ISASI FORUM

JULY-SEPTEMBER 2004

"AIR SAFETY THROUGH INVESTIGATION"

CONTENTS

FEATURES

DEPARTMENTS

ABOUT THE COVER

Forensics and victim identification was extensive in the November 2001 disaster of American Airlines Flight 587, which crashed into a residential area just after takeoff from New York's JFK Airport. *(Photo:* ISASI Proceedings *2003)*

ISASI FORUM

"Air Safety Through Investigation"

Volume 37, Number 3

Publisher Frank Del Gandio
Editorial Advisor Richard B. Stone
Editor Esperison Martinez
Design Editor William A. Ford
Associate Editor Susan Fager
Annual Report Editor Ron Schleede

ISASI Forum (ISSN 1088-8128) is published quarterly by International Society of Air Safety Investigators. Opinions expressed by authors do not necessarily represent official ISASI position or policy.

Editorial Offices: Park Center, 107 East Holly Avenue, Suite 11, Sterling, VA 20164-5405. Telephone (703) 430-9668. Fax (703) 430-4970. E-mail address isasi@erols.com; for editor, espmart@comcast.net . Internet website: www.isasi.org. ISASI Forum is not responsible for unsolicited manuscripts, photographs, or other materials. Unsolicited materials will be returned only if submitted with a self-addressed, stamped envelope. *ISASI Forum* reserves the right to reject, delete, summarize, or edit for space considerations any submitted article. To facilitate editorial production processes, American-English spelling of words will be used.

Copyright © 2004—International Society of Air Safety Investigators, all rights reserved. Publication in any form prohibited without permission. *ISASI Forum* registered U.S. Patent and T.M. Office. Opinions expressed by authors do not necessarily represent official ISASI position or policy. Permission to reprint is available upon application to the editorial offices.

Publisher's Editorial Profile: *ISASI Forum* is printed in the United States and published for professional air safety investigators who are members of the International Society of Air Safety Investigators. Editorial content emphasizes accident investigation findings, investigative techniques and experiences, regulatory issues, industry accident prevention developments, and ISASI and member involvement and information.

Subscriptions: Subscription to members is provided as a portion of dues. Rate for nonmembers is US$24 and for libraries and schools US$20. For subscription information, call (703) 430-9668. Additional or replacement *ISASI Forum* issues: members US$3, nonmembers US$6.

The State of ISASI

By Frank Del Gandio, President

On May 7, ISASI held its semi-annual International Council meeting at ALPA headquarters in Herndon, Va. The Society is sound, and our publications and programs are proactive and accomplishing stated goals.

The Council voted two significant advances into action (both are fully reported in the "RoundUp" section of this magazine). The first deals with feedback I have received from some of our members in the general aviation sector. These members believe there is value in establishing a General Aviation Committee within the structure of ISASI, to address more specifically the issues that affect that sector's role in accident prevention and its investigation. The Council members looked closely at the issue, discussing if the Society would be able to adequately support such an effort and if it could be of benefit. The final consensus was that the establishment of such a group would benefit the overall Society by a potential increase in membership of investigators trained in the specialties of general aviation investigation, and that support for such a committee was feasible, especially if the task was managed by existing general aviation members. Accordingly, the Council approved creation of the Committee with the proviso that existing ISASI general aviation members develop it. I urge any such member with an interest in this endeavor to contact me, or Curt Lewis, who is working on the development of the Committee.

The second Council action deals with a special membership category for persons who attend a Reachout seminar. We have now completed 11 Reachout workshops throughout the world and have achieved great success in influencing the international community's accident investigation process by making low-cost investigator training available to budget-constrained geographic locations. Unfortunately, ISASI's high cost of membership has discouraged membership application from Reachout attendees. To overcome the financial impediment, the Council established a "Reachout Associate" membership for those who attend the workshops. The standard membership rate will apply, but the initiation fee will be waived. The Council will review the progress of the new-member category in December 2006.

Aside from actions taken by the International Council, there is one area that needs to be addressed—the level of activities of our national/regional societies and local chapters. Some are doing a bang-up job. The Canadian Society has been the backbone of, and major contributor to, the Reachout seminar program. The Australian and New Zealand Societies continue to conduct local seminars and provide valuable services to their members. The Mid-Atlantic Chapter just hosted a highly successful ISASI 2003 and holds scheduled meetings. The Dallas/Ft. Worth Chapter is vibrant and has undertaken ISASI 2005. There are other positive examples, but two of our U.S. chapters, Los Angeles and Southeastern, are inactive and other societies and chapters are relatively quiet. Local activities are vital to the health of ISASI. One of the strongest attraction points of our Society is the opportunity to interact with our fellow members. We need to take a good look at our local activities and make a concerted effort to keep the ISASI voice out front in accident investigation and aviation safety. We also need several volunteers for the Positions Working Group.

The Society is sound, and our publications and programs are proactive and accomplishing stated goals.

Now a few words about recent activities. ISASI 2003, celebrating the 100th anniversary of the Wright brothers' first flight, was a huge success, setting new standards in attendance and sponsorship contributions. A record number of papers was presented, and delegate feedback was that the seminar theme of "100 Years of Identifying Safety Deficiencies and Solutions" was met. Barbara Dunn has done a great job in revising and clarifying our seminar guidelines and receives a "well done" from the Council.

We welcomed our first two student recipients of the ISASI Rudy Kapustin Memorial Scholarship to ISASI 2003, and a winner has been selected for ISASI 2004. Incidentally, the Mid-Atlantic Chapter contributed $6,000 to the scholarship fund, ensuring that it will be viable for the near future. Member contributions are tax-deductible and may be forwarded to the home office.

Our *Forum* continues to be a first-class publication, and the recent tribute issue to Jerry Lederer was a journalistic gem. Membership is growing slightly in spite of a downturn in the aviation industry, and the value of the international office space has increased significantly and provides the Society with a permanent home base.

ISASI 2004 on the Gold Coast of Australia is well organized and has every indication of being another hallmark seminar. All in all, ISASI continues to be a vital organization dedicated to promoting aviation safety education at minimal costs. We are able to do this thanks to our generous corporate members and sponsors, our indispensable office manager, and our irreplaceable volunteer membership. ◆

Forensic Medicine and

Forensic medicine provides today's aircraft accident investigators with scientific data and other factual evidence on topics ranging from positive identification and cause of death; the possibility of a pre-impact fire, explosion, and bomb or incendiary device on board; which pilot was controlling the aircraft at impact; and the aircraft's attitude at impact to factual evidence supporting safety recommendations.

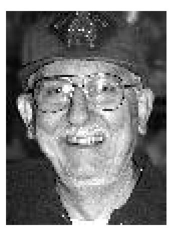
By Steven R. Lund

Forensic medicine is the broad field of medical science where medical matters come into relation with the law—certification of deaths; the study of violent and unnatural deaths, as in accident investigations; scientific criminal investigations involving the coroner; court procedures, etc. The primary interests of forensic medicine for aircraft accident investigations are usually medical and scientific.

Toxicology relates to poisons of all kinds and their effects on the human body, aiding the airliner accident investigators with factual evidence in such areas as to test pilots for substance use or abuse, which might have affected their actions before a crash, and to test passengers' remains for inflight explosion, fire, smoke, or fumes for factual evidence of possible pre-impact fire or explosion contribution to the cause of an accident.

Some important examples of forensic medicine in airliner accidents are positive identification of persons killed in a crash for the statutory responsibility to issue the death certificate. This is usually accomplished using personal effects found on the remains, by comparing fingerprints with government files, matching dental records, and, most significantly, using DNA protocols. To identify individuals, forensic scientists examine 13 DNA regions that vary from person to person and use the data to create a DNA profile of that individual (sometimes called a DNA fingerprint). There is an extremely small chance that another person has the same DNA profile for a particular set of regions. Only 0.1 percent of DNA differs from one person to the next. Scientists can use these variable regions to generate a DNA profile of an individual, using samples from blood, saliva, bone, hair, and other body tissues and products. Then a comparison is made with samples from the victim's close relatives, or, in some cases, from the actual victim, such as hair from a hairbrush, or blood samples from the family doctor. The identification process also includes a lay description of sex, age, height and weight, coloring of hair and eyes, and any special characteristics, such as birthmarks, scars, tattoos, or even any signs of some plain natural diseases.

Another victim identification tool is forensic radiography, which relies on X-ray images of accident victims' remains to obtain information. In the case of the Transportation Safety Board of Canada (TSB) investigation of Swissair Flight 111, which crashed off the coast of Nova Scotia in September 1998, the identification of passengers and crew was carried out by a team consisting of the chief medical examiners of the provinces of Nova Scotia and Ontario, the Royal Canadian Mounted Police (RCMP), Department of National Defense (DND) personnel, and others from the local medical community. One passenger was identified by visual means. The remaining 214 passengers and 14 crew members were identified through a combination of dental record comparison, fin-



About the author: Steven R. Lund *retired after a 32-year career at Douglas Aircraft Company (now Boeing), which was devoted to flight test, flight safety, and commercial jet transport incident and accident investigation. He has been involved in the investigation/analysis of more than 130 jet transport airline accidents worldwide and more than 5,000 incidents. He participated in the RAND Institute for Civil Justice Study on the U.S. national transportation aircraft accident investigation process—"Safety in the Skies—Personnel and Parties in NTSB Aviation Accident Investigations." Among other affiliations, he was a member of the U.S. National Research Council Committee on Aircraft Certification Safety Management, a strategy for the FAA's Aircraft Certification Service.*

Toxicology

gerprint matching, forensic radiography, and deoxyribonucleic acid (DNA) protocols. All 229 occupants of the aircraft were identified within 4 months after the accident.

Other examples of the role forensic medicine has played in accident investigation include

- *A determination of which pilot was at the controls at impact*—through a forensic medicine analysis of the fractured bones in the pilots hands as a result of tightly gripping the control wheel upon impact.
- *Cause of death*—The laws in most countries require a determination of whether an airliner catastrophe was an accident or was due to a criminal act. In at least one case this determination was made by a combination of a loud bang recorded on the CVR and the forensic medicine finding of a bullet hole through the scull of one of the pilots. Criminal act or not, forensic medicine usually determines the cause of death of all fatalities in an airliner crash for inclusion into a "medical certificate of cause of death."

Forensic medicine results are also used to determine the *possibility of an explosive or incendiary device on board* by analyzing full-body forensic radiographic images for small plastic or metallic fragments being deeply imbedded in intact victims, which could only result from an explosion's high-velocity fragmentation of aircraft parts in the vicinity of passengers. Also, the intense heat from an explosion or inflight fire might be detected by forensic medicine when synthetic garments—e.g., nylon—are melted into the flesh of victims. This determination, coupled with the victim's known location, has provided investigators with factual evidence of the physical location of an onboard incendiary device.

- *Impact dynamics*—In some cases forensic medicine results led investigators to a better understanding of the aircraft attitude at impact in addition to the forces involved as a function of time during the crash/aircraft break-up sequence.
- *Product liability litigation evidence*—When the inevitable writs begin flying after a major airliner accident, forensic medicine analysis invariably finds its way into courtrooms. In most states, to prove a product's liability, a plaintiff has to show that the product was defective and was the main cause of the injury. In addition, the surviving relatives or heirs of an individual who died in a fatal accident oftentimes file a wrongful-death lawsuit. The suit is against the person or company whose conduct led to the wrongful death. Plaintiffs can be awarded compensatory and punitive damages. Compensatory damages are comprised of those financial losses that the victim has suffered as a direct result of the defendant's action. Compensatory damages are the most common type of damages awarded to plaintiffs. Compensatory damages can include payment from the defendant to compensate for, among other things, lost wages, lost profits, hospital bills (current and future), cost of home medical care, property damage, mental anguish, loss of friends, loss of respect in the community, loss of reputation, loss of consortium, and pain and suffering (p and s). Forensic medicine evidence, obviously, can play a significant role in proving wrongful death; and even in the amount of pain and suffering (p and s) that might be shown to occur before death, this is normally gauged by the amount of time a victim experiences the p and s as derived from the forensic evidence. For instance, 10 seconds of p and s is often awarded twice as much as 5 seconds of p and s. Punitive damages are not awarded as often as compensatory damages. The judge will award punitive damages only if the defendant's act was so horrible and offensive that the court believes it is important to make an example out of the defendant. Punitive damages are not awarded to compensate a person for his or her direct injuries or property damage (compensatory damages), but are instead added to the compensatory damages in order to discourage other would-be wrongdoers from acting in a similar way. Punitive damages are just what they sound like—they "punish" the defendant.
- *Promote safety changes*—In a more positive area, forensic medicine and toxicology evidence has provided aircraft manufacturers and flight safety officials the necessary means to implement changes to aircraft design to mitigate threats to passengers and crew, such as requiring aircraft interiors to be constructed using materials that don't easily burn and generate pernicious products of combustion. Past examples of some of these changes were substituting stainless steel for plastic counter tops in galleys and lavatories and the addition of "fire blocking" material around all "polyurethane" foam passenger seat cushions because of the pernicious toxicity of some of the combustion products (such as hydrogen-cyanide gas)!

Some important examples of forensic medicine in airliner accidents are positive identification of persons killed in a crash for the statutory responsibility to issue the death certificate.

Forensic medicine and toxicology and the many facets thereof will continue to supply the airliner accident investigator with the extra added bit of scientific information and factual data that might be beneficial in the substantiation of the facts, conditions, and circumstances involved in the findings and conclusions in the complicated investigation of airliner accidents. ◆

The Role Of Aerospace Medicine

The aerospace medicine physician has the role of preventing future accidents and illness in everyone involved in aviation including pilots, passengers, rescuers, and investigators. This role will continue as long as there are airplanes and people who fly them.

By Allen J. Parmet, MD, MPH, FACPM

(This article was adapted, with permission, from the author's presentation entitled The Role of Aerospace and Preventive Medicine *presented at the ISASI 2003 seminar in Washington, D.C., USA, August 2003. The full presentation is available on the ISASI website at www.isasi.org.—Editor)*

Prevention of future mishaps has long been the primary goal of aircraft accident investigation. The secondary purpose for conducting an inquiry is to derive causes of death and injury, with the objective of modifying those factors and improving mishap survivability. Thirdly, the facts of the mishap are essential for purposes of establishing cause and subsequent action in the litigation and regulatory arenas. Since the earliest days of flight, physicians have played an integral role in the progress of aviation safety.

Experts in a diverse array of disciplines, ISASI members are united in their pursuit of the advancement of aviation safety. Amid the multidisciplinary working groups focused upon structures, systems, and operational data, an effective member of an accident investigation team is the human systems maintenance engineer, also known as the aerospace medicine physician (AMP), flight surgeon, or aviation medical examiner (AME). While the AME is designated by the Federal Aviation Administration to perform flight examinations, the training requirements are basic, and consist of a weeklong course taught in Oklahoma City. This physician is responsible for the most important part of the aircraft: the pilot. Malfunction of the pilot has from the very beginning of flight been the cause of most aviation accidents.

About the author: Dr. Allen Parmet *received his B.S. in chemical engineering from the United States Air Force Academy and served on active duty with tours in Vietnam and NORAD before going to medical school. He received his MD from the University of Kansas and Masters in public health from the University of Texas and completed a residency in aerospace medicine at the USAF School of Aerospace Medicine in San Antonio, Tex. After numerous assignments, he retired from the Air Force in 1992. He was the medical director of TWA and currently is in private practice at Midwest Occupational Medicine in Kansas City, Mo.*

The AMP is a medical specialist who functions within in the areas of preventive medicine and its subspecialty, aerospace medicine. One of the 24 medical specialties recognized in the United States, aerospace medicine is the smallest of all specialties, with about 1,000 physicians completing the 3 years of residency training and becoming certified in the United States over the past 50 years. They differ from most of their medical colleagues in that prevention of illness and injury is the goal rather than therapy after one is already sick. Their job, then, is to prevent accidents of aircraft and other forms of vehicles, for prevention is much more effective than treatment after the accident.

While not all accidents can be prevented, the AMP can use the information derived from accident investigations to derive the causes of injury and help modify those factors. This leads to addition of engineering changes for both active and passive protection of occupants, reduction of crash-related environmental factors, and providing for survival and rescue in the post-crash phase.

The lessons learned from accidents are also translated into training to help prevent future accidents, design safer aircraft, and improve crash/rescue operations. The information may also find its way into the courtroom, as the AMP may become an expert witness in helping derive forensic and legal conclusions.

Customarily, there is no separate Medical Factors Working Group in U.S. civil aviation mishap investigations, aside from the participation of the local medical examiner or coroner, who may provide trauma data to the Survival Factors/Crashworthiness Working Groups. However, U.S. military aviation mishap investigations have a flight surgeon as a member of every board. In civil accidents, when the AMP is called to participate, it is usually through invitation of the safety investigators or after the investigation closes and when litigation starts. Although a considerable proportion of aviation mishap causation is human-related, the specialist of the human aspect is not a proportionately routine participant in aircraft accident investigations.

Human factors and accidents

The primary causes of accidents have always been human factors. Even before the Wright brothers flew in 1903, there had been numerous aviation accidents and deaths. Probably the first true accident occurred in 1785 when Pilâtre de Rozier, a French physician who had been on board the very first flight of a Montgolfier brothers balloon in 1783, sought to be the first to fly a balloon from France to England, westbound across the English Channel. The American physician, John Jeffries, preceded him on January 7 of that year, but Jeffries had the advantage of much stronger prevailing winds and needed to spend less time aloft in a hot air balloon. De Rozier decided to combine Charles' invention of a hydrogen balloon with the Montgolfiers' hot air balloon. Hot hydrogen, however, proved to be a very dangerous combination, and de Rozier died in the fiery crash. One might say then that physicians invented the aviation accident.

Over the next hundred years, ascents to higher and higher altitudes were made with safer methods of handling hydrogen, and high-altitude ballooning came into being. Soon, the problems of cold and hypoxia became apparent. In 1862 the English aeronauts Glaisher and Coxwell ascended to 9,480 m (29,388 ft), but they were unconscious above 8,833 m (27,382 ft) due to hypoxia.

Following this, the French physician, Paul Bert, began experiments that determined that humans could not live at oxygen pressures below 45 mmHg (equivalent to air at 33,000 ft/ 10,000 m, which would ultimately be proved a century later when Austrian Reinhold Messner climbed Mt. Everest without oxygen in 1980. Just behind him was an American physician with a team of Sherpas carrying a bicycle ergometer to the base of the Hillary Step in order to replicate Bert's work.

Bert was also the medical advisor to a team of French aeronauts, Crocé-Spinelli, Sivel, and Tissandier. In the summer of 1874, they attempted to set a new altitude record of 10,000 meters) using a primitive oxygen supply system, which consisted of three bags of 72 percent oxygen and simple tubes that were held in the mouth. Bert warned them that this was inadequate, but on April 15, 1875, the trio ascended. While they probably did exceed their goal, all were unconscious and only Tissandier survived. The accident was a national tragedy that shook France as much as the *Challenger* disaster would rock America. As a result, high-altitude attempts would come to a halt until the 1930s.

Physiologic issues had become established as one factor in the cause of aviation accidents. Hypoxia would remain a challenge until oxygen supply systems were perfected and pressurized cabins came into use in the 1940s. Other physiologic issues remain with low barometric pressure at altitudes over 50,000 feet and toxic gases both in the systems and in the event of crashes and fires. Finally the problem of acceleration forces would not become evident until the U.S. Navy invented dive-bombing and a plane capable of 5 g pullouts in the 1930s. Soon fighter aircraft were beginning to dogfight in the realm above 5 g's and acceleration-induced loss of consciousness (G-LOC) became an additional cause of accidents.

The first fatal accident of an airplane occurred on Sept. 17, 1908, at Ft. Myer, Va. The starboard propeller failed on a demonstration flight, seriously injuring Orville Wright and killing his passenger, Army Lieutenant Thomas Selfridge. An Army surgeon conducted the autopsy and found that Selfridge was thrown out of the aircraft on impact and died of a skull fracture. His Army colleagues, such as Lieutenant Henry (Hap) Arnold, were later encouraged to wear their West Point football helmets while flying. It would not be until the 1940s that Dr. John Paul Stapp would lead design changes in helmet safety.

Within a few years, aviation was an important part of world military activities and most militaries developed medical standards—particularly after early studies of Britain's Royal Flying Service in 1915 found that the life expectancy of a pilot was a mere 2 weeks. Of the deaths, 90 percent were due to what we would today call human factors. What has changed, however, is the mixture.

In 1915, medical conditions were the cause of 60 percent of accidents, spatial disorientation another 30 percent. Mechanical problems accounted for 8 percent and combat a mere 2 percent. Pilots were entering training and often dying there. Medical conditions such as asthma (German Oswald Boelcke), skull fracture, and epilepsy (Manfred von Richthofen), tuberculosis (Georges Guynemer), blindness (William Thaw, Edward Mannock), bleeding ulcers (Roy Brown), and psychosis (Frank Luke) were considered unsuitable for such military arms as the infantry or cavalry. Aviation was deemed to be much like an office job; after all, the pilot just sat there.

Medical regulations were soon in place and a military doctor, known as a surgeon, was assigned to flight units. In the United States, Major Theodore Lyster became the head flight surgeon for the flying Army and established standards that would screen out nearly 30 percent of all U.S. flying applicants. In 1926 Dr. Louis Bauer would be reassigned from the Army to become the first federal air surgeon. Dr. Bauer would begin the training program of AMEs that is the standard today. The medical standards for civil pilots were also established at this time.

The presence of AMEs would not do much to affect the first high-profile aircraft accident, the 1931 crash of a Fokker Trimotor in Chase County, Kans., that killed Notre Dame coach Knute Rockne. There was no national system for investigating accidents. Spectators drove around the site, taking souvenirs and destroying evidence. Bodies were barely identified by their clothing. In contrast, the investigation of the 1950s crashes of the Comet IA were directed by an AMP, who noted that the deaths were due to explosive decompression, not terrorist bombs.

As the AMP during the loss of TWA 800, the author's role fell to providing identification data to the local medical examiner, crew medical information to the NTSB, support for disaster response and family assistance, as well as counseling and helping company employees affected by such a catastrophe. The loss of space shuttle *Columbia* was complicated by the hazards to people on the ground from toxic chemicals used for propulsion and power. The author had trained the military flight surgeons who deployed and cared for the military personnel involved in wreckage search and recovery.

The imposition of medical standards on pilots effectively minimized medical conditions as the primary cause of accidents. However, human factors still comprise 80 to 90 percent of all aircraft accidents. Today medical accounts for 2 percent of accidents, spatial disorientation 36 percent, controlled flight into terrain 38 percent, drugs and alcohol are 6 to 9 percent, midair or ground collisions 6 percent, and mechanical problems only 2 percent. Hostile actions such as terrorism are still 2 percent.

Spatial disorientation

Spatial disorientation accidents began to occur as soon as pilots began to fly into clouds, bad weather, and at night. The first real solution to this problem was the Sperry turn-and-bank indicator (TBI), but it met with resistance from pilots who distrusted it. Dr. Ocker developed a combination of a rotating chair equipped with a TBI to train pilots in the effects of vertigo while on the ground and to instill in them the confidence they needed to use their instruments. The "Ocker Box" was the forerunner of instrument simulators, later brought into its common form by Link.

AMP physicians continued their work improving vision, life support, and escape, as well as crashworthiness. High-altitude bailouts were researched by Dr. Randall Lovelace, who discovered the high opening shock forces, cold, and hypoxia and recommended free-fall to lower altitudes. After World War II, Dr. John Paul Stapp began his impact acceleration work on the Corum ranch in California, using the Muroc dry lake bed for sled testing (now known as Edwards Air Force Base). His research team developed the limits of human tolerance to impact accelerations and all modern energy-absorption limits are derived from his work. Stapp's team would develop the standards for ejection seats, shock absorbers, passive restraints, crash helmets, air bags, and seating arrangements. Stapp's chief engineer, Ed Murphy, also discovered that whatever can go wrong eventually will.

The discoveries in aviation safety were to eventually be applied to many other areas of safety, including automobiles and highways and motorcycle and football helmets.

Psychological factors

Accidents still occur due to psychological factors. Judgment and drugs are the main issues. It is difficult to evaluate a pilot's judgment, but many factors come into play, including learning ability, rate, experience, and transfer. Attention, boredom, complacently, task saturation, fatigue, and complacency all have roles to play. Personality states of self-discipline, motivation, supervisory pressures, and cumulative workload interact with outside psychosocial factors of job satisfaction, career expectations, family, and community conflicts. Within the operating environment there are supervisory and management issues as well as crew coordination and cockpit resource management. Organizational issues of aircraft systems, transitions, maintenance, weather, and air traffic control all interact.

Analysis of these factors is known as the "Swiss Cheese Model" after Drs. Shappell and Weigman, in their article "The Human Factors Analysis and Classification Systems" in 2000. An accident is inevitably the end result of a chain of errors. These are classified into latent and active issues. Latent issues consist of organizational and supervisory preconditions. These may include pressure to perform to schedules and ignore crew rest, fuel reserves, or mechanical problems. Active issues include preconditions such as medical problems, weather or traffic, and finally unsafe acts. The unsafe act is a decision made by the pilot to arrive first at the scene of an accident.

Drugs and alcohol are common in society and contribute significantly to aviation accidents. Their use is rare in commercial and military aviation. However in general aviation, the use of prescription and non-prescription drugs as well as illicit drugs is a growing problem. The detection and deterrence of their use is a societal problem as well as an aviation safety issue. Drug testing does serve to deter use by casual illicit drug users, but not those who are addicted. Treatment works. The HIMS program, originated by the Air Line Pilots Association and the FAA in the late 1960s, successfully returns to duty 90 percent of pilots with alcohol problems and 50 percent of those with illicit drug problems.

The AMP should participate in the aircraft accident investigation and help determine the cause of the accident, as well as the causes of death/injury along with the forensic pathologist/medical examiner. Medical examiners may not necessarily be attuned to the specific needs of the accident investigator, such as determining who was at the controls of a multi-pilot aircraft. Nor should it be assumed that the medical examiner would automatically turn that information back to prevent the next accident. It is important to determine if the pilot and passengers were incapacitated prior to, during, or after the crash. Pre-crash incapacitation may be due to medical causes such as cardiac disease, carbon monoxide poisoning, or hypoxia. Crash-related injury is analyzed using CREEP: container, restraints, environment, escape and post-crash factors. As a result of this accident analysis, the AMP will help in recommending remedial actions to prevent the next accident from occurring and reducing injury.

Role of the AMP

The aerospace medicine physician can be a resource to assist the medical triage teams and should be involved in mass casualty issues. Leaving out the preventive medicine physician means that the disaster responders may themselves become ill or injured during the response phase and recovery. Their care and feeding is a basic public health function. Finally, there are preventive measures needed for both rescuers and accident investigators. The environment of the accident site may represent a human health hazard.

Environmental issues include clean water and food, sleeping arrangements, and thermal protection. Sometimes a hazardous chemical, high altitude, or underwater environment exists and additional protective measures must be taken to prevent the investigating team from becoming additional casualties. Finally, there is the problem of infectious diseases. Disease can spread to the investigators through four methods:

- First is blood and body fluids. Any area where there has been spillage of blood and human body products represents a biological hazard. Personal protective equipment must be worn by investigators to avoid contamination by such diseases as hepatitis B and C or HIV, the AIDS virus. Of these, a vaccine exists only for hepatitis B.
- Food and water supplies must be secured to avoid the spread of contamination. Such diseases as hepatitis A, typhoid fever, and polio can be prevented by vaccination. Airborne spread of disease from person to person is unlikely at the accident site, but may be an issue due to the surrounding social conditions. Illnesses such as tuberculosis and SARS are real risks in some areas.
- Last is the problem of vector-borne diseases. Mosquitoes, ticks, and fleas carry illnesses such as malaria, West Nile virus, yellow fever, dengue, Lyme disease, and plague. The best protection is to know what areas are at risk and use insect repellants. Medications and vaccinations are also of use. Always consult the Centers for Disease Control and Prevention website at www.cdc.gov and check Travelers' Health for the latest area assessment.

The aerospace medicine physician has the role of preventing future accidents and illness in everyone involved in aviation, including pilots, passengers, rescuers, and investigators. This role will continue as long as there are airplanes and people who fly them. Most AMPs are members of the Aerospace Medical Association and can be contacted, along with other aeromedical professionals, at www.asma.org. ◆

Using Injury Pattern Analysis

Correlation of medical with other accident investigation data can help reconstruct the mishap sequence through injury pattern analysis. Such techniques often help identify and validate, or eliminate, proposed mishap sequences.

By William T. Gormley, MD, Ph.D., Office of the Chief Medical Examiner, Commonwealth of Virginia, USA

(This article was adapted, with permission, from the author's presentation entitled Enhanced Occupant Protection Through Injury Pattern Analysis *presented at the ISASI 2003 seminar in Washington, D.C., USA, August 2003. The full presentation is available on the ISASI website at www.isasi. org.—Editor)*

The victims of a fatal aviation mishap experience the same damaging events as the aircraft. Analogous to engineering analysis of the wreckage, medical examination of occupant injuries can provide important scientific data for mishap investigators. In fact, the human body is structurally more robust than any aircraft: aircraft structure will fragment under forces an order of magnitude less than it would take to produce the same result in an occupant.

When aircraft mishap investigations are conducted in the United States of America, federal regulations mandate postmortem examination of some, or all, occupants fatally injured in an aircraft mishap. Postmortem examination of aircraft mishap fatalities: 1) U.S. civilian—pilots by federal law, crew and passengers by local jurisdiction; 2) U.S. military—pilots, crew, and passengers.

For more than two decades, specially trained military pathologists who directly support the mishap investigation board have performed postmortem examinations of military aircraft mishap fatalities. In civilian mishaps, postmortem examinations are performed by civilian medical examiners, or pathologists employed by elected coroners. While federal investigators can order postmortem examinations for civilian pilots, state or local regulations and policies determine the extent of postmortem examination for each occupant.

About the Author: Dr. Gormley *received his Ph.D. in chemical and biomedical engineering from the University of California, Davis and his MD from the Medical College of Ohio at Toledo. He is certified in anatomic, clinical, and forensic pathology. During almost 20 years at the Armed Forces Institute of Pathology, he participated as an aviation pathology consultant in many hundreds of aircraft accident investigations and served as a consultant in aviation pathology and forensic pathology to the USAF Surgeon General.*

The legal purpose of postmortem examination by medical examiners or coroners is to scientifically identify the remains and certify the cause and manner of death. In aircraft mishaps, the cause of death is usually blunt force injury, fire injury, or both. For this purpose, the examination need only document lethal injuries and the absence of suspicious features such as bullets, stab wounds, or explosives. The manner of death is certified as an accident unless circumstances and findings suggest another manner of death such as suicide, homicide, or natural. Postmortem toxicology is also collected for analysis by the FAA laboratory, at least for pilots.

In the Commonwealth of Virginia, we perform complete autopsies on all fatalities in aircraft mishaps. As part of our death investigation, we routinely request information about the circumstances of death verbally and in writing. Unfortunately, we usually get little or no response from investigators. With limited information about the circumstances of death, the postmortem examination will produce little more than a document that certifies the cause and manner of death.

The postmortem examination should be more than an administrative exercise to produce documents proving that the occupants are truly dead. For maximum investigational impact, postmortem medical examinations should function as an interdisciplinary effort, with the pathologist and mishap investigation team sharing of data on 1) flight history, 2) crash site data, 3) wreckage analysis, 4) occupant medical data, 5) postmortem examination results, and 6) other pertinent data. This type of effort would promote accurate, effective, and complete medical input for many concerns of accident prevention and occupant safety.

Natural diseases

A complete postmortem examination, in addition to documenting traumatic injuries, will identify pre-existing natural disease. Natural diseases of the heart, brain, and lung are the most likely to be possible mishap factors because they can cause rapid incapacitation. Atherosclerotic cardiovascular disease is by far the most commonly identified natural disease in middle-aged or older pilots. This disease may or may not have a significant role in the aircraft mishap. The flight history must be correlated with the specific anatomic disease to determine the role in a mishap.

In one mishap, a middle-aged pilot flew a single-engine private aircraft into a commercial airliner approaching an airport. Both aircraft crashed, and there were no survivors. Autopsy of the private pilot demonstrated severe atherosclerosis in the coronary arteries, and local authorities announced that the mishap, and almost 100 deaths, was caused by the private pilot having a heart attack. While atherosclerosis can cause a heart attack, there are many people living quite well with similar disease. Investigative interviews, wreckage analysis, autopsy data from all occupants of the private aircraft, crash scene documentation, and radar data indicated that the pilot was mildly lost, navigating visually using a road map, unaware that he had wandered into an approach path to the commercial airport and inadvertently flew into the airliner. There was no evidence of pilot incapacitation prior to the collision, and the heart disease was not a factor in this mishap.

Correlation of medical with other accident investigation data can help reconstruct the mishap sequence through injury pattern analysis.

In another case, a small aircraft with two occupants crashed into trees near an airport on a dark and foggy night. Both occupants died instantly and their bodies were fragmented with evisceration of most internal organs. A heart was recovered from the crash site, and there was severe atherosclerosis in the coronary arteries. Since the pilot was 65 years old and the passenger was 45 years old, it was assumed that the heart was that of the pilot. While heart attacks are not uncommon in 65-year-old people with atherosclerosis, crashing while making an approach instead of finding an alternate airport is also not uncommon. While it is possible that both events occurred at the same time, such a coincidence would be unusual. There was no way to determine the true mishap factors with scientific certainty. DNA analysis demonstrated that the diseased heart was from the passenger, not the pilot.

Mishap sequence reconstruction.

Correlation of medical with other accident investigation data can help reconstruct the mishap sequence through injury pattern analysis. Such techniques often help identify and validate, or eliminate, proposed mishap sequences as shown in the following illustrative examples.

A medical evacuation helicopter crashed and burned with five occupants, including pilot, copilot, two medics, and a patient. All died and the remains were sent for autopsy. The pilot was not burned, but had multiple lethal injuries to the trunk and amputation of the right arm. The other bodies had extensive burns and multiple lethal blunt force injuries, including skull and rib fractures and lacerations of lungs, liver, heart, aorta, and brain. There was no soot in the airways of any victim, and carboxyhemoglobin was not elevated in any victim. The patient had a fracture of his neck, with hemorrhage in the deep cervical muscles. All deaths were certified as due to blunt force injuries and the manner of death was certified as accidental.

What more could be done? The medical data can be correlated with some information about the mishap. The crash scene shows that the helicopter hit a tree with a main rotor blade, then crashed and burned about 50 yards beyond the tree strike. The post-crash fire incinerated most of the wreckage.

Since there were no thermal injuries, the pilot must have separated from the helicopter prior to impact. The amputation of the right arm was caused by a sharp, chop-like injury most consistent with a rotor strike. This injury suggests that the blade may have passed through the cockpit, damaging the tie-down-chain for the pilot's restraint system, and separating the pilot from the crashing helicopter. Engineering analysis of wreckage verified this correlation.

The patient was being transported to a hospital following an accident that may have involved neck injury. The documentation of bleeding in the neck muscles around the fracture provided scientific data that the neck fracture occurred before the helicopter crash. Why? With multiple blunt force injuries there is very rapid loss of blood pressure and circulation. To form a bruise (contusion, intra-muscular hemorrhage, etc.) requires both damage to blood vessels and pressure to propel blood through the torn vessels into the soft tissues. Thus, the patient was alive at the time of the neck injury and was not dying in the helicopter crash.

Another question that may be answered with data from examination of pilots and copilots involves who was controlling the aircraft at the time of the crash. When the hands and feet of a pilot or copilot are in firm contact with aircraft controls (yokes, sticks, throttles, rudder pedals, anti-torque pedals), crash forces may be mechanically transmitted to the hands and feet, causing characteristic injuries. Classic injuries of the hands may include palmar lacerations, fracture-dislocation of the thumb base, serial fractures of the metacarpals, and fractures of the wrists and lower arms. On the feet, plantar lacerations and fractures of the feet, ankles, and lower legs may be characteristic.

> If a human body must compete with environmental structures during a crash sequence for a place to be, tremendous equal and opposite forces may be exchanged with lethal results.

Survivability analysis

Incorporation of data from postmortem examination into survivability analysis can help provide improved design criteria to decrease deaths and injuries in those aircraft mishaps that occur. Throughout the mishap, sequence survival depends upon tolerable crash forces, maintenance of occupiable space, and a survivable post-crash environment.

Overall crash forces as experienced by the occupants in general must be less than 50 g to avoid lethal injuries (laceration of aorta). Crash forces can be estimated by engineering physics based on scene data, aircraft post-crash structural integrity, and occupant injuries. These three independent estimates should be of the same general magnitude if the crash sequence and dynamics are understood. General medical crash force indicators are as follows:

Injury	Forces	Survivability
Compression of Spine	20-25 Gz	Yes
Laceration of Aorta	50 Gxyz	Borderline
Transection of Aorta	100 Gxyz	No
Body Fragmentation	350+Gxyz	No

If the overall crash forces are within survivable limits, then survivability depends on maintenance of occupiable space. If a human body must compete with environmental structures during a crash sequence for a place to be, tremendous equal and opposite forces may be exchanged with lethal results. When such interactions occur, the occupant may sustain patterned injuries, which can be correlated with structures and mechanisms. Such correlations naturally require significant consultation between physicians, engineers, and other mishap investigators. These correlations are also the most valuable for future survivability design.

If crash forces are tolerable and occupiable space in maintained, then mishap survival depends on the post-crash environment. Usually, post-crash fire and post-crash drowning are the hazards to prevent or remediate through engineering design. The success of crashworthy fuel system design in preventing fire deaths in otherwise survivable helicopter crashes is an obvious example.

Postmortem injury pattern correlation is an important element in evaluating the safeguards provided by occupant protection systems. Examples include pattern injuries to determine restraint use and function. Bruises on the surface of the body may document the impact of restraint systems. Pattern injuries have also documented submarining failure of systems with less than 5 points of restraint and subsequent lethal damage to internal organs. They have also demonstrated lethal neck injuries associated with rotation of helmets around neck straps during crash sequences. Such observations are extremely important to avoid lethal protective equipment injuries.

Optimal medical consultation

The following steps will optimize collection, documentation, and incorporation of significant medical data into any aircraft mishap investigation:

• Contact the pathologist before autopsy to explain mishap history, crash site, and specific concerns.

• Attend the postmortem exam to share information, concerns, and questions. (Contact pathologist after the autopsy with questions—sub-optimal but better than nothing.)

• Arrange a brief visit to the crash site (wreckage) by pathologist and medical consultants.

• Arrange a meeting to review medical findings and correlation with other mishap investigation data. Participants should include pathologist and representatives of Human Factors, Investigator-in-Charge, Structures, Engineering, and others depending on mishap specifics.

Sometimes, such active and interactive consultation cannot be arranged. Local medical examiners or coroner's pathologists may not have the time or interest to fully participate in the investigation.

When this occurs, the following elements from the autopsy examination can provide a basis for later consultation with aviation pathologists, if necessary.

• Diagnosis list including all significant injuries and disease.
• Complete autopsy report.
• Toxicology report.
• Photographs of all external body surfaces, clothed and unclothed.
• Total body X-rays with special attention to hands and feet of pilots.

Such documentation, especially the photographs and X-rays, may severely tax the budget and resources of many civilian death investigation systems. Mutual respect, friendly persuasion, and financial reimbursement for additional expenses are key to effective incorporation of injury pattern analysis in the aircraft accident investigation process. ◆

Forensics and Victim Ide

The postmortem examination process may at first seem unrelated to the mishap investigation itself; however, examination of the occupants can serve the goals of the safety investigation: prevention of death and injury.

By M.A. Cimrmancic, DDS (FO4172),
Associate Staff, Transportation Safety Institute,
Oklahoma City, Okla.

(This article was adapted, with permission, from the author's presentation entitled Forensic Aspects of Occupant Protection: Victum Identification *presented at the ISASI 2003 seminar in Washington, D.C., USA, August 2003. The full presentation is available on the ISASI website* at www.isasi.org.*—Editor)*

On Sept. 17, 1908, the first fatal mishap of a powered aircraft in the U.S. occurred at Ft. Myer, Va. Orville Wright was at the controls of the "Wright Flyer" being tested for the U.S. Army Evaluation Board, with Board member Lieutenant Thomas Selfridge as his passenger. The propeller struck a guy wire, breaking the blade and causing subsequent loss of control. The machine pitched and fell 75 feet to the ground. Held in their seats at impact by wire braces crossing in front of them, the occupants' positions were noted before they were transported for medical treatment. Mr. Wright survived, with fractures to the ribs and femur and injuries to the eye area and lip. Lieutenant Selfridge died that evening, having sustained a fatal skull fracture as he struck a wooden support or one of the wires. He was buried with full military honors at Arlington Cemetery on September 25.

The mishap investigation conducted by the U.S. Army Signal Corps contained elements not unfamiliar to modern-day air safety investigators: collection of witness accounts, examination of aircraft damage and occupant injuries, and correlation of these data to reconstruct the sequence of events. In the century that followed, investigations of fatal aviation mishaps have evolved into multi-agency, even multinational, efforts encompassing a wide range of disciplines.

Although conducted independently, the parallel investigations carried out by air safety investigators and local authorities can provide mutual support. The medicolegal death investigation conducted under the aegis of the local medical examiner or coroner (ME/C) serves to account for the fatalities and to certify their deaths, but the findings can supplement the safety investigation as well. Correspondingly, on-scene investigators may, on occasion, come across previously undiscovered fragments of remains. At the outset, these materials may seem insignificant but may very well be important to the victim identification task of the death investigation.

To fulfill the legal requirements of establishing cause and manner of death, and determining victim identity, the local ME/C leads what can be a diverse team of forensic specialists in the field recovery and postmortem examination procedures. The considerable efforts put forth in this process ultimately serve the families who anxiously await the news of the fate of those persons presumed to have been victims of the mishap. With the certification of death and return of the remains identified as their loved ones, the family can settle estate matters and commence grieving.

As each mishap presents its own unique set of circumstances and evidence, so goes the disaster response and investigative procedures, including field recovery and mortuary operations. A very general description is offered: At the site, field recovery personnel may be assigned to methodically locate, document, mark, and recover the fatalities for transport to the mortuary facility, where a set flow of procedures is carried out. Remains are assigned case numbers and documented via X-ray images and photographs, while personal effects and other items are documented and removed for security. Each case is directed to the appropriate forensic postmortem examinations, triaged according to the condition of the remains, and nature of the evidence present. Often a series of stations is set up, each designed for specialized examination and collection of evidence by forensic experts in such areas as anthropology, odontology (forensic dentistry), fingerprints, radiology, and pathology (autopsy). When indicated, DNA and toxicology specimens are collected for laboratory analysis. When examinations are completed and remains are identified, funeral directors may be present to embalm the remains before they are released.

In the United States, when a major aviation mishap overwhelms local and state response capabilities, federal level

***About the author: Dr. Mary Cimrmancic** has a background in forensics and aviation, serves as associate staff at the Transportation Safety Institute in Oklahoma City, Okla., and is an adjunct assistant professor at Marquette University, in Milwaukee, Wisc. She is in private practice with Greenbrook Dentistry, S.C., in Brookfield, Wisc.*

ification

response teams can be deployed to function under local jurisdictional authorities. Access to these resources is facilitated by legislation that assigns the NTSB Office of Transportation Disaster Assistance with the responsibility for coordinating federal resources with local and state authorities.

Safety investigation

While victim identification (ID) is a key element in the legal and humanitarian outcome of the death investigation, it can also contribute to the safety investigation by facilitating placement of individuals in the sequence of events relating to the crash. Identification of the flight crew can direct efforts in postmortem examination and toxicologic analysis to ascertain potential factors relating to mishap causation, evidence of control injuries, and other injuries related to the impact and post-crash environment. If detected, these data can be correlated with the events of the mishap and structural damage. Also of interest is physical evidence of criminal activity and passenger interference with the operation of the aircraft.

The methods by which fatalities are identified depend upon, in part, the nature of the mishap and its effects upon the occupants. Initially surviving the impact of the 1908 Wright Flyer crash, the identity of Lieutenant Selfridge was not in question. Strong circumstantial evidence corroborated his presence at the scene: he was personally known, witness accounts confirmed his participation in the flight, his physical features and clothing were in sufficiently good condition to permit visual recognition. On the opposite end of the spectrum, crash sites have presented notable challenges to mishap investigation, evidence recovery, and victim identification. The effects of high-velocity impact, fire, immersion in water, and difficult-access locales have resulted in the reduction of the volume of evidence recovered.

Both wreckage and remains can exhibit extensive fragmentation, commingling, and thermal and chemical damage. At the scene, human materials may be difficult to recognize when fragmented and burned, and may not appear to be identifiable. Yet, observant field investigators can facilitate the recovery and identification process by recognizing and protecting these materials at the scene, documenting them if possible, and by notifying the ME/C.

The identification process is a multidisciplinary effort. Methods employed will vary with the condition of the remains and available evidence. In short, determining who might have been present may be a provisional conclusion, based upon initial available data. This information can guide the search for antemortem medical and dental records, and other reference exemplars used to scientifically determine whom the remains represent. Scientific ID methods involve comparison of the unique physical features recorded during an individual's life, with those features recorded in the postmortem examination process. When sufficient evidence is gathered, the provisional ID may be confirmed or refuted.

The flight manifest and witness accounts can provide initial data indicating who may have been present. As families of the presumed victims come forward seeking information, they may be asked to provide information describing the individual and for healthcare provider information.

Provisional identification methods—An initial step in the identification process involves establishing whom the remains might represent—a provisional or tentative ID. General physical descriptors such as facial features, height, weight, hair color, gender, and age can provide a good start, as do photo ID cards, clothing, eyewear, jewelry, and other personal effects. Visual features and personal effects can be useful when there is strong corroborating evidence indicating the presence of the individual at the mishap. However, these methods need to be used cautiously, as they can be misleading. For example, items worn by or found with an individual at the site may belong to someone else. Nonetheless, personal effects are recovered and transported along with the remains with which they are found. At the mortuary facility, the items are carefully documented, also noting where at the scene, and with which body, they were found.

Photographs and physical descriptors shown on driver's licenses may not necessarily reflect the actual height, weight, hair color, and usual facial appearance of the license holder, and used alone may mislead the ID effort. Furthermore, identifications based solely on facial features can also lead to an erroneous identification by a distraught family member or friend viewing remains fitting the general description of their loved one. In spite of these drawbacks, personal effects and visual features can form the basis for a provisional or tentative identification, establishing whom the remains might represent. With sufficient corroborating evidence to establish the presence of the individual in the mishap, the ME/C may identify the individual based on this data.

Scientific identification methods—Scientific methods can confirm or refute a provisional ID. The unique physical features of a subject, and a known antemortem reference, are compared for consistencies. The subject is identified when there is sufficient consistency of features with those of a known reference. An individual may be identified by more than one method, depending upon the quality and availability of antemortem and postmortem data, and particu-

Teeth have been used for identification sinc

larly when remains are fragmented.

The American Board of Forensic Odontology describes the strength of conclusions for identification. "Positive identification" indicates that there is sufficient evidence to conclude that the subject and the reference are the same individual. A "possible identification" reflects consistencies, but lesser quality or quantity of antemortem and/or postmortem evidence. Inconsistencies between antemortem and postmortem data can result in "exclusion." "Insufficient evidence" reflects the lack of data to form a conclusion.

Antemortem reference exemplars document identifying features during life in the form of diagnostic medical/dental images, written records, biopsy specimens, recorded and latent fingerprints, and personal items to name a few. To aid in comparison, postmortem photographic and X-ray images, fingerprints, and DNA profiles are recorded in a manner similar to their antemortem counterparts.

A photograph or portrait may serve as a reference exemplar when distinctive features are shown. To some extent, tattoos, piercings, and other body modifications can provide supporting information, depending upon their uniqueness. The individual anatomical features of the teeth, fingerprints, and skeleton, as well as DNA and artifacts of surgery and disease, provide more substantial evidence.

Identification procedures are carried out in three phases: postmortem data collection, antemortem data collection, and comparison of postmortem and antemortem data. Computer databases store the data as they are amassed, and speed the tedious process of searching through antemortem and post-mortem case files for those most likely to match. This permits experts to examine the antemortem and postmortem files most likely to result in an ID. Finally, with evidence assembled from the various examinations and analyses, it is the ME/C who assigns identity to the individual remains. The time frame for this process can be significantly extended by difficulties with recovery, extreme fragmentation, sheer numbers of fatalities, and delays with obtaining antemortem records.

Classic, scientific means of establishing identity are useful in mass-fatality incidents. Used alone, together, or combined with other data, dental features and fingerprints have been important identifiers, particularly where there has been tissue destruction. Radiographic examinations and anthropologic analyses also provide useful data for identification, as well as for evaluation of injury patterns. With the arduous disaster scenarios of recent years, DNA has emerged as a significant means of identification. Instead of replacing classic methods, DNA has supplemented them, extending to those remains not identifiable by other means.

Dental identification

Teeth have been used for identification since ancient Roman times. Variations in shape, position, color, alterations, and patterns of loss are distinguishing characteristics that are readily seen. Teeth are durable, which allows them to retain their fundamental characteristics through the effects of fire, decomposition, immersion, and impact. Their internal and external contours can be sufficiently unique to allow a jaw fragment with a couple of teeth, or a displaced single tooth, to support an ID. Dental X-ray images reveal the external and internal outlines of teeth, their restorations, and other alterations acquired through disease, trauma, or treatment. Antemortem X-ray images document these landmarks, and are compared with analogous postmortem X-rays to reveal consistencies or differences that would reveal whom remains represent.

Postmortem dental examinations, photographs, and radiographs are conducted in a standard manner to gather the same data that would be compiled in a clinical setting. The presence and absence of teeth, their restorations and replacements, orthodontic appliances, and other features are documented.

The same types of data are compiled from antemortem dental records, X-rays, and other materials, and a composite chart is constructed, depicting the existing dental conditions of an individual at the most recent visit to the dentist.

These postmortem and antemortem data are entered into a computer database. When a dentist queries the database regarding a specific postmortem case file, for example, the computer quickly sorts the available data and directs the dentist to the most likely antemortem files that fit the case description. Dentists then compare the X-rays and data from those files to determine whether the remains in question represent one of those individuals. Among dealing with many other issues in dental identification, additional analyses may be conducted, dealing with specific restorative materials and thermal damage, for example.

While untreated teeth and jaw structures are already distinctive, alterations can further differentiate one individual from another. With 32 possible permanent teeth, the potential combinations of missing and present teeth are considerable. Add five surfaces per tooth that can be restored, and categorize restorations as either metallic or tooth-colored, the potential combinations for present/missing/filled teeth are vast.

Individual teeth can be restored with a variety of materials: metal alloys comprised of silver, tin, copper, and mercury; gold alloys; cast semi-precious or base metal alloys; tooth-colored composite resins; porcelain-fused-to-metal restorations; and all-porcelain restorations. Each of ncient Roman times.

these materials exhibit specific physical properties that influence their clinical application as well as their response to high temperatures sustained in a fire.

Single displaced teeth that are not restored may exhibit abrasions that can sometimes provide information about metallic restorations that may be present on adjacent teeth. The enamel surface that contacts an adjoining metallic restoration can be evaluated by elemental microanalysis for trace metal to reveal the presence of alloys comprising that restoration. Traces of elemental gold can indicate that the adjacent tooth was restored with a gold alloy, while the detection of silver, mercury, or tin can indicate an adjacent silver amalgam restoration. The data can be queried in the antemortem database to reveal which records contain the same information for those specific teeth.

Replacements for missing teeth are quite varied. They can be removable, supported by natural teeth, or implants. Others can be fixed to natural teeth or implants. Many permanently cemented fixed bridges are cast in a strong metal alloy, with porcelain fused to the surface for esthetics, while others are constructed entirely of porcelain. As with natural dentition, these structures possess unique contours useful for identification, even when displaced from the oral cavity. Fabricated under high temperatures, they can begin to distort as a fire nears their specific fusing temperatures, giving some indication as to the temperature of the fire they were exposed to in the mishap.

Like Cinderella's glass slipper, removable appliances best fit the person for whom they are made. Required by state laws, removable dentures and partials discretely bear the name, or other identifying mark, of the patient for whom they are made. Constructed of various combinations of acrylics, resins, and metal alloys, removable prostheses can, to various extents, show resistance to the effects of fire and impact.

Implants function as artificial tooth roots, supporting a single replacement tooth, or a larger, multiple-tooth prosthesis. Many are manufactured of pure titanium of specific design and dimensions. Their appearance on X-ray, and the restorations they support, can be useful in identification.

As with aircraft components, fire can produce characteristic thermal damage to teeth, bone, and dental restorations. Thermal changes can indicate approximate fire temperatures and the presence of accelerants. The effects produced are the result of multiple factors, such as the duration, intensity, direct or indirect application of heat, rates of onset and cooling, and thermal protection surrounding the affected structures. Posterior teeth are afforded some protection from fire by surrounding jaw muscles, cheeks, and tongue. With increasing duration and temperature, teeth can darken, dry out, develop cracks, and enamel can separate from the underlying tooth. The outer layer of bone that surrounds the teeth can become charred or fractured, with loss of teeth as supporting bone is destroyed. Eventually, the remaining teeth and bone become ashed, exhibiting a grey color.

Burned teeth and bone can be very fragile, and can crumble if handled. These materials require careful handling by forensic personnel, who may document them at the site with photographs and portable X-rays before stabilizing them for transport. When remains are highly fragmented as well as burned, their volume can be significantly reduced, including teeth and bone. Recovery is difficult, and there are fewer materials with which to make identifications. Despite the challenging situation, the humanitarian mission served by personnel at the scene and mortuary encourages their best effort.

Other scientific methods

Fingerprints—The fingers, palms, and soles exhibit distinctive patterns of friction ridge details forming the basis for what can be a fair proportion of identifications in aviation disasters. These patterns can be recorded from remains that have been exposed to fire or undergone fragmentation and decomposition. In fire, contraction of major muscle groups causes the decedents arms, hands, and fingers to curl inward, forming fists. To an extent, this protects the finger pads from the effects of the fire. Fingerprint experts can print postmortem friction ridge details, and compare them with recorded antemortem prints on file with the individual's employer, fingerprint databases, or other sources. In the absence of recorded prints, latent prints can be lifted from items frequently handled by the individual. Identifications are a product of comparison between the postmortem and antemortem patterns.

Radiographic identification—Medical X-ray images are useful for comparison with postmortem full-body radiographs. Useful medical radiographs include views of the skull, chest, abdomen, spinal column, and extremities. Normal anatomical variations of the skeleton, abnormal bone formation, evidence of disease, and surgical artifacts can serve as identifying features. When viewed on radiographs, the configuration of surgical plates, wires, implants, pacemakers, and defibrillators can provide identifying data. Conveniently, the latter three items typically have serial numbers that can be traced to the manufacturer, and to the recipient. X-ray scanning of body bags can reveal not only remains and their injury patterns, but also personal effects, aircraft parts, and items potentially hazardous to morgue personnel. Fractured bones, displaced teeth, and jewelry can be located and documented for subsequent identification procedures.

DNA can be copied to amplify its volume.

Anthropology—The expertise of forensic anthropologists is key to search-and-recovery efforts as well as the identification process, particularly in scenarios involving extensive fragmentation, commingling, and burning. Anthropologists can direct excavation of difficult recovery sites and distinguish human skeletal materials from those of animal origin. Their familiarity with the distinctive anatomical features of the human skeleton allows them to locate, sort, and reassociate fragmented remains, fundamental to establishing how many individuals are represented. Some patterns of damage to bone can be amenable to anthropologic interpretation as to mechanisms of injury, be it traumatic fractures or thermal changes produced in a fire.

Depending upon materials available, anthropologists can reconstruct and analyze the individual bones and skull to make gender determination and estimates of stature, age, and muscularity. The compiled data form a biological profile—an approximate physical description of an individual. The profile can be compared with physical descriptions of persons listed on the flight manifest, forming the basis for a provisional ID.

Approximate age at time of death can also be estimated, based upon the stages of development of the skeleton and dentition during infancy, childhood, and adolescence. Estimates of age at death are generally based upon areas where multiple structures are forming: hands and wrists, knees, feet and ankles, as well as jaws with developing permanent teeth. Age estimates can be calculated from statistics derived from normal reference populations. Narrower age ranges can be derived from younger individuals who still exhibit numerous areas of growth. With growth processes completed, degenerative changes are used for making more broad age range estimates in adults.

DNA—DNA analysis is based upon examination of specific segments of human genetic material that can distinguish one individual from another. These molecular variations are processed and viewed as a distinctive graphic pattern, or DNA profile. As with classic forms of identification, the pattern of DNA profile from a postmortem sample is compared with profiles derived from reference samples from known sources. A direct reference sample is taken from the decedent in life: a blood sample, biopsy specimen, hair sample, biological residues from a toothbrush, clothing, or other personal items. An indirect reference may be a blood sample or cheek swab obtained from a close relative. The patterns of the subject and reference profiles are examined for consistencies. When the profile derived from the subject matches that of a known reference, two conclusions can be drawn: Either the remains represent the individual in question, or there is another individual with the same genetic profile. Population statistics provide the analyst with probabilities indicating the likelihood of the remains representing the subject in question.

This technology offers a means of identifying remains that could not be identified by classic means. DNA profiles generated from those already identified by classic means can help to reassociate other fragments from the same individual. Environmental insults can damage the DNA molecule and hamper identification.

Molecular biologists have developed methods to extract DNA from diverse biologic samples: bone, teeth, whole blood, saliva, muscle tissue, and various cell-containing tissues and fluids. A small yield of DNA can be copied to amplify its volume. Suitable quantities of DNA are processed to generate a profile that reflects the sequence or the length of the components of the molecular reference points being examined.

Interestingly, human X and Y chromosomes, present in cell nuclei throughout the body, contain a gene that codes for amelogenin, a protein involved in the production of tooth enamel. The length of the gene that codes for this protein serves as a marker for gender determination.

DNA is present within the teeth and contained within cells of the pulp and porous dentin comprising the greater part of the crown and root structure. As vessels for DNA, teeth offer protection from damaging environmental conditions. DNA can be retrieved from teeth using methods developed to preserve their unique contours.

Conclusion

The fundamental goals of air safety investigators are the prevention of mishaps and mitigation of injuries. Forensic science can directly support their mission by contributing victim injury and identification data that can place mishap victims within the aircraft or on the ground, and demonstrate their interaction in the development and consequences of the event. Victim identification can enhance the value of medical evidence to the overall investigation.

In difficult field situations, on-scene personnel may encounter remains yet to be recovered. As materials in these scenarios can be greatly reduced, seemingly insignificant fragments become increasingly necessary for identification. Field investigators can facilitate the recovery and identification process by recognizing and protecting these materials at the scene, documenting them if possible, and notifying the ME of their presence and position. In assisting this effort, air safety investigators can ultimately serve the families of the victims. ◆

Accident Investigation Without the Accident

The author puts forth the argument that the airlines, in many ways, are performing "accident investigation without the accident," and that there are some significant benefits from discovering some of the lessons learned from the relatively small accident investigation community.

By Michael R. Poole (M03278), P. Eng.

(This article was adapted, with permission, from the author's presentation entitled Accident Investigation Without the Accident *presented at the ISASI 2003 seminar in Washington, D.C., USA, August 2003. The full presentation is available on the ISASI website at* www.isasi.org.*—Editor)*

Flight data volume and availability have come a long way since the beginning days of aviation. Traditionally, accident investigators were the only people who examined flight data in great detail, in aid of detailed investigation. Today, with airlines embracing routine flight data monitoring (FDM) programs and the most recent trend for the airlines to use flight animation to replay the data, the domain of flight data analysis is rapidly being driven by the larger airline industry. (Note: Flight data analysis [FDA] is ICAO nomenclature. Flight operations quality assurance [FOQA] is U.S. nomenclature, and FDM is Canadian and sometimes European nomenclature.) This article will argue that the airlines, in many ways, are performing "accident investigation without the accident," and that there are some significant benefits from discovering some of the lessons learned from the relatively small accident investigation community.

A common statement I have heard lately is that FDM programs and accident investigation are not the same and therefore require different tools, and there is perhaps a misperception that "accident investigation" tools are not needed for FDM.

Before exploring this issue, a brief recap of the evolution of flight data is worthwhile. In the 1960s there was the metal foil recorder that recorded analog traces of five basic parameters (airspeed, magnetic heading, pressure altitude, vertical acceleration, and VHF keying on a time base). Then came the digital era (early 1970s) where flight data were digitally recorded on magnetic tape and the FDR name was changed from to DFDR to denote digital FDR (there are no analog FDRs today so the D is not used anymore).

Although the military introduced solid state (digital data stored on memory chips) in the 1980s, it wasn't until the early 1990s before solid-state memory was acceptable for use in civilian aircraft. The military was able to use solid state before civil aviation because the military recorded typically much less data than did the civilian sector and did not have the same crash survivability requirements as civilian standards, thereby being able to take advantage of early chip designs that did not meet international FDR/CVR standards at the time (Eurocae ED55 and ED56). The digital flight data acquisition unit (DFDAU) provided the data source for the FDR, accepting inputs from various sensors and data busses on the aircraft and "packaging" them into a serial bit stream that was sent to the FDR.

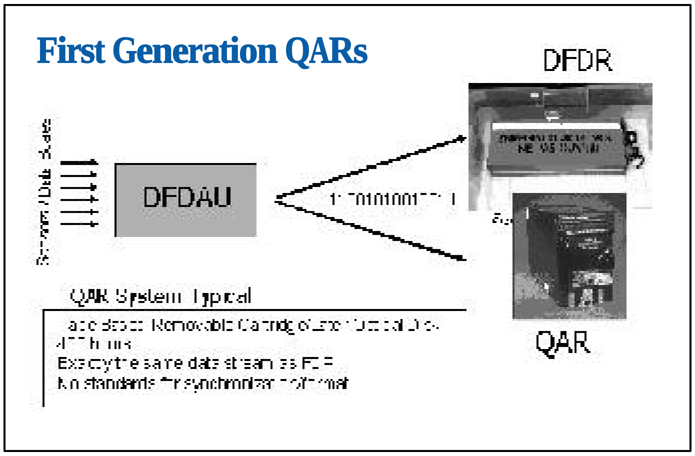
Airlines quickly discovered that extracting data from the mandatory FDR was by no means an easy process. For many, this meant only pursuing the data in reaction to a significant event. The recorder had to be removed from the aircraft and in some cases opened and recertified. Copy processes took hours and were fraught with "dropouts" or bit errors due to the mechanical nature of the recording system.

This erratic process inspired the first generation of quick access recorders (QARs) in the early 1970s. QARs were built with a removable media (initially tape as well) so that the airline could simply pull out the media and substitute another at any time. In the majority of these early systems, the FDAU sent the *identical* data stream to both the FDR and the QAR simply to facilitate easy access to the data. Effectively, airlines had two recorders on board the aircraft, one that conformed to rigorous standards (FDR) and one that conformed to no standards (voluntary), and both recorded the same information.

The data stream in those early days was, for some airlines, not enough, so they asked if they could have more. A very common misconception is that the issue of capacity is rarely an FDR problem, rather it is an acquisition problem. The rea-

***About the Author: Michael Poole** is a managing partner at Flightscape, which he joined in February 2002, following retirement from the Transportation Safety Board of Canada (TSB). Flightscape is a flight safety company specializing in flight sciences and flight data analysis systems. A professional engineer, Poole has with a current pilot's license and is a recognized expert in the field of flight recorder analysis. He started in the field of aircraft accident investigation in 1977 and worked 20 years with the TSB, where he served as the head of the flight recorder and performance laboratory, which he developed for the Board. He represented Canada as the national expert panel member to the International Civil Aviation Organization's Flight Recorder Panel.*

The advent of solid state was a great advancement in data quality and FDR reliability since there were no moving parts.



son that larger mandatory parameter lists did not exist is because of lack of data availability, not lack of FDR capacity. If the data were to be added to the FDR, they did not help the airline because the data were not accessible and any changes to the FDR meant rigorous recertification issues. The data were naturally added to the QAR instead and in some cases a complete additional voluntary FDAU was added to the aircraft, which the airline could reconfigure at will to determine which parameters were recorded.

Solid-state memory media recorders were the next to be introduced. The advent of solid state was a great advancement in data quality and FDR reliability since there were no moving parts. They were also readily downloadable making them truly *"quick access."* Many investigators thought the QAR would simply die a natural death with the advent of solid-state flight data recorders (SSFDRs). Why did investigators come to dislike the QAR? The Swissair Flight 111 MD-11 accident off Peggy's Cove in 1998 is a good example. The Swissair 111 FDR was a solid-state recorder with 64 words/sec. The QAR was a 384 word/sec tape-based unit, arguably less quick access than the FDR. The FDR survived but the QAR did not. The data were available, but they were in the wrong box! The QAR was developed because the FDR was not accessible and has now surpassed the FDR in terms of data quantity. Parameter rules must consider many aircraft types and, therefore, tend to cater to the lowest common denominator. Additionally, early standards *encouraged* a separate box for fear that the mandatory box would be adversely affected. Any change to the mandatory box meant costly certification issues. Airlines on the one hand complained about the costs of additional parameters and on the other hand went to the trouble and expense of recording extra data for their own purposes.

There were some other factors that affected the continued use of the QAR, despite logic dictating that it should become a thing of the past. If you added a parameter to the FDR and the parameter became problematic during routine FDM, regulatory bodies invoked the minimum equipment list (MEL) and grounded the airplane. In the late 1980s, Air Canada actually removed non-mandatory parameters from the FDR because of MEL problems. Operators, still today, do not want to add parameters to the FDR because of the regulatory interpretation of the MEL. The reality is that 99 percent of the parameters today are from a digital data bus and the parameters exist for the operation of the aircraft, not the FDR. The FDR is simply taking advantage of their ready availability. If the airspeed does not work on the FDR for an Airbus A320, for example, it is not an FDR problem—it is an aircraft problem. Yet, some still interpret this as a reason to ground the FDR system. The rules were developed from the days when sensors were dedicated to the aircraft, and the rules have not really been updated even though parameters from digital data busses are incredibly reliable.

It makes much more sense to have an integrated system whereby airlines can routinely access the data and the same data set is available to the accident investigator. In some ways it is simply a "packaging" issue. There was no technical reason why all of the Swissair data going to the QAR could not have also been going to an FDR. There tends to be two different groups in the industry, those who deal with the mandatory FDR and those who deal with the QAR. And it is long overdue that they talk to each other.

Eurocae ED112 and the recent U.S. Future Flight Data Collection Committee are trying to change history in this regard.

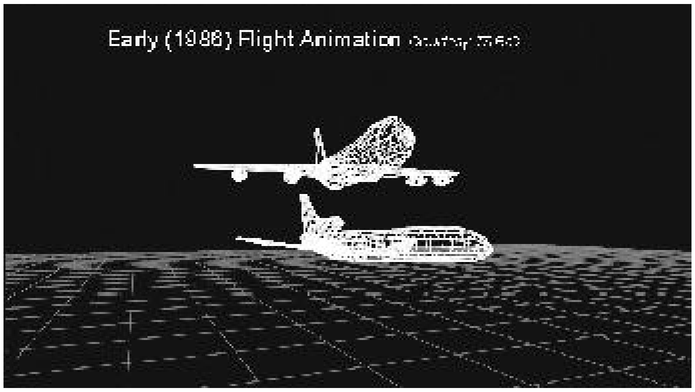
ED112—*"With today's solid-state technology, significantly increased capacities, readily available data on the aircraft, and affordable ground-based wireless download capabilities, an integrated crash-protected recording system that satisfies both accident investigators' and operators' routine playback needs is highly desirable."*

"… it is recommended that industry provide operators with solutions that protect the core mandatory list while allowing the operator to change the recorded data (e.g., additional data, sample rates, or resolutions) in the crash-protected medium without requiring recertification of the flight recording system."

The bottom line is that it is really unacceptable to record more data for routine monitoring of flight data than for a major accident investigation.

Flight animation

Accident investigators have been using flight animation since the early 1980s. Airlines did not use it because there were no commercial systems available, and it was relatively expensive to do. Today, that is not the case and flight animation is readily



available, and numerous systems are commercially available.

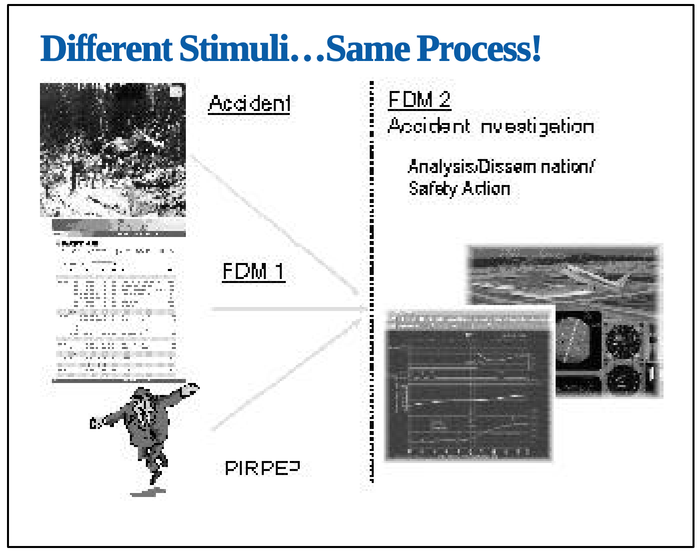
Investigators have long known about the benefits and pitfalls of animation and throughout the late 1980s and 1990s have presented papers at ISASI annual seminars, as animation systems became increasingly popular and controversial.

Benefits of flight animation
- Assimilate complex information
- Facilitate analysis
- Stimulating and effective means of communication
- Powerful and compelling
- Effective training tool
- Easy to disseminate
- Lend credibility to findings

Pitfalls of flight animation
- Pretty-picture syndrome (seeing is believing)
- Fabrication
- Subjective information
- Drawing conclusions without understanding underlying principles
- Misplaced credibility

Investigation vs. analysis

We all know and understand the elements and reasons why we investigate accidents. FDM programs are very valuable as it makes a lot of sense to study the data *before* things become catastrophic. FDM is a proven concept and is being embraced worldwide. So what is the problem? First let's define an FDM program.



FDM is part of a safety management system. It is a systematic collection of flight data for improvement in the areas of operations, maintenance, training, and risk management.

It is effectively an information technology (IT) system to distribute objective information to reduce operations and support costs and improve dispatch reliability. Above all, it is a system that identifies precursors to accidents. For clarification purposes, let's look at FDM as two distinct components.

FDM 1 event detection
- Routine monitoring of flight data
- Automatic detection of events
- Until recently, plagued with poor quality data
- Outputs statistical database
- Flight animation not useful
- Examining daily flights in small detail

FDM 2—occurrence investigation
- Examination of a single event(s) in great detail
- Similar to accident/incident investigation
- Flight animation is very useful for routine events and complex events

Regardless as to whether the stimuli to study a flight sequence is an accident, incident, FDM 1 event, or a PIREP, it can be argued that once you perform the study, there should be no difference in the techniques, expertise, and tools required. Whether the aircraft hits the ground has no bearing on the analysis of the data leading up to the event that initiated the analysis. FDM 2 is arguably accident investigation without the accident.

Unfortunately, in the quest to provide user friendly automatic tools to eliminate the need for expertise, there is a component of the industry that believes and/or advertises that "investigation" skills/tools are not necessary for FDM programs. Some persons believe that you have to be an expert to use an "investigation" system, but you do not need to be an expert to use an "airline" system. The fact is that the expertise required is not a function of the "tools" one uses, but rather it is a function of the flight data itself. If you did not need to have expertise to analyze flight data, we would not need expert accident investigators.

Many airlines want to routinely animate events for training purposes—just hit a button and up pops the animation. While virtually all software on the market can do this, it should be noted that flight animations are actually quite useful for analyzing complex events and understanding and disseminating those events. The current limitations of sample rate, resolution, accuracy, and number of parameters is such that often significant judgment is required. Accident investigators grew up with lousy tools in the 60s, 70s, and 80s, and their experience in flight data analysis and the tools used to perform the job grew up together. Today the airline can jump in with very attractive tools that have internally automated many of the steps investigators performed manually. With this automation and marketing of products as being automatic and requiring little expertise to use comes a significant danger that the judgment is simply lost in the process.

Airline playback systems were originally designed for maintenance. Only in recent years have such systems been used for detailed operational analysis of events, partly inspired by readily available animation capability. Airlines are going to increasingly make operational decisions based on their flight data analysis well beyond this traditional role.

Examples of concerns

There are many technical examples that illustrate some of the concerns. One example is the problematic trend in the airlines to use engineering units (EU) or comma separated variables (CSV) or spreadsheets to pass the data to their analysis/animation systems. The problem with passing EU files is that your analysis/animation tool may be showing you an artifact of the recorded data instead of the real data due to processing that you may be totally unaware of.

Investigators use systems that interactively handle the ARINC bit stream data directly. That is, all applications interact with the source binary data and convert to EU "on the fly" as required. Many systems in use by the airlines, however, cannot accept ARINC data and must first have the data pre-processed by another application so that it is "readable" by their analysis/animation system. This is largely because handling the ARINC data from the aircraft directly is a significant process in itself. Flight recorder manufactures like to sell boxes and sell hundreds of FDRs for every replay station they sell. Consequently, their replay systems, while they will recover the data, have fairly poor analysis tools. Other companies capitalized on this and developed analysis tools but relied on someone else to perform the actual data recovery.

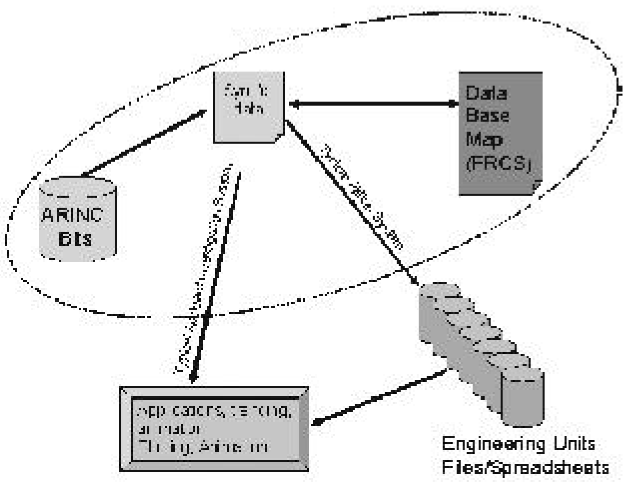
As airlines make more and more decisions based on routine flight data, it will become increasingly important that similar standards of data recording, extraction, and processing that have evolved from years of accident investigation are applied to the rest of the industry.

When EU files have to be passed from one process or system to another as a CSV or spreadsheet file, it becomes problematic to pass all of the recorded parameters. A modern aircraft may have well over a thousand parameters. Imagine an Excel spreadsheet 1,000 columns wide! In fact, that cannot be done in Excel due to limitations. What typically occurs is the sending of only the parameters needed. Although the person at the other end may normally want only to look at a core set, that person's ability to "investigate" the data is compromised because not all the data are sent and the person must then prejudge what is important. As a former Transportation Safety Board of Canada (TSB) investigator, I do not like to have to prejudge what I think I might be interested in. Since investigation systems access the ARINC binary data file, which is a relatively small and nicely packaged file already, investigators have access to all of the data all of the time.

Another more serious problem with passing EU files around for analysis is the time element. Two parameters that are both recorded at one sample per second are actually not sampled at the *same* time within the second. There is a relative offset based on the word location. For example, aileron position and control wheel, while both sampled once per second, will be offset from each other by as much as just under a second. In order to maintain the timing resolution of the original data, the EU file must be incremented at intervals coincident with the data frame rate. For example, a 64 word/sec rate would require the data printed out in 1/64 time intervals to maintain the same time resolution for each parameter. This means that if you want to look at 25 hours of data using EU files, you would need 64 lines of data for each second.

To pass 25 hours of all of the flight data to someone in an EU file format maintaining the recorded accuracy would require a spread sheet 5,760,000 lines long and 1,000+ columns wide! If you move to a 256 or 512 word/sec recording, the numbers get even more impractical. Instead, shortcuts are taken by prejudging what parameters the analysis or animation system needs and by truncating the data all to the nearest second. The NTSB and other investigation agencies have delivered technical papers on how important it is that

Typical Airline vs. Investigation Data Flow



we be able to trace data latency. They are talking about latencies within the second for the most part. For all of these systems out there that truncate the data to the nearest second, there is no point in worrying about latency—you have already reduced the accuracy well beyond the latency concerns. This is simply unacceptable for accident investigators who have expertise in flight data analysis. Systems that can process the ARINC data on the fly do not suffer from this problem, and they will display the data at precisely the times it was recorded.

In many flight animations, it will not matter that the data are inaccurate in the time domain as there are lots of smoothing processes going on internally and the animation is being used to look at a relatively simple, routine event. However, should the team come across a more complex event, it is human nature that they will try to use the tools they have to do the work. This has already happened where an airline has run incidents through its "automatic" tools before the investigation authority even has the data. If we believe that FDM is accident investigation without an accident and accident investigators are not willing to compromise data quality and have stringent standards, why is it acceptable at the airlines? The answer is, it shouldn't be and, like the QAR dilemma, it is another example of how history has taken us to a place that we do not really want to be and it is very hard to undo.

Aircraft manufactures are also becoming aware of this growing problem as airlines will frequently wish to send data to them for assistance in troubleshooting something. Airlines send a CSV file and the analysts at the other end do not get all the parameters, do not get the proper time resolution, and do not have the ability to check the EU conversion process if they suspect a problem. The EU conversion process has many opportunities for error, especially with parameters infrequently analyzed, and one should never accept the EU data as factual. Since the ARINC data file is magnitudes smaller to send and has no compromises, it does not make much sense to be passing EU files. Manufacturers are starting to ask that the airlines please send the raw data, not some artifact of the data in which they have no way of assessing its validity.

ICAO Annex 13, Appendix D

ICAO Annex 13 Appendix D recognizes the difference between an "airline" facility and an "investigation" facility and recommends States use investigation facilities. This was written by the ICAO FLIREC Panel because some States started taking the recorders to airline facilities after a major accident and other States with significant recorder labs felt that this could compromise an investigation. This was written before FDM programs were popular. With the FDM evolution, ICAO will need to revisit this as the stakes have gone up as airlines can now have a flight animation done very quickly. If it is not accurate, or misleading, it is very hard to backtrack once people have seen it. The golden rule of accident investigation is to get it right before disseminating the results. With the accessibility of "automatic" flight animation systems and the manner in which some systems process the data, combined with philosophies that purport that you do not need any expertise to generate animations, we are setting ourselves up to compromise this golden rule.

As airlines make more and more decisions based on routine flight data, it will become increasingly important that similar standards of data recording, extraction, and processing that have evolved from years of accident investigation are applied to the rest of the industry.

With flight animation becoming more and more a popular part of FDM programs, airlines will almost certainly go down the same path the investigation labs have already gone down and eventually demand the same tools and require the same expertise. If you are using animations for training, you still need to make sure that it is right—you can't always jump from the data to training with the investigation part in the middle! The investigation part may be trivial for routine events but will not be trivial for complex events. When is the transition whereby the investigation expert is required, and will you know when you have crossed it? Like most things in life, nothing is free. The proper solution is to make sure the data are treated with the respect they deserve and to develop an expertise and thorough understanding of the process being operated. ◆

Council Sets New Membership Category

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

The ISASI International Council on May 7 in a general meeting in Herndon, Va., set, on a trial basis, a new membership category to be known as Reachout Associate Member. Council action came after lengthy discussion, which included a review of the attendance at the nine Reachout workshops already conducted in conjunction with ICAO. The Council noted that each workshop was placed in geographic location that have few, if any, ISASI members and that approximately 100 people have attended each session. In areas where the workshops are conducted, issues of lack of available funds, distance of travel, and minimum staffing limit the pursuit of air safety objectives. ISASI is attempting to assist in this objective by furnishing low-cost training in the region.

While the workshops have received great support and high praise, ISASI has not been able to receive these attendees as new members due in part to the high cost of membership. ISASI has been reluctant to reduce the cost of membership for international members due to the cost of international mailing. The Internet now seems to offer an alternative to international mailing. With the provision that all mailings will be available through the ISASI website, the ISASI Council created a new membership category entitled Reachout Associate Member. The Council will offer attendees at Reachout workshops this special classification. Each Reachout Associate will be given a membership number that will permit access to the ISASI website and its members only sections. Membership dues for this classification will be at the standard rate with the initiation fee waived for any new member who signs up as a result of attending a Reachout seminar. This program will remain in place until the end of 2006, at which time the Council will review the results of the program.

Other actions included reaffirmation that the ISASI Executive meetings, conducted by the elected officers 1 day prior to the full Council meeting, is open to all members of the Council and issued a standing invitation for such attendance by Council members.

The Council debated a change of policy to permit "limited" business-class travel to Council meetings. The term "limited" means that for flights originating outside North America, Council representatives may be able to travel business class over long, oceanic sectors to the first port of entry into North America. From that point on, travel would be economy class. Experience gained in arranging travel to past meetings indicates that a reasonable deal can usually be obtained. The Council decided to maintain its current policy of coach travel because of the potential for significant cost increase to ISASI for Council meetings.

In another Council action, discussion centered on the formation of a General Aviation Committee within ISASI to support that arm of the industry. The Council decided to move forward as long as an ISASI member from the general aviation area was willing to take the lead in forming the group. Also being considered is the formation of a Corporate Committee for the corporate aviation community from within ISASI.

Reporting activities of the Council meeting follow.

President—Frank Del Gandio reported on the status of the ISASI office condo to include costs of a special assessment levied by the condo association and minor renovation of the office interior.

Joanne Matley and Barbara Dunn work on a proposed resolution.

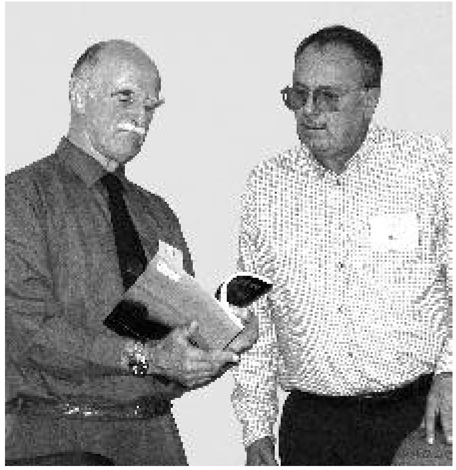
He also reported that refinancing the office condo with a lower interest rate is an action that is under way. He further reported that at his recent attendance of a Southern California Safety Institute (SCSI) seminar he recruited 8 to 10 new members. Also reported was the resignation of Chuck Mercer as chairman of the Bylaws Committee. Lastly, he reported on the special activities and articles associated with the passing of Jerry Lederer and C.O. Miller, some of which are still being initiated to highlight the significant contributions both had made to ISASI, aviation, and aviation safety.

Treasurer—Tom McCarthy reported that financially ISASI was in sound shape, noting that ISASI had received an additional $11,000 from the Victoria seminar. He further reported that because the profit from that seminar was turned over to the Taiwan government, the Taipei seminar did not split the proceeds generated from the seminar with ISASI. This action represented an approximate $13,000 loss to ISASI, which includes the publication of seminar *Proceedings*. All avenues have been exercised in an attempt to recover ISASI's portion of the profit from this seminar, he said. He also reported key bank account balances.

Executive Administrator—Richard Stone reported on the selection of Shannon Harris as the awardee of the Rudy Kapustin Scholarship fund (see page 26). He noted that it was the goal of the selection committee to select two award recipients but of the four papers submitted, the Committee felt that only one qualified for the award. He then opened discussion with the Council on whether the award winner should be provided transportation to the seminar in addition to the financial award. After some discussion, the Council decided that transportation would not be provided as a standard in the award but Council members were encouraged to solicit, through their individual contacts, complimentary or reduced-cost transportation for award winners.

Upcoming Events

- **ISASI 2004** Gold Coast Australia—Aug. 30-Sept. 2, 2004
- **ISASI 2005** Ft. Worth, Tex., USA
- **57th Annual International Air Safety Seminar,** Nov. 15-18, 2004. Location: Pudong Shangri-La Hotel, Shanghai, China. Further information: Ahlam Wahdan wahdan@flightsafety.org or Ann Hill, hill@flightsafety.org or +1-703-739-6700



Ron Chippindale and Ron Schleede engage in an ISASI 2004 discussion.

Reports of National Societies/Councilors

ASASI—Lindsay Naylor reported that most of his activities since the last Council meeting have been in preparation for ISASI 2004.

CSASI—Barbara Dunn reported that the Canadian Society was in sound financial condition with 100 members and that her involvement with SCSI was producing new members for CSASI and ISASI. She also reported that CSASI continues to get requests for and is providing bloodborne pathogen training, most recently for Transport Canada and that plans are being made to train representatives from the Royal Canadian Mounted Police. She also reported that she had received requests to conduct cabin safety Reachout seminars in India and Pakistan.

ESASI—Max Saint-Germain/Ken Smart reported that the European Society continues to attract new members from all areas of the aviation safety community and that currently ESASI is active with 118 individual and 19 corporate members. Within the last year, 10 individual and one corporate members were recruited.

NZSASI—Ron Chippindale reported current membership at 50 and that the New Zealand Society was in sound financial position. A membership meeting and dinner is being planned for NZSASI members and their partners. Election of a new Executive will occur at the membership meeting. As in the past, NZSASI will be subsidizing NZSASI members who attend ISASI 2004. He thanked Air New Zealand for providing complimentary upgrade to/from the U.S. to attend the Council meeting.

USSASI—Curt Lewis reported that ISASI 2005 had opened a website, www.ISASI2005.com, for communicating details regarding the Dallas/Ft. Worth seminar planned for the week of Sept. 12, 2005. He also is planning a U.S. Society newsletter.

International Councillor—Caj Frostell reported on his activities in support of Reachout (see "RoundUp" Section).

ISASI Forum Editor—Esperison (Marty) Martinez reported no changes have occurred in the editorial gathering, production, or printing aspects of the magazine. He also reported on the publication process of the *ISASI Proceedings,* the compilation of the technical papers presented at the annual seminar. During his report the Council discussed the printing of seminar *Proceedings* and of additional copies of ISASI *Forum.* The Council reiterated its position that the seminar *Proceedings* should continue to be distributed electronically via the ISASI website and on CD-ROM. In addition a very limited quantity (25) of hard copies would be produced for sale purposes and for Council use. The Council further directed the printing of 100 additional copies of the ISASI *Forum* for the use of members involved in Reachout and other ISASI activities that may result in new members. The issue was raised of the $5,000 that is presently required for the Seminar Committee to provide to ISASI to cover the cost of publishing seminar *Proceedings*. The question was asked if the cost was still necessary. It was explained that the bulk of the $5,000 was actually used for completion of editorial processes and prepress production procedures that would continue to be required even for electronic distribution. In addition, it was reported that the ISASI Executive renewed the editor's contract for another 3 years; the Council agreed with the action.

ISASI Committees

Membership—Tom McCarthy provided a written report and verbally reported that the current ISASI membership status stood at 1,385 individual members, of which 135 were delinquent in dues. There are 109 corporate members, of which 10 were delinquent in dues. He and the President reminded all Council members to review the list of delinquent members and to contact the members personally for renewal.

MOVING?
Please Let Us Know

Member Number____________________

Fax this form to 1-703-430-4970 or mail to ISASI, Park Center
107 E. Holly Avenue, Suite 11
Sterling, VA 20164-5405

Old Address (or attach label):

Name____________________________

Address __________________________

City _____________________________

State/Prov. _______________________

Zip ______________________________

Country __________________________

NewAddress*

Name____________________________

Address __________________________

City _____________________________

State/Prov. _______________________

Zip ______________________________

Country __________________________

E-mail ___________________________

*Do not forget to change employment and e-mail address.

Curt Lewis (left) and Ken Smart listen to ongoing discussion.

Seminar—Barbara Dunn reported that the seminar manual had been finalized. She noted that no formal bids for the 2006 seminar had been received yet, but individuals and societies had expressed interest in hosting in 2006 from the following locations: Prague, Hong Kong, Israel, Mexico, and Korea. In addition, Singapore expressed an interest in hosting a seminar in 2007. She also reported that Jim Stewart had offered to help with the Seminar Committee.

Reachout—Jim Stewart was unable to attend the meeting but submitted a written report in which he noted the Mexico City workshop in January. He also noted a Beijing workshop scheduled for late May. Interest in a workshop has been shown by Bulgaria and South Africa. Barbara Dunn mentioned cabin safety Reachout in India and Pakistan. Caj Frostell mentioned that discussions have been held with the FAA international office about coordinating Reachout with the ICAO COSCAP activity.

Technical Library—Corey Stephens provided an update on developments with the ISASI website. He said that the ISASI membership roster was now "real time," meaning it is tied to the membership database at ISASI headquarters so that when changes are made there the changes would also be seen in the roster available through the website. He also reported that a search engine had been added and that a corporate membership database would also be added to the site. Also to be available on the site will be the CSASI membership application and the Canadian Society web address.

Cabin Safety—Joanne Matley reported that she had recently completed the NTSB course and had distributed the materials obtained from the course to the cabin safety group.

Positions—Ken Smart reported that the biannual Positions review would be submitted in May 2005. Ken also reported that the Committee was down to three members.

Corporate Affairs—John Purvis reported that attendance at the corporate meeting held during ISASI 2004 was small due to the scheduling of overlapping meetings. The Council asked that the Seminar Committee minimize scheduling overlapping meetings during future seminars.

2004 Gold Coast Australia Seminar—Lindsay Naylor provided a status update on ISASI 2004. The technical program has been finalized. Registration has begun and the hotel indicates that accommodation bookings have also commenced. Naylor expects great technical and social programs.

2005 Dallas/Ft. Worth Seminar—Curt Lewis reported that the Seminar Committee is planning a get together sometime this summer to begin preparations for the 2005 seminar. He also reported that he was preparing an info package regarding ISASI 2005 for

NEW MEMBERS

Corporate

BEA—Bureau D'Enquetes et D'Analyses, CP0220
Martine Del Bono
Aircraft Accident Investigation Bureau—Switzerland, CP0223
Jean Overney
Olivier De Sybourg
State of Israel, Ministry of Transport, Aviation Incidents & Accidents Investigation, CP0224
Itzhak Raz (Razchik)

Individual

Abruzzese, Charlie, FO5059, Sydney, NSW, Australia
Ahsan, Imran, MO5045, MacDill, FL, USA
Alberto, Jr., Conrad, ST5035, Los Angeles, CA, USA
Alghamdi, Ali, G., AO5048, Jeddah, Saudi Arabia
Almotairy, Ayedh, N.D., MO5051, Jeddah, Saudi Arabia
Bagsair, Sameer, S., MO5043, Jeddah, Saudi Arabia
Barden, David, W., MO5052, Jeddah, Saudi Arabia
Binyousef, Hussein, I., MO5055, Jeddah, Saudi Arabia
Cha, Kisu, MO5037, Geyonggido, South Korea
De Silva, Anoma, AO5064, Mirihana Nugegoda, Sri Lanka
Doxey, Justin, M., MO5063, Clitheroe, England
Erini, Mark, P., AO5036, Canberra, ACT, Australia
Fearon, Rod, G., MO5058, Mt. Warren Park, OLD, Australia
Haider, Abdulaziz , A., AO5050, Jeddah, Saudi Arabia
Heck, John, W., MO5033, Washington, D.C., USA
Hughes, Kerri, L., FO5060, Higgins, ACT, Australia
Hunter, Skye, A., FO5039, Terrigal, NSW, Australia
Iqbal, Javed, MO5067, Karachi, Pakistan
Khan, Tanzeem, A., MO5044, MacDill, FL, USA
King, Brian, T., MO4962, Summerville, SC, USA
Langhof, Dietrich, MO5009, Kelsterbach, Germany
Larrain, Monique, C., ST5040, Daytona Beach, FL, USA
Lohmar, John, S., AO5054, St. Charles, MO, USA
Mahmood, Suheli, AO5065, Dhaka, Bangladesh
Menniti, Maximo, AO5038, Rome, Italy
Puggaard, Martin, F., MO5056, Roskilde, Denmark
Roberts, Cameron, J., MO5057, Ocean Reef, Australia
Sefton, Adam, R., AO5042, Thornton, CO, USA
Sheehan, James, E., MO5034, Greenwich, CT, USA
Shehab, Ahmad, T., AO5047, Jeddah, Saudi Arabia
Siska, Frankie, J., MO5062, Nowra, NSW, Australia
Wadud, Muhammad, A., MO5066, Dhaka, Bangladesh
Watson, James, R., MO5053, Friendswood, TX, USA
Wood, Mark, A., AO5041, Boulder, CO, USA
Younes, Mohamed Hany, A., AO5049, Jeddah, Saudi Arabia
Young, Steven, D., FO5061, Macgregor, ACT, Australia
Zahid, Rana Farooq Ali, MO5046, MacDill, FL, USA

distribution at ISASI 2004 and that a website had been established for the seminar, www.ISASI2005.com. ◆

ISASI 2004 Plans Complete

The Australian Society of Air Safety Investigators reports program plans for ISASI 2004 have been completed. The 35th annual seminar, which the Society is sponsoring, will take place Aug. 30-Sept. 2, 2004, and carry the theme "Investigate, Communicate, Educate." It will be held in the ANA Hotel Gold Coast, Queensland, Australia. Registrations continue to be received and present count indicates an excellent turnout for the Society's annual seminar, according to Chairman Lindsay Naylor.

There will be two tutorial workshops on Monday, August 30. Each costs A$85. The tutorials will run at the same time. The two subjects to be delivered are

Interviewing—Interviewing is a critically important skill for all types of safety investigations. This tutorial will provide an overview of witness/ interviewee limitations, general principles of investigative interviewing, and some specific principles useful for different types of interviews and situations. The tutorial will also include a practical exercise and an opportunity for participants to discuss any issues of interest or concern. Tutorial facilitators are Mike Walker and Brent Hayward.

Communicating and Educating—Al Bridges, tutorial facilitator, says communicating and educating explores the sometimes-neglected side of the investigation process. It concentrates on the messages that are important for you, as a safety specialist, as a company pilot, as an engineer, or as a passenger; indeed, anyone with a vested interest in aviation. What are the messages applicable to each of these groups and how should they be communicated? "We will look at some examples, find the essential messages for each group and the best methods to communicate those messages," he says.

The social program including the companion program calls for a cocktail reception on Monday evening, August 30, for all delegates and companions. An off-site dinner is planned for Tuesday evening, and the seminar Awards Banquet will be held in the hotel on Thursday evening.

On Tuesday, the companion group will enjoy lunch while cruising the Southport Broadwater to Sanctuary Cove, Australia's first fully integrated tourism resort. (Readers can get a photo look at these two areas by visiting the ISASI 2004 website—companion programs—and clicking the names of the two interest points.). Companions will have the choice of staying to shop or returning to the hotel. Activity planners said of the evening, "Get ready to hear the tunes of a Bush band, participate in some fair 'dinkum' Outback activities, pet the kangaroos and koalas, and watch an Aboriginal Corraboree—be sure to bring your camera!"

On Wednesday, companions will visit the Hinterland where they will experience "beautiful views, flora, and wildlife and have an opportunity to purchase gifts and produce handcrafted by the locals," said program planners. The Hinterland, also known as the "green behind the gold," is the Gold Coast's best-kept secret. It is a 30-minute drive from the coastal strip, and is considered the Gold Coast's natural "theme park"—along with its famous beaches. Popular Hinterland attractions include Curtis Falls and Gallery Walk at Mt. Tamborine, Springbrook and Purlingbrook Falls, Aussie Country at Canungra, Binna Burra Lodge, and O'Reilly's Guest House.

Those staying the extra day for the wind-down tour will visit Tamborine Mountain, a volcanic plateau 560 meters above sea level. The area has an extensive variety of waterfalls, rainforests, bird life, and many breathtaking walking trails. Next comes a spot of wine tasting followed by a leisurely three-course lunch at the historic homestead and award-winning Albert Winery.

Main program plans are, for the most part, said Naylor, "complete." He noted that the keynote address will be made by Bruce Byron, chief executive officer of the Civil Aviation Safety Authority of Australia, and that the address will be followed by a video tribute to Jerry Lederer. The 3 days of the seminar will be packed with presentations illuminating the theme "Investigate, Communicate, Educate." The ISASI 2004 website has a "to date" full listing of all speakers and subjects. Individual wise, speakers number 45, which may sound daunting until one sees that many presentations have multiple speakers/authors and all names are listed on the program delivered on the website. ◆

Kapustin Scholarship Winner Named

The ISASI Rudy Kapustin Memorial Scholarship Fund has selected as winner of the 2004 award—Shannon Harris (ST4983), a senior at Embry-Riddle Aeronautical University, Florida, USA, according to Richard Stone and Ron Schleede, ISASI co-administrators of the scholarship fund.

Shannon Harris

The administrators received four applications for consideration. In notifying the applicants of their selection, the Committee said: "The ISASI scholarship was awarded to the student we felt wrote the best essay. Some of our criteria were explained in the application, but some were based on our view of what knowledge a prospective accident investigator should have gleaned from his/her education. That criteria included

• submission of a 1,000 (+/- 10 percent) word paper in English addressing "The Challenges for Air Safety Investigators."

• submission of a paper that indicates understanding of the accident investigation process and the resulting safety implications of the findings.

• submission of a paper that is brief and clear and avoids overusing technical language that may not be understood by non-technical readers.

Shannon Harris's award provides for attendance at the upcoming ISASI annual seminar.

The Fund was established in memory of all ISASI members who have died, and was named the ISASI Rudy Kapustin Memorial Scholarship Fund in honor of the former ISASI Mid-Atlantic Regional Chapter president and long-term ISASI member who developed a reputation as "tinkicker extraordinaire" among his peers.

The scholarship is intended to encourage and assist college-level students interested in the field of aviation safety and aircraft occurrence investigation, according to Richard Stone, ISASI Executive Advisor and one of the two fund administrators. Contributions have and will continue to supplement the Kapustin's family initial endowment. The memorial will provide an annual allocation of funds for the scholarship. All members of ISASI enrolled as a full-time student in a recognized and accredited education program with a concentration on aviation safety and/or aircraft occurrence investigation are eligible for the scholarship. A student who has once received the annual scholarship will not be eligible to apply for it in another year.

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 34th International Semina*r, held in Washington, D.C., Aug. 26-28, 2003, by downloading the information from the appropriate section of the ISASI web page at http://www.isasi.org. The seminar papers can be found in the "Members" section. Further, 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 2003* 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.

The following papers were presented in Washington, D.C.:

SESSION I

Keynote Address Human Spirit and Accomplishment Are Unlimited *by Ellen G. Engleman, Chairman, NTSB, USA*

The Practical Use of the Root Cause Analysis System(RCA) Using Reason ®: A Building Block for Accident/Incident Investigations *by Jean-Pierre Dagon, Director of Corporate Safety, AirTran Airways*

From the Wright Flyer to the Space Shuttle: A Historical Perspective of Aircraft Accident Investigation *by Jeff Guzzetti, NTSB, USA, and Brian Nicklas, National Air and Space Museum, USA*

The Emergency and Abnormal Situations Project *by Barbara K. Burian, R. Key Dismukes, and Immanuel Barshi, NASA Ames Research Center*

SESSION II

Accident Reconstruction—The Decision Process *by John W. Purvis, Safety Services International*

CI611 and GE791 Wreckage Recovery Operations—Comparisons and Lessons Learned *by David Lee, Steven Su, and Kay Yong, Aviation Safety Council, Taiwan, ROC*

Application of the 3-D Software Wreckage Reconstruction Technology at the Aircraft Accident Investigation *by Wen-Lin, Guan, Victor Liang, Phil Tai, and Kay Yong, Aviation Safety Council Taiwan. Presented by Victor Liang.*

CVR Recordings of Explosions and Structural Failure Decompressions *by Stuart Dyne, ISVR Consulting, Institute of Sound and Vibration Research, University of Southampton, UK*

SESSION III

Keynote Address Learning from 'Kicking Tin' *by Marion C. Blakey, Administrator, FAA, USA*

Investigating Techniques Used from DHC-6 Twin Otter Accident, March 2001 *by Stéphane Corcos and Gérald Gaubert, BEA, France*

Investigation Enhancement Through Information Technology *by Jay Graser, Galaxy Scientific Corporation*

Historical Review of Flight Attendant Participation in Accident Investigations *by Candace K. Kolander, Association of Flight Attendants*

Accident Investigation Without the Accident *by Michael R. Poole, Flightscape*

SESSION IV

Keynote Address Growth of ATC System and Controllers Union *by John Carr, President, National Air Traffic Controllers Association, USA*

Crashworthiness Investigation: Enhanced Occupant Protection Through Crashworthiness Evaluation and Advances in Design—A View form the Wreckage *by William D. Waldock, Embry-Riddle Aeronautical University*

Enhanced Occupant Protection Through Injury Pattern Analysis *by William T. Gormley, Office of the Chief Medical Examiner, Commonwealth of Virginia*

Forensic Aspects of Occupant Protection: Victim Identification *by Mary Cimrmancic, Transportation Safety Institute, Oklahoma City, Okla.*

Aircraft Accident Investigation—The Role of Aerospace and Preventive Medicine *by Allen J. Parmet, Midwest Occupational Medicine, Kansas City, Mo.*

Expansion of the ICAO Universal Safety Oversight Audit Program to Include Annex 13—Aircraft Accident and Incident Investigation *by Caj Frostell, Chief, Accident Investigation and Prevention, ICAO*

SESSION V

The CFIT and ALAR Challenge: Attacking the Killers in Aviation *by Jim Burin, Flight Safety Foundation*

Flightdeck Image Recording on Commercial Aircraft *by Pippa Moore, CAA, UK*

Flightdeck Image Recording on Commercial Aircraft *by Mike Horne, AD Aerospace, Ltd., Manchester, UK*

An Analysis of the Relationship of Finding-Cause-Recommendation from Selected Recent NTSB Aircraft Accident Reports *by Michael Huhn, Air Line Pilots Association. Presented by Chris Baum.*

Ramp Accidents and Incidents Involving U.S. Carriers, 1987-2002 *by Robert Matthews, FAA, USA*

SESSION VI

Keynote Address Accident Investigation in Brazil *by Col. Marcus A. Araújo da Costa, Chief Aeronautical Accident Prevention and Investigation Center (CENIPA), Brazil*

Airline Safety Data: Where Are We and Where Are We Going? *by Timothy J. Logan, Southwest Airlines*

Use of Computed Tomography Imaging in Accident Investigation *by Scott A. Warren, NTSB, USA*

Investigating Survival Factors in Aircraft Accidents: Revisiting the Past to Look to the Future *by Thomas A. Farrier, Air Transport Association of America, Inc.*

The Accident Database of the Cabin Safety Research Technical Group *by Ray Cherry, R.G.W. Cherry & Associates Limited, UK*

Search & Recovery: The Art and Science *by Steven Saint Amour, Phoenix International, Inc.*

National Transportation Safety Board Recommendations Relating to Inflight Fire Emergencies *by Mark George, NTSB, USA*

Lucky winners: Top prize winners at the MARC meeting were Bob MacIntosh and Don Arendt. MacIntosh won a roundtrip flight to any place on AirTran Airways schedule, compliments of the airline, and Arendt won a free registration to the FSF Shanghai seminar later this year. Shown in top photo, left to right, D. Borden, J.P. Dagon (Air Tran); MacIntosh; and R. Schleede, MARC President. Photo to left, left to right, Arendt, S. Matthews, and Schleede.

The Fund administrators ensure that the education program is being completed at a recognized school and applicable to the aims of the Society and assess the applications and determine the most suitable candidate. The scholarship consists of an annual $1,500 award.

Contributions to the Fund may be mailed to the ISASI home office. Checks should be made payable to the ISASI Rudy Kapustin Memorial Scholarship Fund. ◆

MARC Members Host FSF President

The ISASI Mid-Atlantic Regional Chapter annual meeting kept to its established schedule and was held in Washington, D.C., on May 6, to coincide with the spring ISASI Council meeting, conducted the next day.

Guest speaker was Stuart Matthews, Flight Safety Foundation president and CEO. The FSF is also a corporate member of ISASI.

Matthews' address titled "Aviation Safety: Things That Can Be Done Better" included three prime topics: criminalization of accident situations and its effect on accident investigations; need for greater use of airline flight data collection and analysis; and will aviation safety be affected by aviation security costs.

He said the criminalization issue now threatens the protection of data and accident evidence by making information difficult to obtain and impeding investigations. The topic has been one of concern to the FSF and many safety officials. At ISASI 2002, the chairman of Indonesia's National Transportation Safety Committee made a stirring presentation on the need for caution on this subject. So, it was with some sense of accomplishment that Matthews announced the International Civil Aviation Organization's (ICAO) agreement to address the subject through an assembly resolution at ICAO's September 2004 ordinary session of the assembly.

Similarly, flight operations quality assurance (FOQA) programs have been long discussed and studied. Matthews ratcheted up the discussion by calling for the FAA to mandate the establishment of such a program on all U.S. airlines. He noted that although the present voluntary program has shown its worth through its ability to correctly predict unsafe operational trends, not all air carriers use it.

Already ICAO has issued its recommendation that a non-punitive flight-data-analysis program be established by all operators of airplanes with a maximum takeoff weights greater than 27,000 kilograms/60,000 pounds, by Jan. 1, 2005, and Europe's Joint Aviation Authority is following ICAO's lead, said Matthews.

He believes that if the FAA does not mandate FOQA, the many countries outside of Europe that normally follow FAA's lead will continue their style and not bother to mandate the program's use. He told the MARC audience, "the FAA must provide leadership. The FAA must mandate FOQA."

Matthews next raised the audience's interest level considerably when he opened the topic of security vs. safety. The thrust of his talk was that notwithstanding the industry's disastrous economic fallout following the terrorist use of passenger aircraft as weapons on Sept. 11, 2001, and the correct response of heightened security, air safety concerns have not changed since that date.

Air safety and good security are both expensive. Considering the severe cutbacks in air carrier operations and staff since 9/11, owing to the economic fallout, is air safety in danger of being placed in the shadow of security? Matthews cautioned that "It might be tempting to think that with such a low accident rate, for the time being, the industry was safe enough so that, by relaxing some of the safety safeguards, costs might be saved or be made available to be spent elsewhere. However, this would only increase the overall risk level and I would contend that a major aircraft accident would not only cost the carrier concerned infinitely more than any hoped for savings, it could well have the same detrimental effect on the aviation industry as another terrorist attack."

In closing the topic, he noted that assets and interests need to be wisely directed because, "…day in and day out, the public's primary risk in commercial air travel will come from accidents, not from criminal acts or terrorism." ◆

PNRC Briefed on Year 2003 Accidents

The Pacific Northwest Regional Chapter, well attended by both members and guests, received a presentation on hull-loss aircraft accidents that occurred during 2003 from Richard Anderson of the Boeing Air Safety Investigation at the Chapter's June meeting held at the Boeing Longacres facility in Renton.

Anderson, who has worked extensively with the statistical aspects of accidents, gave an excellent overview of the year 2003 air carrier accidents and how that compared with previous years. He also discussed the shuttle accident and how Dennis Rodriguez, recently retired from the Boeing Company, had received the prestigious Snoopy Award for his contributions to that investigation.

Part of the 156 participants who attended the first European edition of the International Aircraft Cabin Safety, Security, and Health Symposium.

The PNRC will be continuing its technical meetings throughout 2004. Guests from other regions or individuals interested in aviation safety are always invited to attend any of the Chapter meetings. Details on the exact times and locations for these presentations can be obtained directly from Chapter President Kevin Darcy at kdarcy@safeserv.com or from Leo Rydzewski at leo.j.rydzewski@boeing.com. ◆

Cabin Safety Symposium Held in Prague

The first European edition of the annual International Aircraft Cabin Safety, Security, and Health Symposium was held in Prague, Czech Republic, on March 23-25. The Symposium, now in its 22nd year, has been traditionally held annually in North America and hosted by the Southern California Safety Institute (SCSI), an ISASI corporate member. The special Prague edition marks the first time that the Symposium has held a general session outside North America.

The concept of conducting a special European edition was introduced by Ladislav Mika (MO4226), Ministry of Transport of the Czech Republic, in discussions with Dr. Peter C. Gardiner, president and CEO of SCSI (CP0098). The Prague organizing committee established panels of outstanding speakers that focused on trends and best practices in cabin safety training; cabin safety, security, and health; and lessons learned from accidents and hijackings. Workshops were also conducted on arctic, jungle, water, and desert survival training.

Planners of the Symposium set the goal of gathering aviation, medical, and security experts from Europe and States that might not be able to attend a North American event, and providing them a chance to participate either as panelists making presentations or to listen to presentations, attend workshops, and participate in a realistic hijack exercise conducted at the Czech Airlines training center.

More than 156 delegates from 28 countries in central, eastern, and western Europe, the United States, South America, the Middle East, Hong Kong, and Africa traveled to Prague to hear presentations, participate, network, and discuss cabin safety, health, and security issues of mutual concern. Robert Kruger, deputy director of the

European and North Atlantic office of ICAO, was a keynote speaker. Delegates also decided to form two special interest groups (SIGs) for continued networking and dialoging between symposia by e-mail: SIG Cabin Safety and Security and SIG Training.

Plans were made to meet again in Prague in 2006 for a second European edition. ◆

NZSASI Elects New Executive

At its biennial meeting the New Zealand Society of Air Safety Investigators elected new members as the group's Executive body. Peter Williams was elected to the office of President; Wing Commander Russell Kennedy, Vice-President; and Ron Chippindale, Secretary/Treasurer and New Zealand Councillor. All appointments became effective on May 30.

The biennial meeting was held on May 29 at RNZAF base Ohakea and was in conjunction with a visit to the Air Force museum and dinner with partners. Business discussion involved plans for the spring Council meeting, the venue for the Australia/New Zealand seminar in June 2005, the recent review of the transport sector in New Zealand with reference to the comments on accident investigation, membership recruiting, subsidizing attendance at ISASI and ANZSASI seminars, the various scholarship and other prizes offered by ISASI and associated societies, financial reports, and comments from the members of the Executive. ◆

65 Attend Reachout Beijing

Sixty-five participants representing the full spectrum of civil aviation safety, including airline pilots, government investigative authorities, and airport managers, attended the Beijing, China, Reachout workshop held in May. Most of the participants were from China; however, 11 were from the Republic of Korea and 3 from the democratic People's Republic of Korea, reported Jim Stewart, Reachout Committee chairman.

Part of the group attending the Reachout workshop. Dignitaries in the front row are, from 2nd from the left, Huang Sui Fa, director general CAAC; Jim Stewart; Laurence Barron, president Airbus, China; Minister Yang Yuan Yuan; Len Cormier, COSCAP; Caj Frostell, ISASI; and Hugues Depigny, vice-president of Customer Services, Airbus, China.

The program included a 5-day ISASI Reachout workshop consisting of accident investigation and prevention and safety management topics. Instructors came from France and Canada. Minister Yang Yuan Yuan officially opened the workshop. Laurence Barron, president of Airbus, China, welcomed the participants to the Airbus training facility and emphasized the importance of the ISASI Reachout program.

The ICAO Cooperative Development of Operational Safety and Continuing Airworthiness Program (COS-CAP) North Asia (COS-CAP-NA), the Civil Aviation Authority of China, and Airbus Industrie hosted the workshop, which consisted of 3 days of accident investigation and 2 days of safety management systems. Jim Stewart taught safety management systems while Caj Frostell (ISASI and ICAO), Nicholas Rallo (BAE, France), and Dr. Kwok Chan (Airbus) taught accident investigation.

Instructors prepared their own training material consisting of paper handouts, CD-ROM libraries, and published manuals and booklets. ICAO provided numerous documents that were shipped from its headquarters in Montreal. These included Chinese-language copies of the latest accident prevention and investigation documents. Each participant received copies of documents and CD-ROMs with considerable background materials for future reference.

The COSCAP-SA covered all travel and daily subsistence costs for the three instructors. There was no need for ISASI to obtain any additional

TRAINING COURSE CALENDAR 2004

UNIVERSITY OF SOUTHERN CALIFORNIA
- **Aviation Safety Program Management**
Sept. 20, Oct. 1, Dec. 6-17
- **Human Factors in Aviation Safety**
Sept. 13-17, Nov. 8-12
- **Safety Management for Aviation Maintenance**
Nov. 1-5
- **Software Safety**
Nov. 15-18
- **Gas Turbine Accident Investigation**
Nov. 15-19
- **Accident/Incident Response Preparedness**
Oct. 18-20
- **Photography in Accident Investigations**
Oct. 21-22
- **Helicopter Accident Investigation**
Oct. 25-29
- **Aircraft Accident Investigation**
Oct. 4-15
- **Incident Investigation/Analysis**
Aug. 30-Sept. 2

For further information contact:
University of Southern California/Aviation Safety Programs
Tele: 310-342-1345
Website: www.usc.edu/dept/engineering/AV.html

TRANSPORTATION SAFETY INSTITUTE & FAA
- **Aircraft Accident Investigation**
Jul. 27-Aug. 4, Aug. 18-26
- **Accident Investigation Recurrent Tng.**
Aug. 10-12, Sept. 14-16
- **Human Factors in Accident Investigation**
Aug. 31-Sept. 2
- **Aircraft Cabin Safety Investigation**
Aug. 19-20

For further information contact:
Pat Brown, Transport Safety Institute
Tele: 405-954-7206
Website: www.tsi.dot.gov

SOUTHERN CALIFORNIA SAFETY INSTITUTE
A = Albuquerque, NM
T = Torrance, CA
O = Ottawa, Canada
V = Vancouver, British Columbia
PR = Prague, the Czech Republic

- **Aircraft Accident Investigation (A)**
Oct. 11-22
- **Human Factors for Accident Investigators (A)**
Oct. 25-29
- **Investigation Management (A)**
Nov. 1-5
- **Gas Turbine Accident Investigation (A)**
Nov. 8-12
- **Aircraft Performance and Structures Investigation (A)**
Nov. 17-21 (03)
- **Ramp and Maintenance Safety (T)**
TBD
- **Fire and Explosives Investigation (A)**
TBD
- **Safety Management Systems (T)**
Sept. 13-24
- **Human Factors in Safety Management Systems (T)**
Sept. 27-Oct. 1

For further information contact:
Eduardo Treto, Registrar
SCSI, 3521 Lomita Blvd, Ste 103
Torrance, CA 90505-5016, USA
Tele: 1-800-545-3766 or 310-517-8844,
Fax: 310-540-0532
E-mail: registrar@scsi-inccom
Website: wwwscsi-inccom

sponsorship from ISASI sources for the workshop. Local sponsorship was provided and managed by Len Cormier, the chief technical advisor to COSCAP NA, including air travel for instructors, local ground transportation, and instructor lodging. The Airbus training facility was provided, and Airbus sponsored lunches and refreshments. Sponsorship for ISASI Reachout was also obtained from the Air Line Pilots Association, International, which provided staff time and administrative support, as did ICAO. Airbus representatives were very positive about the Reachout program and made a strong commitment to continue their association with future ISASI Reachout workshops.

The support of ICAO was critical in establishing the credibility of the workshop, said Stewart. The office of COSCAP-NA distributed the invitation and the registration form for the workshop to its member States, he added. ◆

NTSB Gains Hersman, Loses Goglia

Deborah Hersman was sworn in on June 21 as a Member of the National Transportation Safety Board. Before joining the Board, Member Hersman was a senior professional staff member of the U.S. Senate's Committee on Commerce, Science, and Transportation for the last 5 years. Prior to that, she served as staff director and senior legis-lative aide to Congressman Bob Wise of West Virginia from 1992 to 1999.

In her Senate position, Member Hersman was responsible for the legislative agenda, oversight, and policy initiatives for surface transportation issues, including railroad regulation, safety and passenger issues, truck and bus safety, pipeline safety, and hazardous materials transportation safety. She was also extensively involved with aviation and maritime issues. She also worked on transportation security issues following the attacks of September 11. Her term expires Dec. 31, 2008.

John Goglia departs the NTSB after a tenure of 9 years. He was appointed to the Safety Board in 1995 by President Bill Clinton. During his time on the Board, he often warned about the risks of ill maintenance and of bird-plane collisions and persuaded airports to do a better job of keeping birds from nesting and feeding near runways. He was the first airline mechanic on the NTSB and often focused on mistakes by his brethren. He was instrumental in persuading airlines and labor unions to adopt new ways to prevent those mistakes.

When he accepted the government job, he was required to cut all ties with USAir, which meant he had to sacrifice about $3,500 per month in retirement pay, plus his health benefits. He sacrificed the money because the NTSB gave him "an opportunity to make a difference." ◆

ISASI INFORMATION

OFFICERS

President, Frank Del Gandio
Executive Advisor, Richard Stone
Vice-President, Ron Schleede
Secretary, Keith Hagy
Treasurer, Tom McCarthy

COUNCILLORS

United States, Curt Lewis
International, Caj Frostell
Australian, Lindsay Naylor
Canadian, Barbara Dunn
European, Max Saint-Germain
New Zealand, Ron Chippindale

UNITED STATES REGIONAL CHAPTER PRESIDENTS

Arizona, Bill Waldock
Mid-Atlantic, Ron Schleede
Alaska, Craig Beldsoe
Northeast, David W. Graham
Dallas/Ft. Worth, Curt Lewis
Pacific Northwest, Kevin Darcy
Florida, Ben Coleman
Rocky Mountain, Richard L. Perry
Great Lakes, Rodney Schaeffer
San Francisco, Peter Axelrod
Los Angeles, Inactive
Southeastern, Inactive

NATIONAL AND REGIONAL SOCIETY PRESIDENTS

Australian, Kenneth S. Lewis
SESA-France Chap., Vincent Fave
Canadian, Barbara M. Dunn
New Zealand, Peter Williams
European, Ken Smart
United States, Curt Lewis
Russian, V. Venkov
Latin American, Marco A. de M. Rocha

CORPORATE MEMBERS

Accident Investigation Board, Finland
Accident Investigation Board/Norway
ACE USA Aerospace
Aeronautical & Maritime Research Laboratory
Air Accident Investigation Bureau of Singapore
Air Accident Investigation Unit—Ireland
Air Accidents Investigation Branch—U.K.
Air Canada
Air Canada Pilots Association
Air Line Pilots Association
Air New Zealand, Ltd.
Airbus S.A.S.
Airclaims Limited
Aircraft Accident Investigation Bureau—Switzerland
Airservices Australia
AirTran Airways
Alaska Airlines
All Nippon Airways Company Limited
Allied Pilots Association
American Airlines
American Eagle Airlines
American Underwater Search & Survey, Ltd.
ASPA Mexico
Association of Professional Flight Attendants
Atlantic Southeast Airlines—Delta Connection
Austin Digital, Inc.
Australian Transport Safety Bureau
Avianca & SAM Airlines
Aviation Safety Council
Avions de Transport Regional (ATR)
BEA—Bureau D'Enquetes et D'Analyses
Belgian Air Force, Air Staff Brussels, VSF
Bell Helicopter Textron, Inc.
Board of Accident Investigation—Sweden
Boeing Commercial Airplanes
Bombardier Aerospace
Bombardier Aerospace Regional Aircraft/de Havilland, Inc.
Cathay Pacific Airways Limited
Cavok, International, Inc.
Civil Aviation Safety Authority, Australia
COMAIR, Inc.
Continental Airlines
Continental Express
DCI/Branch AIRCO
Delta Air Lines, Inc.
Directorate of Flight Safety (Canadian Forces)
Directorate of Flying Safety—ADF
Dutch Transport Safety Board
EMBRAER—Empresa Brasileira de Aeronautica S.A.
Embry-Riddle Aeronautical University
Emirates Airline
Era Aviation, Inc.
EVA Airways Corporation
Exponent, Inc.
Federal Aviation Administration
FedEx Pilots Association
Finnair Oyj
Flightscape, Inc.
Flight Safety Foundation—Taiwan
FTI Consulting, Inc.
GE Aircraft Engines
Global Aerospace, Inc.
Hall & Associates LLC
Honeywell
Hong Kong Airline Pilots Association
Hong Kong Civil Aviation Department
IFALPA
Independent Pilots Association
Int'l. Assoc. of Mach. & Aerospace Workers
Interstate Aviation Committee
Japan Air System Co., Ltd.
Japanese Aviation Insurance Pool
JetBlue Airways
KLM Royal Dutch Airlines
L-3 Communications Aviation Recorders
Learjet, Inc.
Lufthansa German Airlines
Middle East Airlines
National Aeronautics and Space Administration
National Air Traffic Controllers Assn.
National Business Aviation Association
National Transportation Safety Board
NAV Canada
Northwest Airlines
Phoenix International, Inc.
Pratt & Whitney
Qantas Airways Limited
Republic of Singapore Air Force
Rolls- Royce Corporation
Royal New Zealand Air Force
Sandia National Laboratories
Saudi Arabian Airlines
Scandinavian Airlines
School of Aviation Safety and Management, ROC Air Force Academy
SICOFAA/SPS
Sikorsky Aircraft Corporation
Singapore Airlines, Ltd.
Smith, Anderson, Blount, Dorsett, Mitchell & Jernigan, L.L.P.
SNECMA Moteurs
South African Airways
South African Civil Aviation Authority
Southern California Safety Institute
Southwest Airlines Company
State of Israel, Ministry of Transport, Aviation Incidents & Accidents Investigation
SystemWare, Inc.
TAM Brazilian Airlines
The Ministry of Land, Infrastructure, & Transport, AAIC, Japan
Transport Canada Aviation
Transportation Safety Board of Canada
U.K.—Civil Aviation Authority
UND Aerospace
University of NSW AVIATION
University of Southern California
Volvo Aero Corporation
WestJet ◆

The Association of Professional Flight Attendants

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

Headquartered in Euless, Tex., USA, the Association of Professional Flight Attendants (APFA) was certified as the recognized labor bargaining agent for the American Airlines flight attendants in 1977. And from the beginning, the organization has worked diligently to keep safety in the forefront. The APFA has been an ISASI member since 1989.

Aware of the importance of teamwork, the APFA works with American Airlines to continually review, monitor, and track safety and security concerns for its members. The APFA maintains files and a database for the purpose of tracking potential safety hazards and exchanges this information with its counterparts at American Airlines, working together to mitigate unsafe conditions and to prevent accidents.

An important element of APFA's safety structure is its GO Team, which is an organized response team in the event of a serious aircraft accident or incident. Union representatives are trained to assist company and/or government agents in post-incident/accident debriefs and investigations. The GO Team is trained to fulfill its responsibilities under the provisions of Annex 13 of the International Civil Aviation Organization (ICAO).

The APFA, along with other flight attendant groups, has worked on a myriad of issues over the years with industry and regulatory agencies to promote cabin safety. This is done under the direction and guidance of the Association's president. Similarly, the APFA also responds to proposed government regulations that have both direct and indirect impact on cabin safety. The APFA Safety Department takes an active role with relevant legislative, government, and other factions of industry to facilitate cabin and passenger safety initiatives.

As the flight attendant's bargaining agent, APFA's primary function is to negotiate contracts and working conditions for all flight attendants at American Airlines and TWA LLC. In addition, the APFA monitors work rule compliance to ensure that American Airlines and the flight attendants comply with the terms and conditions of the current bargaining agreement, participates in multiple efforts toward enhancing aircraft safety, and provides up-to-date information to the APFA membership via award-winning newsletters, telephone hotlines, and a dedicated website.

The Association is a democratic organization, defined by a constitution, operated by and for its members. The APFA is the largest independent flight attendant union in the United States, with a membership of approximately 26,000.

Within the organization, there are structured departments, each with a charter. These departments include Contract Administration, Communications, Health, Hotel, Safety, and Scheduling. Daily, there are approximately 50 volunteers, staff, and officers available to assist the flight attendants.

Each of the 18 flight-attendant domiciles is represented within the organization, and each is committed to the safety of its customers and co-workers as a core value. The APFA officers and union representatives are flight attendants on leave to work for the APFA. All union representatives maintain their emergency qualifications, and periodically they work trips. This keeps the union leadership in close touch with the membership. The APFA is dedicated solely to the issues and concerns of the women and men of the Association's membership. ◆

ISASI
107 E. Holly Ave., Suite 11
Sterling, VA 20164-5405
USA

NON-PROFIT ORG.
U.S. POSTAGE
PAID
Permit #273
ANNAPOLIS, MD