation Commission. The session, which was based on the Air Line Pilot's Association training package, was modified by the instructors to include emphasis on the importance of incident investigation and ensuring a linkage between the components of an SMS program and the investigation of possible accidental loss. ISASI Reachout Chairman Jim Stewart and Caj Frostell, international councillor, conducted the program.

Following the Taiwan program, the ISASI team traveled to Seoul, Korea, and presented a more detailed 4-day SMS program to about 50 participants from the Republic of Korea and Mongolia as well as from Boeing. The workshop was the first to be held in Korea, and current plans are for a follow-up workshop on accident investigation, which may be scheduled in 2006. Korean Airlines, Asiana Airlines, the Ministry of Construction & Transportation, the Korean Civil Aviation Authority, and members of the Korean Aviation Accident Investigation Board all attended the session.

ISASI has presented 14 Reachout workshops around the world since the program started in May 2001 in Prague, Czech Republic. The participation of corporations has been critical to the success of the program, and the delivery of these two programs was no exception. The Air Line Pilots Association and

Shown at the completion of the Reachout program in Korea are, from left, Jim Stewart, Shin Myung Nam (flight operations), Capt. Yoo Byung Yul (flight operations), Kim Yong Seok (ATC) all from the Korea Aviation Accident Investigation Board, Caj Frostell, and Jenny Yoo, cabin safety and survival factors.

Continental Airlines continued their outstanding support of the Reachout program with ALPA agreeing to allow the use of training material and documents prepared by its safety management systems project team under the leadership of Capt. Rick Clarke (United). Continental Airlines provided instructor travel in North America as it has frequently done in the past. In particular, Jim Stewart highlighted the personal commitment of ISASI members Keith Hagy (ALPA) and Toby Carroll (Continental Airlines) as key elements in the program's continuing success.

Danny Ho and EVA Airlines provided all instructor travel from North America to Taiwan and then to Korea for both workshops and provided all instructor support in Taiwan. The ICAO COSCAP-NA program, with the support of Boeing, covered instructor expenses in Korea.

The Reachout program continues to meet the objectives of the Society and has expanded its program to link other important safety programs to the need for effective accident and incident investigation. The Reachout Committee is still trying to recruit a suitable instructor for the maintenance area.

If interest exists in participating in the Reachout program as a sponsor, please contact Jim Stewart, chairman, ISASI Reachout at sms@rogers.com. ◆

New Members

CORPORATE

Directorate of Aircraft Accident Investigations-Namibia, CP0236
- Mwangi C. wa Kamau
- Ananias N. Shivute

European Aviation Safety Agency, CP0238
- John W. Vincent
- Alain Leroy

Flight Attendant Training Institute at Melville College, CP0237
- Dennis E. Adonis
- ODell S. Patterson

Star Navigation Systems Group, Ltd., CP0235
- Viraf Kapadia
- Amir Bhatti

INDIVIDUAL

Alston, Gregory, A., MO5149, Albuquerque, NM, USA
Dittmann, Paul, G., MO5163, Ottawa, ON, Canada
Edwards, Michael, MO5152, Southampton, United Kingdom
Granger, Matthew, E., AO5148, Fayetteville, NC, USA
Guetta, Stephen, D., MO5154, Carleton Place, ONT, Canada
Hudson, Donald, F., FO5159, Surrey, B.C., Canada
Jones, Patrick, H., AO5147, Gardena, CA, USA
Jones, Wayne, D., AO5156, Auckland, New Zealand
Levasseur, Real, MO5155, Chelsea, QE, Canada
Madsen, Kurt, E., MO5150, Jyllinge, Denmark
Mrazek, Richard, J., FO5158, Langley, B.C., Canada
Polley, Graeme, R., AO5151, Hamilton, New Zealand
Poole, Gregory, J., MO5157, Hibiscus Coast, New Zealand
Sardana, M.D., Tarek, M., MO5160, Ottawa, ON, Canada
Smith, D, MO5161, Blanchard, OK, USA
Soucy, Christine, K., MO5153, Arnold, MD, USA
Studtmann, David, E., AO5146, Mesa, AZ, USA
Wall, Dan, G., FO5162, South Fort Worth, TX, USA

ANZSASI Seminar Draws 103 Registrants

The Pacific Regional ANZSASI Seminar held at Queenstown, South Island, New Zealand, from June 9 to 11, and hosted by New Zealand SASI, attracted a record 103 registrants and 20 partners.

The meeting, held in a resort hotel by Lake Wakatipu under the Remarkables mountain range, provided an attractive setting for a program as varied as the audience.

The audience included solid representation from the Australian and New Zealand military and civil safety investigators and administrative authorities. Speakers from both sides of the Tasman Sea gave well-illustrated and informative reviews of significant accident investigations in the area interspersed with dissertations including those on formulating safety recommendations, the 406 MHz ELT, ageing aircrew, recovery of data from EGPWS, and a review by the Japanese representatives of an air miss between a DC-10 and a B-747 near Tokyo. The inventor of a general aviation fuel selector position monitor described his approved device for reducing the probability of takeoffs with incorrect fuel selections.

On the social side, there was an opportunity for "networking" at a 2-hour cocktail reception on Friday coupled with pre-dinner drinks and a banquet on Saturday. These events plus all meals were included in a very modest registration fee.

For the partners, scenic attractions abounded in this pioneering mountain area. Despite difficulties with weather at airports around the country, all but three registered members participated in what was considered a training seminar equal to the larger events run by our parent body. ◆

Braithwaite Appointed To Chair ITEWG

President Frank Del Gandio has appointed Dr. Graham Braithwaite, director of safety and accident investigation training, Cranfield University, U.K., chairman of the ISASI Investigator Training and Education Working Group.

ISASI Forum asked that he introduce himself and provide a brief overview of how he views the tasks associated with his appointment. His response follows.

"I am delighted to have been asked to chair the ISASI Investigator Training and Education Working Group and want to take this opportunity to ask members of ISASI to be vocal about what they want from the Group and what they may be able to contribute to its work. My own background is in education and training and in particular the development and running of courses in safety management and accident investigation. I am a proud member of ISASI, but I do not claim to be an expert investigator and wish to appeal to both investigators and educators alike to get involved in the work of this Group. I currently work at Cranfield University,

In Memorium

Robert E. Kutzleb (Life Member, LM2177), Landover, MD, USA, January 2005.
John (Jack) G. Young (Life Member, LM0819), Herndon, VA, USA, January 2005.
Norman, D. Bruton (MO4063), Pretoria, Gauteng, South Africa, May 2005.
Peterlyn Thomas (MO3128), Kingston ACT 2604, Australia, June 2005.
Robert (Bill) M. Kidd (Life Member, LM0549), Beaconsfield, PQ, Canada, 2004 (month unknown).

U.K., running its accident investigation courses and hope that my experience can help the Group, but ultimately, I just want to be one member of an active group.

"The ISASI Investigator Training and Education Working Group is not a new group, but it is one that has been dormant for a while. Few of us would deny the importance of training and in particular the sharing of our collective experience to further the science of accident investigation. Ron Schleede wrote in the January/March 2004 issue of *ISASI Forum* about the budgetary pressure that many agencies are finding themselves in. Investigators are also finding the stakes raised as lawyers, coroners, and the news media question their qualification to investigate. The Working Group provides the opportunity to continue to develop guidelines for the training of new investigators, the ongoing training of existing investigators, and to discuss ISASI's role in establishing standards.

"Air safety investigators are an interesting crowd, to say the least. A quick look around the room at the ISASI seminar will tell anyone that, but how is it that anyone picks up all the skills that the modern investigator needs? There is no simple answer, but there is a clear interest in understanding what investigators should know, be able to do, and how they should approach the task—the so-called knowledge, skills, and attitudes. Past winners of the Jerry Lederer Award give some inspiration as to what investigators may aspire to, but is there a common view about what makes a good investigator and, more importantly, how we can train someone to become one?

"Here in the U.K., the accident investigation community is reflecting on the need for basic competencies to be defined for accident investigators and training to be designed to keep investigators up-to-date throughout their careers. Experience is important, but many agencies are finding the need to manage the experiences that their investigators are exposed to. The Australian Transport Safety Bureau, for example, uses a diploma framework, which involves investigators demonstrating their competency in a variety of roles on investigations in addition to their technical training. On-the-job training is important, but sometimes things get so busy that there is just not enough time for new investigators to be talked through the experience. At the same time, there is no option of getting things wrong, so the pressure is very much on a new investigator.

"I am very interested in hearing from anyone who may be willing to participate in this Working Group. I envisage a meeting at ISASI 2005, our annual seminar, followed up by e-mail discussions, and I hope that we can assemble a group from different backgrounds to share ideas and experiences. I can be contacted at the following e-mail address: g.r.braithwaite@cranfield.ac.uk. I look forward to what we can achieve for the member of ISASI." ◆

ASASI Member Receives International Award

Dr. Graeme Maclarn, a long-term ASASI/ISASI member, was presented the Aerospace Medical Association's John A. Tamasiea Award for his service to civil and general aviation medicine in Australia and overseas over the past 23 years. The presentation was made at the Association's 76th annual meeting held in Kansas City, Mo., May 12.

Dr. Maclarn (center) displays his award and is flanked on the left by David Millett, M.D., Civil Aeromedical Association, and on the right by Melchor Antuanano, president of the Aerospace Medical Association.

Dr. Maclarn was cited for his work in the education and training of trainee and qualified pilots, medical students, and physicians in aviation medicine in Australia and overseas. He has developed and organized training programs for the School of Community Medicine, University of New South Wales, and for 13 years as president of the Aviation Medical Society of Australia and New Zealand (NSW branch) for New South Wales based physicians known as designated aviation medical examiners. He has lectured for the Federal Aviation Administration in the United States and in Europe.

His work within the education and safety committees of the Aerospace Medical Association, particularly with reference to the "Age 60" Rule and the medical aspects of airplane accident investigation, particularly in the area of computational crashworthiness and injury modeling, is world recognized within the aviation medicine community. His expertise and opinion in these areas of aviation medicine are sought worldwide. ◆

ISASI represented at IFATCA 2005

ATSWG Chairman John Guselli represented ISASI at the annual International Federation of Air Traffic Controller

Associations (IFATCA) conference in Melbourne, Australia, during April 18 - 22. Several hundred delegates, corporate sponsors, and observers actively participated in an agenda ranging from legal obligations of individual controllers to future ATM technology interfaces and associated human factors.

Issues associated with the protection of personal identities for ATC personnel involved in accidents and serious incidents generated significant debate during conference sessions. Additionally, considerable discussion ensued on regional difficulties related to the requirement for common English language proficiency for ATC personnel.

During the conference, the IFATCA executive noted the substantial progress made in the field of normal operations safety survey (NOSS) processes and looked forward to reviewing the initial results. As a safety management tool, NOSS is on track to capitalize upon the foundations of LOSA and further contribute to a reduction in ATC operational errors. Secretary Bert Ruitenberg will provide feedback to ISASI on the progress and evolution of NOSS early in 2006. ◆

SCIS Conducts Czech ATS Accident Investigation Course

The Czech Republic's Ministry of Transport facilitated a Southern California Safety Institute (SCSI) Air Traffic Services Accident Investigation Course in May 2005. Ladislav Mika, co-chairman of ISASI's ATS Working Group and Czech Ministry of Transport official, was a most gracious host in this classic eastern European city.

Air traffic professionals from the Slovak Republic, Finland, the Republic of Bulgaria, South Korea, Sweden, Poland, Hungary, and the Czech Republic represented the class.

Ladislav Mika addresses students attending SCSI's accident investigation course.

Instructors included John Richardson (SCSI), Darren Gaines (NATCA/FAA USA), and Johan Reuss (BFU Germany). The class studied the history of air traffic control, establishing the ATS investigation, human factors, international directives, numerous case studies, and much more. The interaction of the group was positive as it was interesting to share different cultural perspectives and information regarding ATS safety issues across regional boundaries. ◆

Independence Air Repeats As FAA Award Winner

The Federal Aviation Administration (FAA) has again honored ISASI corporate member Independence Air with the Diamond Award, the highest award in the FAA's Aviation Technician Training Program. The airline company's maintenance team has received the Diamond Award every year since 1997.

The award was given to Independence Air based on a detailed evaluation of its maintenance and training programs—which measured the extent of its initial and recurrent maintenance and airworthiness training as well as the company's regular participation in FAA-sponsored policy and regulation seminars.

Independence Air President Tom Moore said, "We could not be more proud of our maintenance team and the outstanding work they do every day." ◆

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WHO'S WHO

BEA Vocation: Improve Aviation Safety

(Who's Who is a brief profile on an ISASI corporate member to enable a more thorough understanding of the organization's role and function.—Editor)

Created in 1946, the Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA) is the official French and independent organization within the Ministry of Transportation in charge of technical investigations into civil aviation accidents and incidents.

To accomplish its mission, the BEA has 110 staff members, 35 of whom are investigators and 10 are investigative assistants. Located at Le Bourget Airport, the BEA also has regional offices in Toulouse, Bordeaux, Rennes, Lyon, and Aix-en-Provence.

The BEA is involved in around 500 events a year on French territory and abroad.

While investigations are at the heart of the BEA's activities, its final vocation is to contribute to improvements in aviation safety. It is the reason why information from reports on safety investigations must be exploited and widely distributed to aviation professionals and civil aviation organizations around the world so as to develop, in particular, cooperation with investigators from other countries.

Because the number of accidents occurring in the area of general aviation remains preoccupying, while the human dramas resulting from them are tolerated less and less, the BEA developed in 2000 the Confidential Reporting System (CRS) as a tool for improving safety, in concert with the Aeronautical Training and Technical Inspection Service and user groups. This system of voluntary reports constitutes a complementary channel for feedback. It is based on the study of minor events mainly linked to human factors, which may be the precursors of accidents.

In the same way, for 2 years the BEA has issued a quarterly publication on incidents in air transport—*Incidents en Transport Aérien*—which groups together reports on investigations into incidents that have occurred in public transport in France and to French operators.

Paul-Louis (Paul) Arslanian is the head of the BEA. He is a former student at the Ecole Polytechnique in Paris and the Ecole Nationale de l'Aviation Civile in Toulouse.

Since he joined the BEA in 1986, Arslanian has taken part in a large number of investigations in France, including its overseas territories, with a direct or managerial participation. Also, through France's role as state of manufacture for the Airbus, ATR, and Falcons airplanes and Eurocopter helicopters, as well as state of the operator for French airlines, he has received wide experience in accident investigation abroad.

Arslanian obtained a worldwide reputation in international matters as a leading member of the European and ICAO com-mittees on aviation noise, from 1980 to 1990.

Paul-Louis (Paul) Arslanian is the head of the BEA.

Since 1991, he has been the chairman of the Accident Investigation Committee (ACC) of the European Conference on Civil Aviation. In this capacity, he is also in charge of safety aspects within the ECAC Valuation Group for new member States. ◆

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