FORUM

ISASI

Air Safety Through Investigation

JANUARY-MARCH 2022

Journal of the International Society of Air Safety Investigators

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FORUM ISASI
Air Safety Through Investigation
Journal of the International Society of Air Safety Investigators

Volume 55, Number 1

Publisher Frank Del Gandio
Editorial Advisor Richard B. Stone
Editor J. Gary DiNunno
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ISASI Forum (ISSN 1088-8128) is published quarterly by the 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, jgdassociates@starpower.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 is used.

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: A subscription to members is provided as a portion of dues. Rate for nonmembers (domestic and Canada) is US$28; Rate for nonmember international is US$30. Rate for all libraries and schools is US$24. For subscription information, call 703-430-9668. Additional or replacement *ISASI Forum* issues: Domestic and Canada US$4; international member US$4; domestic and Canada nonmember US$6; international nonmember US$8.

AIR SAFETY INVESTIGATORS
INCORPORATED AUGUST 31, 1964

CONTINUED VIGILANCE AND PROFESSIONALISM

ISASI members certainly helped ensure that air accidents and incidents were significantly lower in 2021 compared to previous years, but the fact that commercial flights continue to reel from adverse effects of the COVID pandemic also played a major role. Airlines are still operating fewer flight than before the pandemic, and new variants of the virus are resulting in an increase in cabin and flight crews contracting COVID. Air traffic controllers are also being affected. All other forms of flight—general and sport aviation, helicopter operations, military aviation, and perhaps even space operations—have been adversely impacted. So your continued vigilance and professionalism is very much needed.

As air accident investigators and safety personnel, we don't work alone—we're part of a team—sometimes a large team—and may work in direct contact with colleagues from many parts of the world. Consequently, as you go to work, please stay aware of COVID-avoidance protocols and take whatever prevention actions that are available in your part of the world. Stay safe and healthy so that you can ensure that aviation stakeholders can remain as safe as possible. We're familiar with on-the-job biohazards and should also be cautious with COVID exposure.

There are also a few new safety concerns that accident investigators and aviation safety personnel may need to consider.

The world is experiencing a new COVID variant that is highly contagious, but perhaps not as deadly as previous strains. But because of the increasing numbers of people requiring sick leave and then a short isolation period, the numbers of available experienced airline flight and cabin crewmembers and aviation mechanics significantly dropped over the last year. Some airlines have resorted to premium pay offers to staff flights, and other carriers have been forced to significantly cancel scheduled flights due to crew shortages. Safety personnel and investigators may need to consider human factors as an integral part of their routine. Are pilots flying under pressure? Are cabin crewmembers experiencing too much stress and worry about what adverse event they may face today? Are mechanics becoming overworked due to staff shortages? Are aircraft manufacturing workers facing longer hours or pressure to keep the assembly deadlines?

Another ongoing human factors problem is an increase in "uncooperative" airline passengers who cause disruptions in operations, threaten, or even attack cabin crewmembers and other passengers thereby either forcing cabin crewmembers to use physical restraint or require pilots to declare an unscheduled emergency landing. Such situations diminish air safety and may lead to accidents and incidents that investigators must consider.

A possible threat to air safety has arisen anew with the expansion into 5G bandwidth for electronic mobile devices that is very near to and may interfere with the C-Band frequency that aircraft use for navigation ground proximity and landing. The Federal Aviation Administration (FAA) has identified some 17 vital electronic aircraft applications that could be adversely affected. This same problem surfaced several years ago when electronic communication devices first became ubiquitous and people aboard aircraft wished to use their phones and computers while in flight. Then the FAA allowed use of electronic communication devices in flight only above 10,000 feet.

The 5G problem will hopefully be resolved or mitigated in the U.S. by the time you read this "President's View." In late December 2021, the FAA published a Safety Alert for Operators warning that "a wide range" of aircraft safety devices could malfunction from 5G interference and that the agency might issue specific use restrictions during flights. The FAA suggested electronic communications providers delay implementing 5G technology, planned for January 5, for two weeks to allow the agency to study 5G mitigation in Europe and begin applying appropriate safety efforts to U.S. aviation. The FAA and the Department of Transportation suggested that the delay would allow 5G service to start in January with specific exceptions around priority airports that the FAA and the U.S. aviation industry would designate where a buffer zone could permit safe operations while the agency continues to assess appropriate mitigations.

My concern is that air safety margins all over the world are being tested—not yet crossed, only tested. Air accident investigators and safety personnel cannot make COVID go away, but we certainly can do our part to keep air safety as robust as possible. Remain vigilant and continue to stay safe. ◆

Frank Del Gandio
ISASI President

Not Enough Accidents, Not Enough Data:

Incident Investigation with The Focus on Aerodromes

By Adrian Young, Aviation Accident Investigator with To70, an Aviation Consultancy Based in The Hague, Netherlands

(This article was adapted with permission from the author's technical paper Not Enough Accidents, Not Enough Data: Incident Investigation with the Focus on Aerodromes *presented during ISASI 2021, a virtual seminar hosted from Vancouver, B.C., Canada, from Aug. 31–Sept. 2, 2021. The theme for the seminar was "Staying Safe, Moving Forward." The full technical paper is available on the ISASI website, www.isasi.org, in the Library section under the Publications and Governance/Technical Papers tabs.—Editor)*

While airport accidents and incidents are often not fatal accidents and they may not even be accidents in the sense of the definition contained in the International Civil Aviation Organization (ICAO) Annex 13 to the Chicago Convention, the area of airport accident and incident investigation is an important part of the overall safety of the aviation industry.

Aviation safety at airports and safety related to infrastructure is not a new topic, not in general and not in the annals of this organization and its conferences. The fourth annual conference in August 1973 included a paper on discouraging birds arounds airports. Further back, well before ISASI was founded, the influential aviation author Assen Jordanhoff noted in 1941 that 12% of scheduled domestic airline accidents were caused by "airport and terrain." It is no surprise that as a pilot and flight instructor, Jordanhoff chose not to elaborate further on this statistic and stuck to matters relating to flight operations.

Jordanhoff's approach is, to some degree, like the environment that has existed since then. The focus of attention is on flight operations first, followed by airworthiness and air traffic service issues. The safety of airports and maintenance safety tag along behind. This should not be seen as a complaint or a criticism but as a reflection of the development of the aviation industry.

Before moving on, here is a brief thought about the status of airport safety: The ICAO Annex 13 definition notes, "takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked…." This means many safety events that may occur airside at an airport are not actually accidents. These events range from health and safety accidents such as injures to catering or cleaning staff to airplanes being accidently towed across an active runway without a clearance. The former may involve the loss of life but is still officially not an aviation accident. There is no great practical problem posed by this, as the definition, further in the same paragraph of Annex 13, for "incident" is not as limiting. Unfortunately, the ICAO document that provides further guidance shows that accident and incident investigation is primarily limited to flight operations.

Regardless of the scale of the problem that the above may cause, it is principally an issue for the state-appointed investigation body. The issue only arises when procedures are developed to decide what events are reported to the investigation body. Airport owners and operators are not limited in what they choose to investigate, and from the airport's perspective why would the airport only care about incidents and accidents only once the crew arrives? What would that say about our approach to safety and safety culture? Thus, it is the airport owner/opera-

Adrian Young

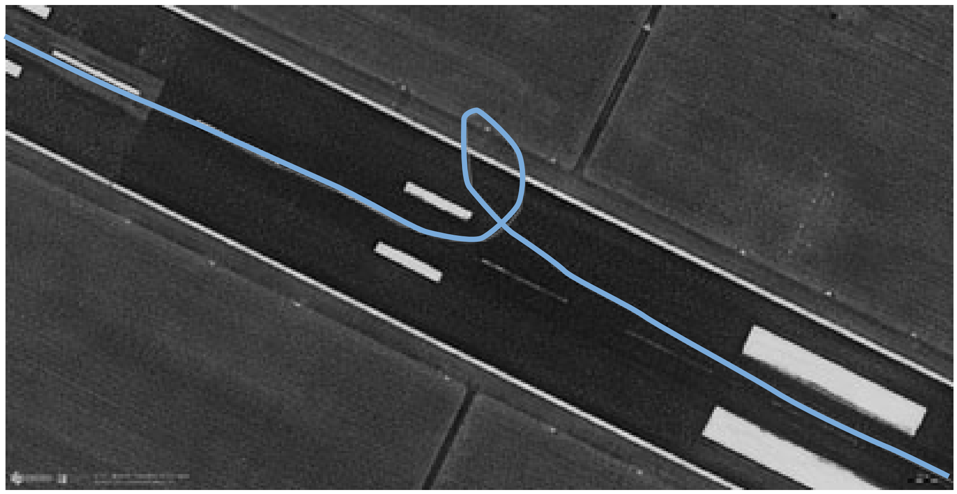


Figure 1. The image shows a track for a particular airside vehicle.

tor that this paper addresses, more than the investigation body—the air operators that use the airport or the air navigation service provider (ANSP) that provides air traffic services.

As ISASI members over the years have discussed, aviation safety has been built, in part, on the acquisition and use of data. And there are two trends that ISASI members will recognize: there are fewer and fewer accidents to commercial air traffic worldwide—for which we are all grateful—and aircraft data sources have grown larger and larger. The air operator has flight data recorder/flight data monitoring (FDR/FDM) data, and the ANSP has radar and other sensor data, but the airport often has none of this. Air operators have access to vast amounts of safety data, more than they can sometimes actually make use of. Airports tend not to generate data that is of use to the investigator, and while air accidents are declining, ground incidents do not seem to follow this trend.

The picture is not wholly clear, but data from insurance organizations and the International Air Transport Association does not show the same downward trend in accidents, at least not when measured again costs to the industry. Allianz, in its 2020 safety report, states that some ground accidents have gone "largely unnoticed by the industry."

A consequence of the fact that airport accidents, even ones that result in fatalities, are not covered by Annex 13 is that investigations may be performed by the police, judiciary, or other body—none of whom, as a rule, has the same interest in "just culture," learning from mistakes that is embodied in its working practices.

And Then I Adopted the Brace Position

To illustrate, I would like to offer a brief anecdote from an incident in 2018 that I—sitting in the passenger cabin—witnessed. The airport in question permits intersection takeoffs.

The airplane I was in lined up for a full-length takeoff while another air-

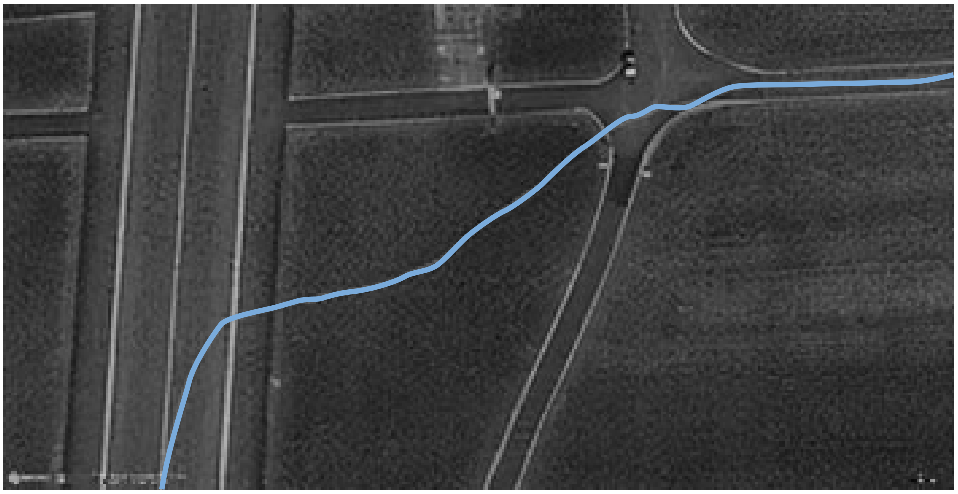


Figure 2. The image tracks the accurate path of a fire truck.

plane, of the same operator, approached the hold for the intersection. For reasons that were the subject of the ensuing investigation, the airplane waiting at the intersection hold moved past the hold line toward the runway as the other airplane started its takeoff roll. A high-speed abort followed; and having been able to see that the other started to move onto the runway, I adopted the brace position waiting for what I thought would be an inevitable collision. In the end, the airplanes passed each other without contact. A sidenote: Except for my traveling companion, all the other passengers were oblivious to the reason for the sudden stop on the runway. It may be true that a little knowledge is a dangerous thing.

The airport was equally uninformed. Which exit, which aircraft, how close was the contact, who said what and to whom? All of these are questions that the airport had limited or no answers to. A quick call to the air data team at To70 postincident meant that, from public data sources, most of the questions could be answered. The ground track and the speeds of the two airplanes came from the automatic dependent surveillance-broadcast (ADS-B) antenna that we maintain at several of our client airports. The radio communications between the flight crew and air traffic control came from open-source websites that redistribute aviation radio communications. Communications from inside the flight decks of the two aircraft were not available.

Within an hour (and before I had landed at the destination airport), our team had put together a synopsis of the event. While this exercise was intended to sooth my ruffled brow, the data could equally be of use to an investigator at an airport when trying to establish what occurred in an incident on the ground. It need not be an event between two aircraft as more and more airports—not only those with a surface movement guidance and control system—have transponders added to vehicles that are permitted to move in the maneuvering area. The location of vehicles and aircraft can be established with reasonable accuracy, and this may be a useful aid to incident investigation. Making use of ADS-B data means that, as an airport, you are not reliant on third parties for information on the location and movement of the incident vehicles.

Examples of ADS-B Data in Use

The accompanying images are taken from actual datasets at airports where we collect data.

The loop-shaped movement on the runway in Figure 1 (see page 5) is a single event. This illustrates how detailed the data can be. Let us assume that the driver had cause to drive like this. The image could be used to assist in interviews—a memory aid to the discussion or to confirm the vehicle's movements.

Figures 2 and 3 show the path of a fire vehicle. The tracks in Figure 2 show that the vehicle does not follow the hard surface but cuts across the grass; there is data validation required here to confirm that the track is accurate. The very

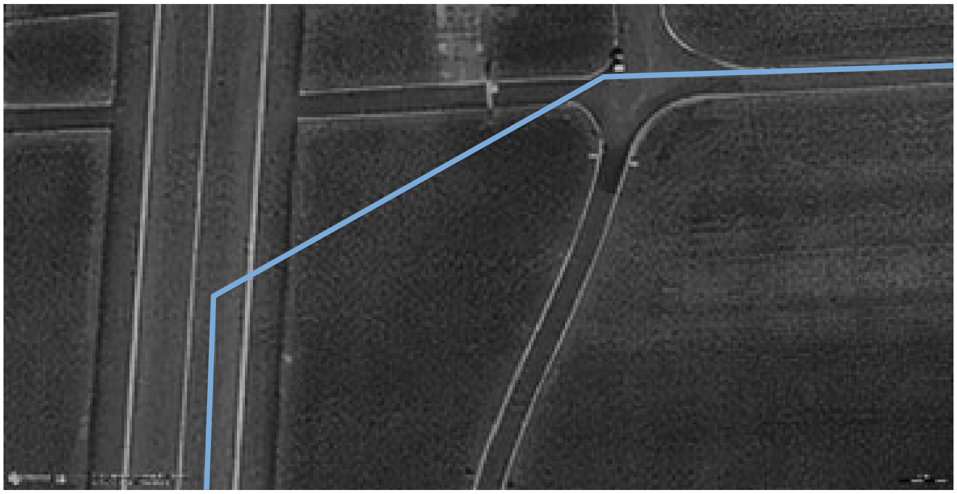


Figure 3. The straight track of the fire truck may be a software error.

straight line across the grass in Figure 3 suggests that data was not collected correctly, and the gap was filled in by software. This may be an example of a blind spot for the ADS-B ground receiver at the airport or just a momentary loss of data.

Going a step further, investigations often raise questions about what normal behavior is—not the behavior that is required, but the behavior that is prevalent on the airfield. Whether this is speed limits or mandatory routings, the ADS-B data helps determine what normal is. In a just culture, there is an argument that it is counterproductive to punish the individual whom you have noticed doing something wrong when everyone else is doing it too. From the point of safety investigations, the determination of what is normal is probably the most important function of this sort of work.

Figure 4 (see page 8) came from data in an investigation into aircraft taxiing practices at an airport. Aside from showing the volume of traffic that uses each of the runway entry points, the image demonstrates another use of data, somewhat removed from investigation. The image shows that one of the three runway entries is being used far less frequently than the others. This could allow the airport to refine its maintenance planning and focus more on the two that are used more frequently.

While not part of an investigation, this sort of work can be seen as proactive safety planning that may prevent incidents in the future.

Thinking about this investigation tool from the perspective of an airline's FDM program, some of the same privacy issues that are so important there will be equally important here. When the airport seeks to make use of the data, it must be clear to all parties that a just culture is being applied and that the data is not intended to be used for sanctioning personnel. This means that however attractive it might be to some postholders, the data cannot be used to "catch" and discipline airside personnel who are, say, driving too fast. As an example, at one particular airport, our data team looked at 1,000 trips along a service road parallel to a taxiway and between two remote aprons over a 5-day period. The location was chosen for this sample as it is a simple straight road and is located somewhere where the airside authority is not often present. Three quarters of the 1,000 trips along this stretch of road were made at a speed greater than the 50 kilometers per hour permitted. The maximum speeds were above 80. Our analysis shows that these were not emergency vehicles.

The benefits of a good and reliable data supply to improving safety outweigh those gained by sanctioning staff. To be clear, it is not suggested that an airport should not sanction those who violate requirements; the airport just cannot make use of the safety programs to do so. A possible topic for monitoring could be the response times of rescue and firefighting vehicles. Heat maps to show the routes taken by these vehicles and the times taken to get there may be of use if there are concerns about re-

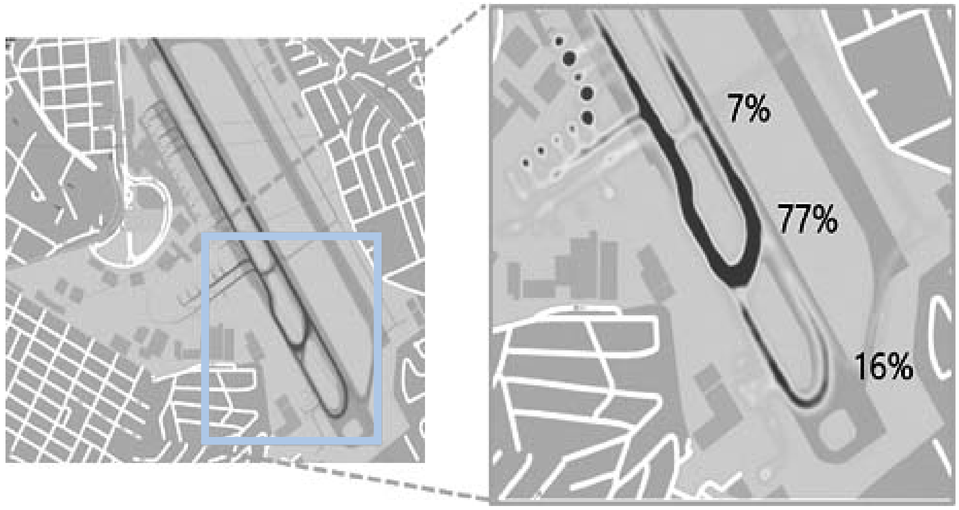


Figure 4: Aircraft taxiing practices at a particular airport.

sponse times. From this basis, improvements to the infrastructure—provision of routes or removal of obstructions—can be considered. I digress slightly from the issue of investigations to offer an example of what I mean. An airport's airside infrastructure was such that a conflict between taxiing aircraft and ground vehicles at a busy hold led to the construction of an extra length of service road to deconflict the traffic and reduce the chance of delay and incidents. This, from a safety point of view, is the difference between a reactive and a proactive approach.

So far I have mentioned ADS-B; the use of multilateration data with Mode S works equally well. There are, of course, limitations to the data. For a start, it is not as accurate as FDR or FDM data, recording data at 1 hertz. This is, however, better than the data rate of primary radar.

There are a number of signal accuracy issues. As a rule of thumb, do not expect a positional accuracy that is better than about 10 meters. Trying to demonstrate if a vehicle has or has not crossed from the apron to the maneuvering area is not really viable. However, some aircraft and some vehicles perform better than others. Either way, tailor what you do to the data's accuracy. An aircraft or vehicle just about to encroach on the runway strip is not what you want to analyze. Regular shortcuts across the runway end safety area will be traceable.

Let us just take a quick pause to look at the basic technology that is being discussed here. Let us sort out our squawks from our squits. A "squawk" is a response from a transponder that is made upon interrogation by ATC equipment, the secondary surveillance radar. Starting from the Mode C transponder, the majority of IFR and VFR traffic can squawk their identity, position, and speed. Using a Mode S transponder, the vehicle—be it an aircraft or ground vehicle—can squit its ID and position information without being interrogated by ATC equipment. This reduces the back-and-forth interrogation/response cycles and thus minimizes the number of messages transmitted, increasing the system's surveillance capacity. The more modern ADS-B units use an extended squitter (ES). This just means more data per squit. So instead of ATC equipment having to correlate the Mode S message against radar data, the aircraft's GPS sends its data message once a second. An ES message can carry 49 datapoints compared to 7 from a basic Mode S transponder and just 3 from a Mode C transponder.

Most of the traffic at airports handling commercial aircraft will have 1090 ES transponders, potentially delivering a lot of data. However, the expense of these units may be a disincentive to airport operators to install them on ground vehicles, especially vehicles that do not usually enter the maneuvering area. Using low-power radio transmitters and receivers, it is possible to develop a local triangulation system to track vehicles for a much lower cost than for 1090 ES transponders. Somewhere in the middle lies the cost for GPS-tracking equipment.

The layout of the airport may create blind spots, making data collection difficult. This is especially true on the end of the stands that is closest to the terminal building. If an airport is considering collecting data from the aprons, too, multiple antennas may be needed to build up a complete picture.

Making use of the data

In addition to basic position and speed data, additional information via Mode S Comm-B messages (e.g., Mode S EHS [enhanced surveillance), ELS [elementary surveillance], and meteorological routine air reports) is only available from aircraft sources and not ground vehicles.

How does an airport's safety department get the ADS-B data into a readable form? There is a two-step procedure required. First, decode the data. Because bits and bytes and ones and zeros occasionally get corrupted before being processed, all of the data needs to be run through a system that can verify it and flag possible erroneous data. Pushback tugs moving at hundreds of knots is a data error and not a trigger for an investigation. Occasional errors in the call signs of aircraft, set in the cockpit by the flight crew for each flight, will need debugging too. For more on decoding transponder data, refer to Junzi Sun's excellent book *The 1090 Megahertz Riddle*.

Once decoded, the raw data from the transponder's responses must be transferred into a database that will allow the data to be used.

In To70's experience, the quantity of data is such that it is unlikely that a tool such as Excel will be robust enough to handle the data. Every airplane and many ground vehicles delivering a message once a second, day in, day out, adds up to a lot of data very quickly. Engineering scripts in Python or Matlab are the best way forward. On top of this data warehouse, the airport will have to invest in a system that can code the translation of the database into visual representations. Hexagon Geospatial's tool, Luciad Lightspeed, is a good example of the sort of software needed.

Conclusion

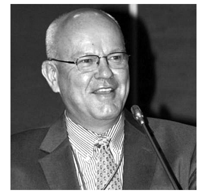
The ADS-B antenna has become ubiquitous in aviation, and this data source provides the airport with an opportunity to analyze data for safety purposes in a way that most airports have never had in the past, partly because the data is owned by the airport operator. We argue that this part of the safety picture that to quote Allianz is "largely unnoticed by the industry" can be improved by the better use of data that is freely available to airports.

Experience at a number of To70's client airports has shown that the collection, analysis, and use of the data is cost effective. The use of ADS-B data offers the airport insight into what is normal and what occurred in specific events in a manner that is similar to the way that air operators can use flight data in their FDM program—something that is of great value to the airport safety investigator. ◆

Using Big Data to Improve Pilot Training and Aviation Safety

By Lou Nemeth, Director of Flight Operations, CAE

(This article was adapted with permission from the author's technical paper Using Big Data to Improve Pilot Training and Aviation Safety *presented during ISASI 2021, a virtual seminar hosted from Vancouver, B.C., Canada, from Aug. 31–Sept. 2, 2021. The theme for the seminar was "Staying Safe, Moving Forward." The full technical paper is available on ISASI's website, www.isasi.org, in the Library section under the Publications and Governance/Technical Papers tab.—Editor)*



Lou Nemeth

No one disagrees that we can still improve aviation safety despite the excellent record we have. Getting there, however, is the problem as illustrated by the fact that the needle with respect to training has not moved to create meaningful safety improvements. This means we need to examine how we change that.

Aviation is no stranger to using big data as evidenced by the U.S. Federal Aviation Administration's development of the Aviation Safety Information Analysis and Sharing (ASIAS) program in 2007 using safety data and information across government to identify emerging systemic safety issues. But its development has been hampered, and, according to the U.S. Department of Transportation inspector general, it still lacks the predictive capabilities and dissemination of analysis needed to effect safety improvements.

While ASIAS has grown with the inclusion of data from 41 airlines—99% of air carrier operations—there remains no robust process to prioritize analysis requests. ASIAS sources include important information such as data gleaned from Flight Operations Quality Assurance, the Aviation Safety Action Program, the Air Traffic Safety Action Program, mandatory occurrence reports, digital flight data, ATC voice data, surveillance and weather data, and data from National Flight Data Center. The agency expects to make incremental enhancements leading up to 2025 when its predictive capabilities will be available.

The timeline means industry must develop other sources to improve safety in any number of areas but specifically in pilot training. We have found that with the adoption of new, powerful tools, we can dramatically improve pilot training by using data to identify weak areas and the current human-centered evaluation of competencies. In other words, big data and artificial intelligence (AI) can pave the way for the future.

Using data, of course, is all part of an integrated safety management system (ISMS) with which we are all familiar, and applying it to measure training effectiveness is an integral part of a successful ISMS. This solution enhances that system by incorporating the ISMS risk-based mentality into pilot training. These are the lessons learned by CAE from its broad-based experience from ab initio, business aviation, and commercial airline training at its 60 training centers worldwide, which train 135,000 pilots per year.

We know it is either the original equipment manufacturer (OEM), the customer, or the regulatory authority that drives the training program. The OEM, in cooperation with regulators, develops the footprint that is traditionally followed. Airlines overlay their Advanced Qualification Program, which is a significant undertaking based on a job-task analysis approach and not necessarily a risk-based approach. Some operators call this evidenced-based training, which also has a regulatory-specific application and definition in some parts of the world.

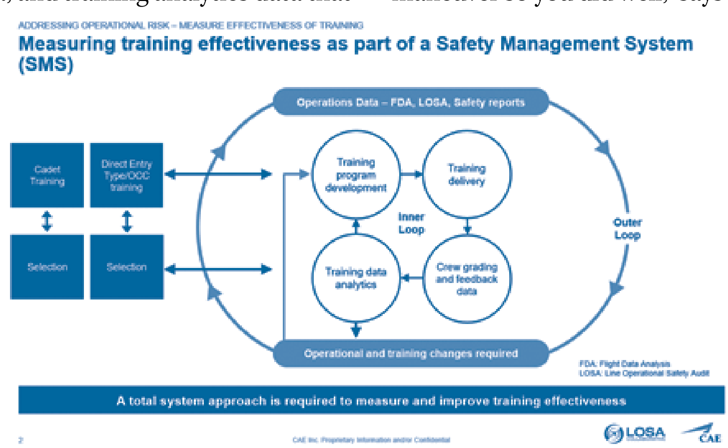
However, by using big data to develop both micro- and macroadaptive learning programs, we can move that needle. Microadaptive learning tailors the courseware to the individual's learning style. It is an algorithm measuring what they missed or what their competency is and how fast or slow they accomplish a task. Macroadaptive learning examines the overall data coming from various sources, including the learners, to identify problem areas.

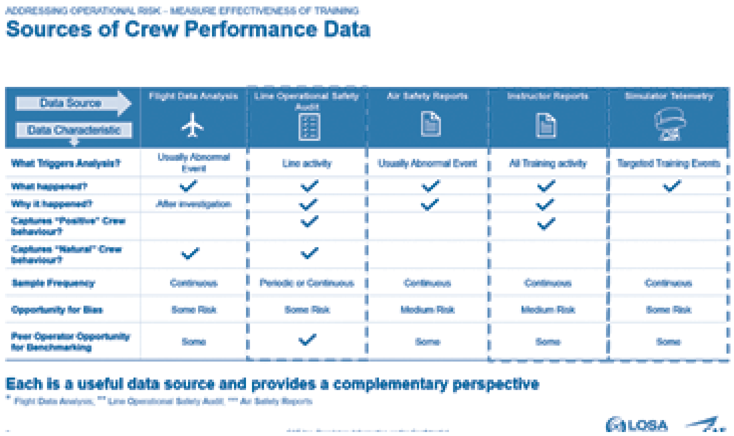
The system is driven by two data loops, the inner loop and the outer loop. The inner loop, data derived from training events, includes the training delivery data, crew data, and training analytics data that looks at things like repetitions to proficiency and the pass/fail rate of the training development program.

The inner loop is then connected to the outer loop, data taken from the flying environment or what we learn from daily operations. This data includes flight data monitoring analysis, line safety audits, and voluntary safety reports that determine what we know from flying the line. This data informs the operational and training changes that are required. Complementing this is demographic information derived from cadet training and selection information and direct entry/Operational Control Center training. In short, we are taking a total systems approach required to measure training effectiveness and to improve it along with aviation safety.

The benefit of this approach is that it replaces training through fear, the threat of being washed out. Instead, we use an improvement approach, focusing on identifying deficiencies in a positive way that ultimately incentivizes the learner to do better. Learners are already highly motivated, and tapping into that can help develop better pilots. If you show them their own data, through self-discovery they will be motivated to improve. It shares with them crew performance data and what the characteristics of doing it right are. You simply have them examine their microdata and put it into context with the macrodata so that we may facilitate improvement.

"Your test results show you are in the 88th percentile of proficiency in this maneuver so you did well," says an instruc-





Data Source → / Data Characteristic ↓	Flight Data Analysis	Line Operational Safety Audit	Air Safety Reports	Instructor Reports	Simulator Telemetry
What Triggers Analysis?	Usually Abnormal Event	Line activity	Usually Abnormal Event	All Training activity	Targeted Training Events
What happened?	✓	✓	✓	✓	✓
Why it happened?	After investigation	✓	✓	✓	
Captures "Positive" Crew behaviour?		✓		✓	
Captures "Natural" Crew behaviour?	✓	✓			
Sample Frequency	Continuous	Periodic or Continuous	Continuous	Continuous	Continuous
Opportunity for Bias	Some Risk	Some Risk	Medium Risk	Medium Risk	Some Risk
Peer Operator Opportunity for Benchmarking	Some	✓	Some	Some	Some

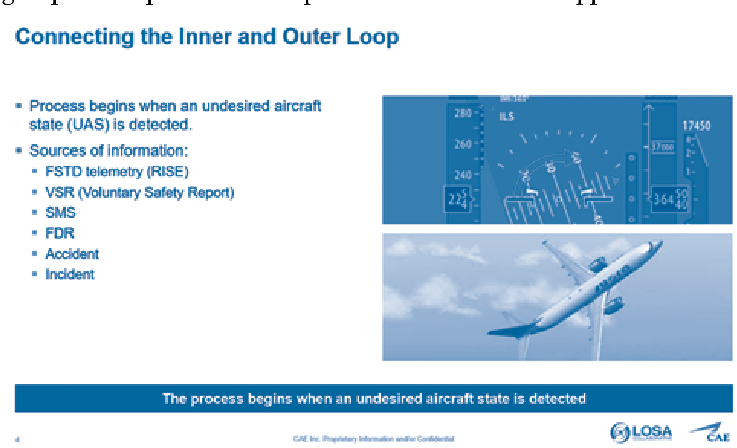
tor well versed in facilitation. "What will it take to get into the 90s?"

This is the positive way to change behavior. Using big data and AI helps you motivate pilots to do better. They are not competing with other pilots; they are competing with themselves to improve the way they fly.

There are five different buckets or channels of information that paint the picture. While each one is important, the actionable insights come when they are aggregated to tell you what is going on. These channels include flight data analysis, Line Operation Safety Audit (LOSA), air safety reports, instructor reports, and simulator telemetry. They are triggered by an undesired aircraft state (UAS) and help determine what happened and why it happened while identifying positive crew behaviors. Factored into this are the sample frequency and the opportunity for bias. We think we are moving to a continuous sample frequency as some airlines are already pioneering this. Bias is always there, but some media carry greater risk for bias than others. However, by examining all the information in an aggregate way, bias can be mitigated to provide a better picture and a complementary perspective of what the information from all the different sources is telling us.

Another value proposition is the fact that analyzing data helps operators compare and benchmark their training program with others. Many airlines have been audited so it is possible to compare information. Operators can compare the strengths and weakness of each area of data. As with putting a learner's performance into context, this system puts one operator into context with the rest of the industry, providing operators motivation to improve.

One fundamental of connecting the inner and outer loops is looking at the UAS, which comes from the simulator telemetry (CAE Rise), voluntary safety reports, ISMS, flight data monitoring, or an accident or incident. Detecting the UAS is the beginning of the process and must be accompanied by a process to find an effective mitigation. This process includes the creation of a safety action group, including the client and training department or third-party training providers, operations safety, and training program development. The mission of this nominal group technique is to develop a consensus on what happened and why



it happened and what to do about it.

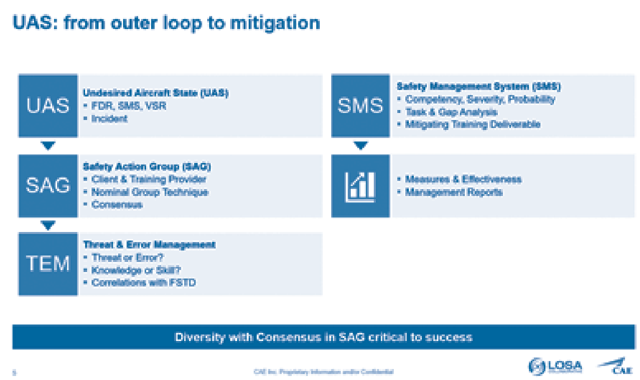
Was it a threat or error? Was knowledge or skill in play? Data from other sources, especially the training device or simulator from the inner loop, is then correlated to determine the competency in question, the severity of the problem, and the probability it will happen again. Using a task, threat, and error-and-gap analysis, the safety action group must then determine the mitigating training deliverable—how does the operator train pilots going forward so the risk is minimized as much as possible.

Finally, the group establishes the measures and effectiveness of what the training changes need to be and then delivers stakeholder reports so the effectiveness can be constantly monitored.

The most important factor in this process and the reason for having all the stakeholders at the table is to provide thought diversity—the ability to look at the issue from different perspectives to establish a mitigation that take all factors into consideration.

Data can also identify issues with human evaluators by comparing what the telemetry tells us with human analysis of what happened, why it happened, and what to do about it.

Let us take a TCAS event as an example. Here we see the instructor graded the pilot with a less-than-satisfactory response 1.6% of the time. But the telemetry data, primarily from the simulator, graded the performance less than satisfactory 20.2% of the time. The big question here is why. Why is one data source so significantly different from another? By comparing the data between independent sources, we can increase confidence in grading quality driven by data rather than human judgment.



Drilling down a little further found that the instructor missed critical information the machine caught. The instructor should have seen the autopilot off, flight director off, and the flight guidance defaulted to speed mode when the flight director was selected off. The flight crew should have pitched the airplane up or down into the green arc.

It is very likely the evaluator saw autopilot off and the pitching activity by the crew into the green arc on the TCAS escape guidance or vertical speed indicator. Investigating more closely, we found that the crew failed to turn the flight director off and failed to verify that the flight guidance went into speed mode. This particular aircraft is an Airbus, and with autothrottle engaged with the flight director, the airplane did not go into speed mode and the autothrottle system fought with crew input into the side stick controller during the TCAS resolution advisory escape maneuver.

(Continued on page 30)

Compassionate Care in the 21st Century:

The Evolution of Aviation Disaster Family Assistance

By Dennis Post, Senior Manager Emergency Response, Southwest Airlines

(This article was adapted with permission from the author's technical paper The Evolution of Aviation Disaster Family Assistance: Compassionate Care in the 21st Century *presented during ISASI 2021, a virtual seminar hosted from Vancouver, B.C., Canada, from Aug. 31–Sept. 2, 2021. The theme for the seminar was "Staying Safe, Moving Forward." The full technical paper is available on ISASI's website, www.isasi.org, in the Library section under the Publications and Governance/Technical Papers tabs.—Editor)*

Dennis Post

The commercial aviation industry, particularly in the United States, continues to experience one of the safest periods in its history. From March 2009 to October 2019, there were two fatalities resulting from an aircraft accident involving a Part 121 airline in the United States. Any loss of life or injury to persons because of an aviation accident in the United States or elsewhere in the world is a tragedy and requires assistance from the involved air carrier. Much like the evolution of accident investigation and the introduction of safety management systems (SMSs), the aviation disaster family assistance domain is also evolving, and must continue to do so, to meet the needs of those affected by an aircraft accident. This evolution must continue to expand beyond traditional family assistance legislation, processes, and practices.

The collective aviation industry—regulators, operators, manufacturers, agencies, vendors, and employees—shares a common goal: to safely transport passengers to the people and places that are important to them. The industry operates within a risk-based safety system that is designed to prevent accidents when possible and to investigate them if they do occur while caring for all those involved. In the United States, aviation disaster family assistance legislation has been in existence since 1996, called for by family groups that had experienced considerable loss and those in government and industry who served them absent any documented legal obligation.

Since its passage, this legislation has experienced limited change. Those responsible for enacting this assistance have since had full careers, many with the good fortune to never put into practice what they planned for. The traveling public trusts commercial aviation, and with good reason; but when an accident occurs, all those involved in aviation disaster family assistance hope to answer "yes" to one question without hesitation: "Are we prepared for this?"

In this paper, I propose to explore the changes in family assistance brought on by the passage of time since legislation and guidance documentation were written and implemented in the United States, the challenge of decreasing institutional and experiential knowledge of family assistance as a result of the excellent improvement in aviation safety, and the beginnings of a virtual revolution of family assistance accelerated by the COVID-19 pandemic. This paper will also explore the individual and collective roles of air carrier emergency response teams, investigators, government agencies, and vendors working to serve and care for those affected by an aircraft accident.

Why Family Assistance?

ISASI represents a collective group of the world's finest aviation safety professionals working together through objective and transparent sharing of information to promote the development and improvement of incident and accident investigation. Through its purpose and design, ISASI and its members are guardians and servants to those affected by an accident: the survivors, families, and communities. This work will forever be intertwined and requires the same level of dedication, selflessness, and sense of duty.

Tragedy and Change

The 1990s

The process of assisting those who have lost a loved one due to an aircraft accident, or those who survived, has been a need for as long as accidents have existed. The requirement to do so, however, is just now approaching its 25th anniversary. While there was no shortage of tragic accidents throughout the 20th century, the 1990s were without a doubt the decade during which the glaring need for formalization of family assistance became apparent.

In the United States, this period saw several significant accidents that exposed the raw truth that the families of those who died were not receiving appropriate and consistent care in the worst moment of their lives. While not solely responsible, accidents like USAir Flight 427 in Aliquippa, Pa., on Sept. 8, 1994; American Eagle Flight 4184 in Roselawn, Ind., on Oct. 31, 1994; ValuJet Flight 592 on May 11, 1996, near Miami, Fla., and Trans World Airlines Flight 800 on July 17, 1996, in East Moriches, N.Y., resulted in similar struggles for the families of those who died. Family groups struggled to get information on the status of their loved ones from the airline and responding agencies, saw news media outlets reporting information they had not yet been told, and were not provided resources to begin the next chapter of their lives following the loss.

Call to Action

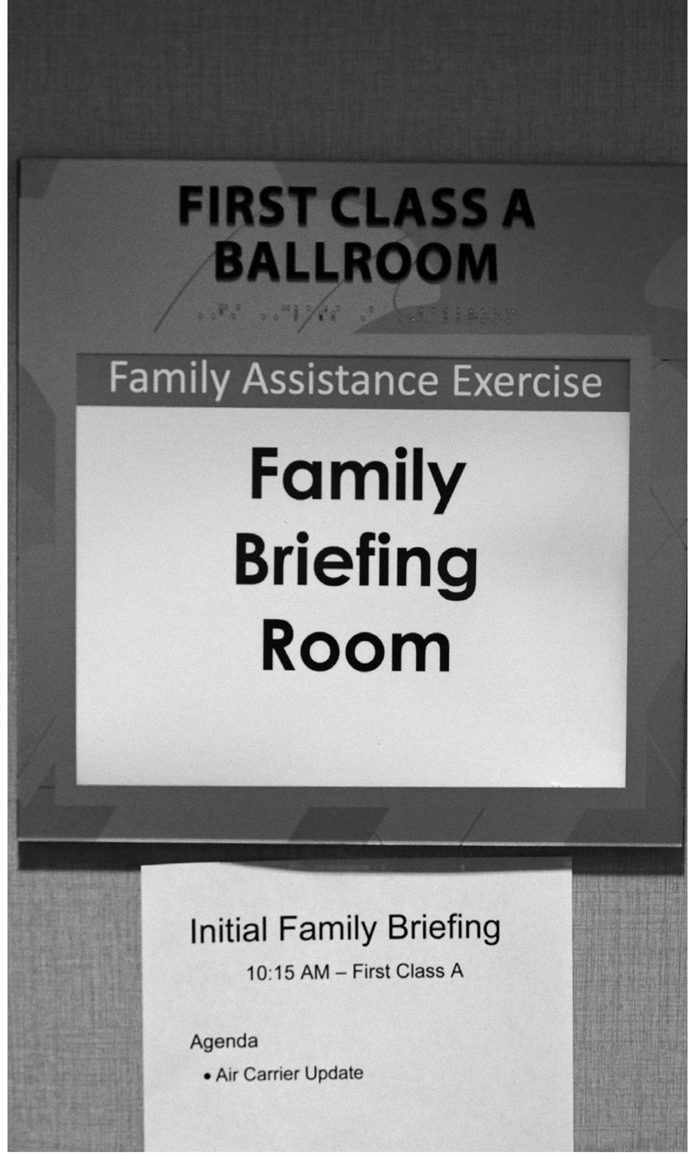
Some family groups, seeing the repeated challenges and suffering, formed a bond and a cause to do everything in their power to create change so that others would not experience what they did, even as accidents continued to occur. These groups called upon the U.S. government to examine the failures and find a better way. Accounts of their traumatic experiences would eventually be published via family letters, testimony, and in the final report of the Task Force on Assistance to Families of Aviation Disasters, cochaired by the then secretary of Transportation and the chair of the National Transportation Safety Board (NTSB).

Legislation and Guidance

Following several years of advocacy and collaboration with members of the U.S. Congress and the NTSB, the Aviation Disaster Family Assistance Act was introduced and passed in September 1996, codifying requirements through the Department of Transportation for airlines to establish plans to care for the families of those impacted by an accident, followed by similar legislation for foreign airlines flying into the United States. It also established the NTSB as the agency responsible for overseeing family assistance through the Transportation Disaster Assistance Division and for developing guidance documentation for airlines to ensure that the requirements of the legislation were met.

The International Civil Aviation Organization (ICAO) also established consistent practices airlines should use. In 1998, the ICAO Assembly acknowledged that "the policy of ICAO should be to ensure that the mental, physical, and spiritual well-being of victims involved in civil aviation accidents and their families are considered and accommodated by ICAO and its contracting states."

ICAO Circular 285, Guidance on Assistance to Aircraft Accident Victims and Their Families, was issued in 2001 (later reissued as Doc. 9973 in 2013) and included in Annex 9 in 2005.



Priorities of Family Members

In the years that followed, the NTSB found consistent priorities that families would need addressed following an accident. These priorities provide the framework for airlines and all other organizations involved in family assistance to build their response plans and ensure that their moral and legal obligations are met.

Notification of Involvement

Families need to be contacted as soon as information is available on their loved one, even if the information is not fully confirmed. For example, if a family member asks if their loved one's name appears on an initial list of reservations for the accident flight, even if the passenger manifest has not yet been fully reconciled, airlines must share that information. Airlines must have dedicated toll-free phone numbers that are staffed by trained employees or a qualified vendor and widely publicize this number with the news media. Families crave information, and it is required of and incumbent on the airline to provide factual information as it is available.

Access to Information

Airlines must continue to inform family members of the next steps once their loved one has been verified on the accident flight, including what information will be available to them, where and how it will be shared, and who will be sharing it with them.

Victim Accounting
Once it has been confirmed that their loved one was involved in the accident, a family's first priority will likely shift to asking, "Where are they? What is their status?" Airlines must ensure that they provide the information available to them and ensure that they are deferring information on search and rescue, confirmed survivors, and confirmed fatalities to the appropriate authorities. Airlines must work in collaboration with the organization or agency responsible for victim accounting where the accident occurred to share information that will assist with the victim-accounting process.

Personal Effects
After learning the status and location of their loved one, or potentially simultaneously, families will want to know where the belongings of their loved one are. They will want to know their condition and when and if they will be getting them back. Airlines most often use vendors trained in appropriate personal effects recovery, cleaning, and restoration to ensure that any recovered item associated with a passenger is returned to the family, if they decide to receive it. Airlines must also ensure that any unclaimed personal effects are retained for at least 18 months from the date of the accident.

Evolution of Family Assistance Over Time

Experience Leads the Way
As the 20th century gave way to the 21st century, the legislation experienced limited change. Several amendments were incorporated to better define needs. The industry, however, continued to refine and improve family assistance processes as airlines built out emergency response and family assistance teams, organized industry working groups, and learned from accidents.

Public and Industry Expectations
While industry experience was being gained through these various means, the public awareness of the new requirements and assistance also increased. When an accident occurred, the news media was better prepared to report on the assistance being provided to the families and/or survivors based on the legislated requirements. An important confluence of these expectations and industry learning assisted with building robust programs and training in the private and public sectors.

Technology and Information Dissemination
In the 1990s and 2000s, dissemination of information was primarily via cable news channels, phone conversations, and printed media. The legislated requirements for airlines were mostly based on these mediums and continue to be today. Airlines find themselves in a position of needing to ensure they maintain the right level of technological support and expertise to meet these requirements, such as public toll-free numbers separate from their normal reservations lines, secure private toll-free numbers dedicated for families, and the ability to integrate with secure conferencing tools to link remote family members to family briefings at the on-scene family assistance center.

At the same time, airlines must also ensure that they are prepared to respond to, and appropriately leverage, their social media accounts to disseminate and collect information from family members who may reach out via one of these channels. They must have plans in place to rapidly update their website to link information about the accident and appropriately adjust their branding. Some airlines have implemented customer service chat functionality, either automated, staffed by a live representative, or both. They must ensure that the same level of training is provided to those who manage these communication tools as those who answer the phone lines when an accident occurs and direct families to the toll-free number for assistance.

In the United States, the legislation requires the airline to establish public facilities in the departure and destination cities of the accident flight to broadcast any NTSB hearings that are conducted, and these hearings are now streamed publicly via the NTSB's website. Through close collaboration with the NTSB and other agencies, airlines can ensure that they not only meet the requirements, but also provide the best level of assistance to those affected by the accident using modern technology.

Improvements in Aviation Safety
There is arguably no greater achievement in the aviation industry than the marked increase in safety. Investigations, their recommendations, voluntary safety reporting, safety cultures, and SMSs have produced a significant decrease in accident rates. This is, of course, a never-ending pursuit. And while it would never be traded away, it is not without downline impacts.

Loss of Knowledge and Experience

Real-World Experience Decreases
Some emergency response managers may tell you they are setting up a business they hope to never run. For some, that has been true, particularly related to large-scale hull-loss fatality accidents. Review of the decrease in accidents over the past 10 to 20 years, coupled with the average career span of an airline emergency response manager, shows many have been fortunate to have full careers with limited real-world experience.

Family assistance programs must rely on industry benchmarking and collaboration among airlines, government, public-sector response agencies, and vendors to ensure they are prepared. Training programs have shifted from review of past accidents to role playing of theoretical scenarios. Airlines must be equipped to adapt how they prepare and not let their guard down based solely on the increase in safety.

The COVID-19 Factor: Airlines in Distress
The ongoing COVID-19 pandemic has decimated more than one industry; however, the travel industry, and namely airlines, suffered the most catastrophic impact in their history. A near overnight loss of passenger revenue, coupled with the need to source equipment to protect their employees, resulted in drained capital, long-term storage of idle aircraft, and employees taking early retirements or extended leaves. Pay cuts, furloughs, and layoffs were planned, and in some cases implemented, while awaiting pending government assistance. Most airlines with in-house family assistance teams rely on their frontline workforce to staff these teams; and as that workforce dwindled through one of more of these ways, their rosters began to drop.

A reduction in operations, however, does not result in the ability to reduce staffing or support for emergency response and family assistance programs. The impact of an accident with a carrier flying one aircraft is the same as a carrier flying a fleet of several hundred.

Investing in Emergency Response

Airlines will rebound, and as of this writing some have begun to see the return of passengers. However, additional variants of COVID-19 continue to emerge. Airlines must prioritize investing in their emergency response programs with qualified, expert individuals who can both maintain and grow their processes for the future. A failure of one airline to properly respond could result in a cascading impact across the industry.

Virtual Family Assistance

Immediate Contingency Planning

Most airline family assistance programs are based on the traditional model of a family assistance center established in the accident location, often at a hotel or large conference facility. Hotels are established for families, survivors, employees, responders, and vendors. A joint family support operations center is set up for the leaders of the respective agencies at the family assistance center to oversee and coordinate all operations. Airline family assistance plans also contain provisions to assist families who did not want to travel by dispatching a member of their staff to the family.

Airlines and other agencies had to immediately evaluate how they would respond to an accident without the ability to coexist in some of these locations. Go-teams were cut to only the personnel essential to establish an operation in the accident location. It simply would not be possible to continue the traditional model during this time. Platforms like Microsoft® Teams and Zoom© were in various states of adoption within some organizations, and there was no guarantee that family assistance team members or families themselves would possess the necessary technology or ability to use them to effectively give and receive assistance. Airlines had to ensure they had contingency plans to secure devices that could be sent to employee and family homes while still preparing for some on-scene representation.

Long-Term Planning and Implementation

While it is still too early to know for certain, the industry generally believes that the mindset of most families will continue to be the desire to travel to the on-scene family assistance center once it is safe to do so. The need to have trained teams that can provide virtual assistance and the tools to do so, however, will certainly be part of the expectation and need moving forward.

Training

The rapid onset of the pandemic, the closing of airline headquarters and training facilities, and the inability to move employees around the system to conduct family assistance training required airlines to pivot quickly to ensure they were providing required and appropriate training to their employees. Some may have already begun to develop or implement types of virtual training; however, family assistance training has long traditionally had an in-person/instructor-led component to ensure that the appropriate skills for interacting with family members and survivors are demonstrated and reviewed. Some family assistance volunteers had limited to no familiarity or access to virtual training tools.

As a result of these challenges, coupled with the lack of funding to develop new training programs, some airlines postponed training throughout 2020 and began building stopgap measures to continue to hone the skills of their family assistance teams while turning their focus to long-term solutions once the world begins to emerge from the pandemic. Virtual family assistance training can and likely will be an effective opportunity for airlines to continue to build their program and reach more employees across their system.

Our Collective Role and Responsibility

Collaboration: Preparing as an Industry

Aviation disaster family assistance is a complicated and connected link of airlines, government agencies (including their respective investigators), nongovernment/nonprofit agencies, vendors,

and business partners. Several of these groups have legislated responsibilities to provide family assistance while others are an integral part of ensuring a successful response.

These groups must continuously meet, discuss, train, and exercise together. While individual roles and responsibilities may differ, each possesses the same desire to do their part for those affected by these disasters. As a combined force, they are not only able to provide assistance, but also advocate for and influence change in the industry.

Conclusion: Looking Forward

As a result of the progression of time since legislation was passed, the decrease in accidents, and the loss of experiential knowledge and talent within the industry, airlines and all those involved in aviation disaster family assistance must blend the traditional and legacy ways of family assistance with the needs and abilities of today.

The mission remains the same: to provide the most compassionate care and assistance possible to those who have experienced an accident or lost a loved one, not just to meet the requirements of legislation or the practices in guidance documentation, but more importantly to exceed those requirements where possible. We cannot heal and we cannot provide closure, but we can provide the best of all of us, individually and collectively, and they deserve nothing less.

Acknowledgments

The author wishes to thank counterparts in industry and government for their collaboration, mentorship, and endless dedication to this cause. Above all, the author is grateful to those who have shared their stories publicly and privately about losing their loved ones or surviving an accident in order to better us all. ◆

Large Volume Data Gathering Shapes Aircraft Accident Investigations

By Marcin Makowski, Embry-Riddle Aeronautical University

ISASI Kapustin Scholarship Essay

The following article is the second of three essays from the 2021 Kapustin Scholarship winners that were presented during ISASI 2021. The number of scholars selected each year depends upon the amount of money ISASI members donate annually to the scholarship fund. Details about scholarship applications and additional information can be found on the ISASI website at www.isasi.org. Application and essay deadlines are mid-April of each year.—Editor

Aircraft accident investigation can trace its roots to the beginning of 20th century, when the first fatal accident involving the Wright brothers' airplane occurred. Reactive investigations in those times largely focused on technological problems.

Later, in the mid-1960s, the focus shifted more toward human factors and pilot error. Further on, as more and more information was being gathered from investigations, it was soon realized that many of the problems could be traced back to the organizational level of the company involved in the accident. Safety investigators also realized the importance of predictive safety actions. [1]

Within those changes, many problems arose, and safety investigators had to adjust their techniques and develop new tools and models to use. The 21st century brought technological changes that affected how all industries are shaped, and this also includes the aviation industry. Air safety investigation is adjusting for those changes and is constantly challenging investigators with the need for new tools, methods, and knowledge.

Big Data

The modern aviation industry is driven by the "Internet of Things." Multiple devices connected with one another can interact and provide users with millions of data points, ranging from information about passengers to airplane systems to performance, economics, and safety. Terabytes of data are gathered by the airplane's sensors, and the critical information may be analyzed in near real time. Noncritical safety information is uploaded after landing and analyzed as well. [2] Large volumes of data, arriving at the inputs with significant speed, and coming from many different sources, are called big data. Big data relating to safety information is referred to as safety-related big data (SRBD). [2] It plays a fundamental role in preventive investigations of aircraft accidents or incidents.

Accident and safety investigations focus on the following phases: gathering of facts, analysis of those facts, and developing conclusions with preventive measures. In order to assist safety investigators with analysis, different models have been developed, for example, the Swiss Cheese Model, Human Factors Analysis and Classification System, and the SHELL Model. These models, while extremely effective, have certain limitations such as the inability to analyze thousands or millions of complex pieces of information that the aviation industry is capable of gathering through the most innovative technologies that are being utilized. Safety managements systems (SMSs) and flight operations quality assurance (FOQA) are using data analysis for threat and error management but can't comprehend all the information that could be made use of.

Hence, a new model of accident investigation has been proposed. It consists of a layered structure that begins with SRBD. It is raw information that was gathered in the system, and it is not always in usable form. It needs to undergo structuring and modeling. One step higher in the model is safety information. On this level, SRBD is being filtered, and essential, useful information is extracted into safety information.

Following this process, safety law is generated based on safety information. Safety law can be defined as safety information that was further analyzed to predict future trends of events. This is the proactive element of investigations. On the top of the model is safety knowledge, which is all the actions taken based on the previous analysis. [3]

In the era of big data, many safety investigators have to be able to perform this process. They need to have tools to effectively gather data in an organized manner, clean this data, organize it for investigative use, and analyze it. Such use of data will bring benefits in the form of the possibility to analyze the entire data set, the opportunity to analyze data from all the resources available, and the ability to make connections between them without the data being prone to interference from the investigator's possible natural subjective judgement. With proper tools and software, the entire process will make analysis more efficient, more effective, less time consuming, and more thorough.

Applications and Challenges of Using Big Data

Applications of SRBD analysis can be of extreme use for future analysis, real-time analysis, and past analysis. Future and real-time applications are of special interest for the aviation industry nowadays. These can include the analysis of an airplane's perfor-

Marcin Makowski

mance, flight path, systems health, or pilot inputs.

However, with increased amounts of data, it may not always be possible to transmit all of this data to investigators in real time. The most versatile way would be the use of satellites, but the transmission speeds and volumes are limited. The more data that is being sent, the more the costs. And operators are not always willing to pay the price. Flight data recorders (FDRs) gather thousands of points of information every second, and not only would live transmission be costly, but the equipment required to perform this operation would also cost a lot. [4]

How the industry could make use of real-time big data analysis is to develop a system transmitting information only when certain parameters would be exceeded, for example, in an emergency. At that time, the aircraft would be able to send all the data from a certain time, and it would be ready for further analysis. At all other times, only certain limited data would be transmitted at longer intervals. This would also prevent not having access to the FDRs if they were lost in an accident and not yet found.

This implementation of SRBD would require air safety investigators to categorize very specifically at what points the receiver would send all of the information. A thorough review of the accident database would have to be performed to develop a structured way to categorize those parameters.

While it is relatively easy to gather big data from airplane systems and components, it is crucial to remember that approximately 80% of accidents are caused by human error. [5] Human factors are what the aviation industry is focused on, and data analysis in this area cannot be performed that easily. However, as safety science suggests, almost all human factors can be traced to the managerial side of the organization. [6] It is also being suggested that aviation big data analysis should make use of the multilayer network correlation. [7]

Therefore, big data analysis can be performed on many layers, including the aircraft and its performance or the management of the organization. Then correlations can be found between different layers, and conclusions can be drawn. For example, any changes to the operator's policy, any maintenance action, or any other trackable information could be assigned to the particular aircraft's systems or flight path that it is affecting. Whenever there is any issue in the future with parameters in the systems or flight path, the causing action that finds its source in management of the organization will be easily tracked and identified.

Such a network of connections is not something all air safety investigators have worked with before. Technological developments will pose a need for a new type of investigative techniques. [8] Data-driven and risk-based approaches must be taken into consideration to continuously decrease the risk for accidents or incidents. There is no time to wait for safety improvements, and the priority is to develop preventive actions.

Air safety and accident investigators will also need to be able to analyze the data that was gathered in the past in terms of accidents or incidents that happened. They will be responsible for data cleaning, analysis, and interpretation. They will also need to be able to investigate why the proper use of data hasn't been performed in the past, leading to an incident or accident. In addition, there is a need to allow air safety investigators to access the network of all the databases created by operators. This may raise concerns of privacy and security; however, information combined from different systems might be extremely valuable in early error detection.

Conclusion

Gathering and analyzing large amounts of data is crucial to make the aviation industry safer. While not a simple task, development of new methods that air safety investigators can utilize has to be emphasized in order to make the most use out of the available technologies. They are able to provide almost any information needed in extreme detail. Currently, systems such as SMS, Aviation Safety Information Analysis and Sharing (ASIAS), and FOQA make use of extensive data analysis. As more data is available and as the aviation enters the era of big data, more complex systems will be developed, and currency and training of current safety investigators are of the utmost importance. A challenge is placed on the safety segment of the industry to create, structure, and implement systems associated with SRBD and its complex network. This requires cooperation with other industries such as IT or mathematics. Air safety investigators play a vital role in this development and are responsible for guiding the industry in the right direction. ◆

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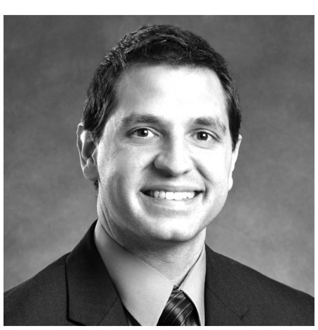
Virtual Wreckage Mapping Using Public Media Photos

(This article was adapted with permission from the author's technical paper Virtual Wreckage Mapping Using Public Media Photos *presented during ISASI 2021, a virtual seminar hosted from Vancouver, B.C., Canada, from Aug. 31–Sept. 2, 2021. The theme for the seminar was "Staying Safe, Moving Forward." The full technical paper is available on ISASI's website, www.isasi.org, in the Library section under the Publications and Governance/ Technical Papers tabs. A blank version of the photo review catalogue discussed in this presentation is available for free from the author. Please e-mail Jacob.N.Zeiger@boeing.com to request a copy. Suggestions for improvements or feedback from "field" use is strongly encouraged.—Editor)*



Jacob Zeiger

By Jacob Zeiger, Senior Air Safety Investigator, Boeing Commercial Airplanes

Introduction

In the early stages of any aircraft accident investigation, one critical task is the security and collection of perishable evidence, particularly with respect to the airplane wreckage itself. The hours immediately after an investigative team is notified of an event represent a critical time in which the team is managing multiple logistical tasks. Travel to the accident site must be arranged, and the local official agencies must be contacted to help secure the site in preparation for the team's arrival. During this period, local authorities are also busy with handling potential disruptions to infrastructure (roads, power lines, etc.) and managing a potentially large number of casualties.

Professional news media is normally quick to seek out information about an accident (including photos and videos) as well to provide critical initial information to the general public. As social media posts receive increased attention and wider distribution, both on their own and with the help of professional news media, the general public becomes incentivized to document and post information about newsworthy events that they encounter. The collective result of these combined media can be a wave of photos and video being published about an event like an aviation accident in the very early hours after it happens, during the time when the investigative team may still be gathering information and preparing to travel.

Additionally, investigation teams are occasionally hindered in their ability to arrange timely travel to an accident site, despite local citizens having immediate access to the site. While the reasons for travel restrictions may stem from diplomatic or political circumstances at the site, international and domestic travel can also be restricted by internal company or agency travel policies, or by a variety of other reasons.

The COVID-19 pandemic demonstrates one major way in which site access can be restricted to local citizens and press in the initial hours after an accident takes place. Even in cases in which the investigation team can deploy to an accident site rapidly, wreckage in populated areas can be disturbed by civilians prior to first responders' or investigators' arrival. In these cases, the available media from professional outlets and social posts can still be valuable in viewing a wreckage field and making observations about the components that are photographed.

In nearly all accident cases, a minimum of an investigator-in-charge or a designated representative can visit the wreckage site and gather relevant photos and evidence. As long as an official resource is given access to a secure site, restricted travel on the part of a particular support organization can be easily resolved with good communication and the sharing of investigative data in accordance with International Civil Aviation Organization (ICAO) Annex 13. These cases can present a different set of challenges for an investigative team from those discussed in this paper—while the source of the photos is normally verified and trustworthy, the team can instead be faced with a large number of images from investigators that must then be sorted on a larger scale.

The information in this paper is intended to provide an overview of one example event in which professional and social media provided valuable information into understanding a wreckage field that could not be accessed by an investigation team in the initial days after an event. In the January 2020 accident involving a Ukraine International Airways B-737-800, Boeing collected publicly available photos and videos for review in order to create a virtual wreckage map that could be studied within Boeing. The virtual wreckage map also provided an efficient method for Boeing's observations of the wreckage field to be shared with the government investigation.

Investigation Protocol

As an airframe manufacturer, Boeing assists government investigations by providing technical advisors to the U.S. National Transportation Safety Board under the protocols and reporting structure of ICAO Annex 13. This participation also allows Boeing to review investigative findings as part of a formal internal safety process to identify and correct safety-related findings quickly. For the event discussed in this paper, Boeing used the observations from media photos to help inform that safety process in the early stages of the investigation. Those observations were shared with the Annex 13 investigation as

	FIRST 48 HOURS Photo Information			24 HOURS + Part Information									Engineering Review								
Photo Numbe	URL Source	Source Type (choose 1)	Media Sourc	Part Class (choose 1	Part ID Numbe	Part description	AT	Part Numbe	STA	W	B	Stringer	Notable damage	Propulsion Review	Propulsion Notes	Structures Review	Structures Notes	Fire Marshal Review	Fire Marshal Notes	Systems Review	Systems Notes
MED0001	www.cnn.com/exampleevent/13lk0	News Outlet	CNN	Engine (ENG)	ENG-001	Left Engine core with some fan blades							Heavy impact damage	x	Visible fan blades bent in the direction opposite rotation - consistent with engines operating on impact	x	Engine fuse points show damage consistent with drag overload				
MED0002	www.twitter.com/exampleuser//j4	Private Citizen	Twitter	Systems (SYS)	SYS-001	Hydraulic Actuator - Possibly Elevator			2830	215	L32		Impact damage - exterior sooting					x	Sooting evidence on exterior but no evidence on surrounding ground - consistent with inflight fire	x	No corrosion or pre-impact damage observed on inner cylinder
MED0003																					

Figure 1: Image catalogue overview.

part of Boeing's involvement as a technical advisor to the investigation.

Forming a Team

Boeing was first notified of an event involving a B-737 hull loss in the Islamic Republic of Iran on Jan. 8, 2020, the day the accident happened. It was clear from the outset that company travel to the accident site would take far longer than typical to arrange, if indeed a site visit by Boeing investigators were to happen at all. In response, air safety investigation prioritized finding what could be learned from publicly available sources, beginning with the photos found on public media.

While one investigator was assigned to support the Annex 13 investigation that was initiated by the Aircraft Accident Investigation Board (AAIB) of the Islamic Republic of Iran using the company's typical process, an additional investigator was assigned to the dedicated task of collecting and cataloguing the photos from the various social and professional media sources that were covering the event.

Boeing's process for reviewing these photos involved collecting six experts in relevant areas of the investigation—in this case, internal experts in structures, systems, and propulsion were invited to participate, as well as a fire marshal. The team convened the following day to begin reviewing photos.

Creating an Image Catalogue

To track the images that were used in the team's observations, as well as the parts that were identified and the relevant observations themselves, an image catalogue was created in standard spreadsheet software as a main record of the review process. The layout of the catalogue was adjusted and expanded during the team's work, with the final version of the spreadsheet satisfying three overall goals:

1. Maintain as much of the original image as possible (metadata, source URL, filename, type of source).
2. Provide traceability from key wreckage observations back to the specific images from which they were derived.
3. Allow for filtering/searching by key stakeholders (by focus group or component).

The final format of the spreadsheet is shown in Figure 1.

First 24–48 Hours: Photo Collection and Cataloguing

The team's focus during the first 1–2 days of work was to collect as many images of the airplane wreckage from as many sources as possible. Public websites and news organizations were monitored by the team, looking for photo and video documentation that could

1. reasonably be shown to be of the event airplane's wreckage, and
2. provide information that was relevant to the investigation.

Images and videos that met the criteria were downloaded for retention. To save as much source data as possible for future reference, filenames and metadata were kept intact, and a cataloguing index in the format "MED####" was added to the beginning of the filename.

Adding Images to the Catalogue

Images were added to the catalogue in the order that they were obtained, along with the following information:

1. **MED#### Index**—Allowing each image to be located in the folder of saved photos.
2. **URL Source**—Providing a link to the relevant source news article or social media post in case follow-up was needed later.
3. **Source Type**—Indicating whether the image originated with a news outlet, private citizen, or official investigative agency.
4. **Media Source**—Noting the specific source of each image (e.g., Associated Press, CNN, Twitter).

The overall intent during this phase was to keep as much of the original source information as possible intact if questions about the source of a particular finding or image arose later. During this phase, news organizations with reports of the event continuously updated their articles with new information, occasionally replacing photos with new ones. Because of these updates, accurate recording of the source material was even more important to retain traceability if the original source of information was later changed or removed.

Boeing Communications and the Talkwalker Application

In this event, the team was able to leverage other areas of the corporate structure to find assistance in locating unique images and videos. The Boeing Communications Department utilizes software called Talkwalker to monitor news and social media sites, gathering relevant news and social media material and displaying it in a user friendly format.

Figure 2: Catalogue with first section filled in. Note: Included data is exemplar in nature and not indicative of the subject event.

	FIRST 48 HOURS Photo Information		
Photo Numbe	URL Source	Source Type (choose 1)	Media Sourc
MED0001	www.cnn.com/exampleevent/13lk0	News Outlet	CNN
MED0002	www.twitter.com/exampleuser//j43	Private Citizen	Twitter
MED0003			

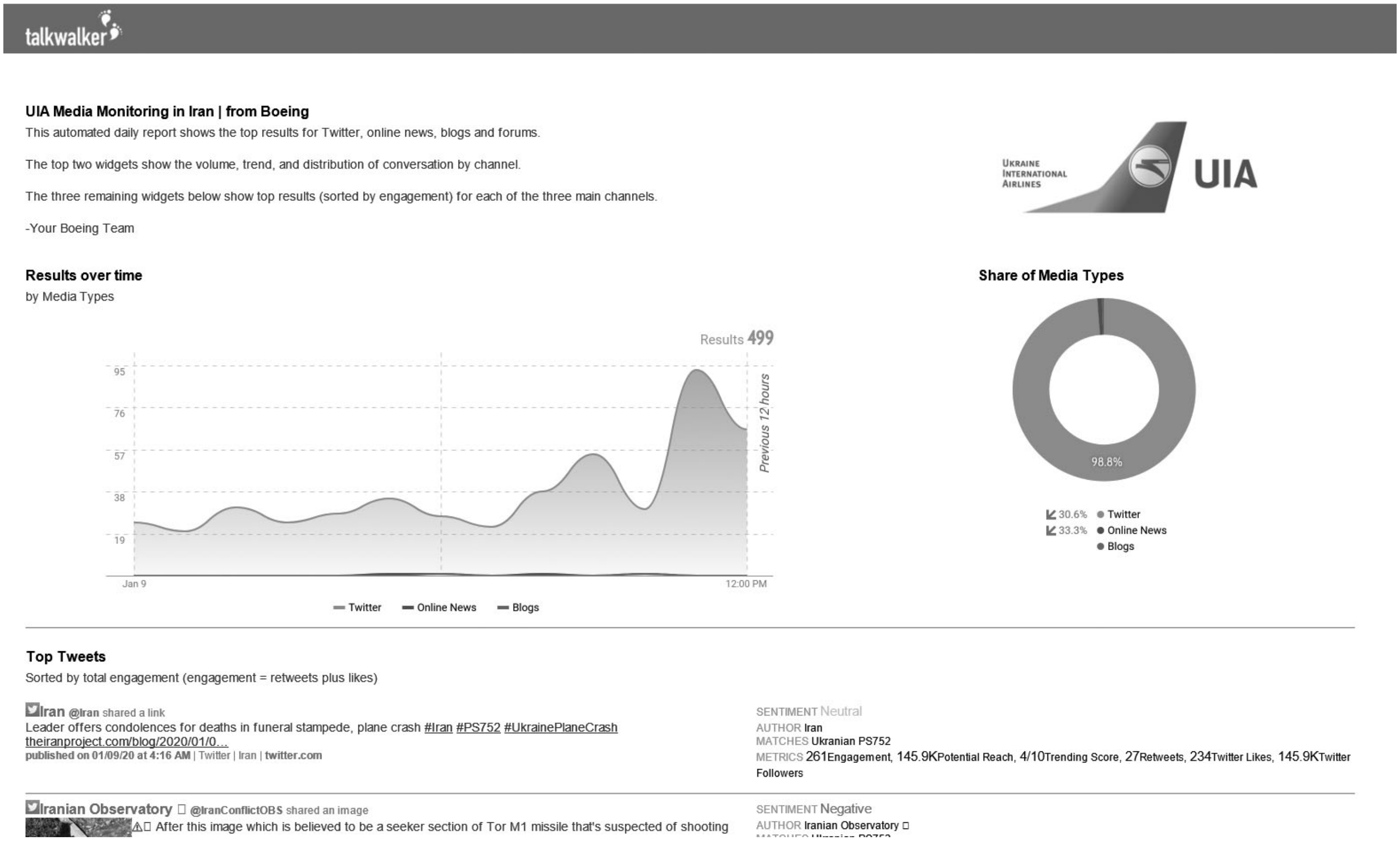


Figure 3: Talkwalker media-monitoring page. This application was able to locate photos that the team had not previously seen and that contributed to the team's understanding of the wreckage field.

Talkwalker cut down on the total time involved in gathering data and allowed the team to expand its coverage beyond the "typical" sources of information.

As new media continued to be posted to the Internet, the Communications Department remained in touch with the team, providing occasional updates and new material. This automated method cut down significantly on the amount of time and effort that individual team members had to put in to traditional search engines and allowed the team to focus on reviewing photos rather than finding them.

Beyond 24 Hours: Building the Wreckage Map

Around 48 hours after the initial notification of the accident, photos and videos were posted and updated less often. The team transitioned to an initial review of the photos that had already been collected to start trying to identify

1. any key aircraft components and
2. major landmarks that could be used to locate the wreckage components in space.

While convened together, the group reviewed each photo and discussed initial observations, noting them in the spreadsheet.

Wreckage Observations

The spreadsheet catalogue of images was updated to include notable information about the parts that were seen in each image. Any identifiable parts were given a unique designation based on the general area of the airplane where they were installed (F-001 for the first identified fuselage part, SYS-012 for the 12th identified systems part, etc.) and the following basic location and damage information was noted in the spreadsheet:

- **Part Class**—Identifying the "class" of wreckage that was included in the image (systems, engine, fuselage, etc.).
- **Part ID Number**—The specific identifier assigned to the wreckage shown, which allowed for multiple photos of the same piece of wreckage.
- **Part Description**—A plain English description of the part.
- **ATA Chapter Number**—If known.
- **Part Number**—If known.
- **Specific Airplane Location**—Using Boeing's standard three-point location system.

Photos that contained multiple identifiable pieces of wreckage were given additional entries in the spreadsheet for each additional component that was included in the image. This allowed for sorting of the spreadsheet by component later. Similarly, if the team recognized a particular component in one photo from a review of a prior photo, the component number would be repeated in the spreadsheet to identify that it had already been identified as being included in two separate photographs. This in turn improved the accuracy by which other components were placed on the final map.

One important advantage of having the whole team review each photo was that the group as a whole could discuss whether components would benefit from a deeper review by any of the individual experts on the team. Components with evidence of fire damage, for example, were marked for follow-up by the fire marshal group, while sections of wing and fuselage

	24 HOURS + Part Information								
Photo Numbe	Part Class (choose 1	Part ID Number	Part description	AT/	Part Numbe	STA	W'	B'	Stringer
MED0001	Engine (ENG)	ENG-001	Left Engine core with some fan blades						
MED0002	Systems (SYS)	SYS-001	Hydraulic Actuator - Possibly Elevator			2830	215	L32	
MED0003									

Figure 4: Spreadsheet updated with basic component information. Note: Included data is exemplar in nature and not indicative of the subject event.

were marked for follow-up by the systems group to try to identify specific structural damage and narrow down the specific airplane section where the structure might have originated.

Naming and Orienting Landmarks

Due to its wide distribution and ease of use, Google Earth was chosen to plot the locations of the wreckage that were identified. Using location information in the text of news reports and the most notable landmarks from the initial photos, the team identified an impact point in a recreational area northwest of the Tehran airport near residential apartment complexes and continuing through an area of walled-in orchards. With the general area of the wreckage field defined, the team could move to labeling particular landmarks in other areas of the photos.

Labeling these landmarks explicitly in Google Earth proved to be highly beneficial when sharing the photo review with the larger investigative team and discussing observations over the phone. Both sides of the conversation were able to refer to areas of the wreckage field by these predetermined names.

Follow-On Work: Deeper Engineering Review

Completing the initial review of photos, including identifying components and marking images for follow up by specific groups, took approximately 5 business days. Following the first two phases, the group was then split into subteams made up of the individual focus areas that were previously identified. The spreadsheet was provided to each team in parallel, and each took additional time to perform a more detailed review of the photos and provide their specific notes on each photo individually. Notes were collected directly in the spreadsheet, aligned with the individual photos and component entries that provided the observations that were recorded. This process provided a basis for recording the data upon which each significant observation was based.

Figure 5: Example photo with both airplane components and landmarks. Note the vertical concrete walls and water tower in the distance. Source: CC BY Fars News Agency via Wikimedia Commons

Figure 6: Wreckage map with landmarks labeled. Source: Google Earth

Virtual Field Notes

Using the observations gathered in all three phases and the

	Engineering Review								
		Propulsion		Structures		Fire Marshal		Systems	
Photo Number	Notable damage	Review	Propulsion Notes	Review	Structures Notes	Review	Fire Marshal Notes	Review	Systems Notes
MED0001	Heavy impact damage	x	Visible fan blades bent in the direction opposite rotation - consistent with engines operating on impact	x	Engine fuse points show damage consistent with drag overload				
MED0002	Impact damage - exterior sooting					x	Sooting evidence on exterior but no evidence on surrounding ground - consistent with inflight fire	x	No corrosion or pre-impact damage observed on inner cylinder

Figure 7: Spreadsheet updated with engineering review notes. Note: Included data is exemplar in nature and not indicative of the subject event.

virtual wreckage map that was created for this event, the team was able to collect its observations into a set of virtual field notes. In particular, the team was able to provide some key observations to the investigation team at large:

- Observations of the "four corners" of the aircraft, as well as their approximate locations in the wreckage field.
- Observations on the state of the engines at impact.
- Observations on the condition and location of fire prior to impact.
- An approximate heading and attitude at impact.

As Boeing air safety investigation continued to support the official investigation by Iran's AAIB, the photo review team was pleased to learn that its observations were supported by evidence gathered and observed by the aircraft accident AAIB team that traveled to the site.

Notable Challenges

The team encountered some minor challenges in this event that are worth noting:

- **Removal of Images from Social Media**—Initial efforts to collect and catalogue the visual media did not include the source of the image or video, under the assumption that the images were likely to remain online in their original location indefinitely. However, as the days progressed, it became apparent that some media (particularly those from social media posts) were occasionally being altered or removed entirely from their original locations. In some cases, the images were rebroadcast by other social and professional news media sources that gave credit to the original source, but in others the team's downloaded version of the image became the only working copy.
- **Movement/Removal of Wreckage**—As the team continued to monitor additional images and video in the days following the accident, items that were previously imaged and catalogued could sometimes be seen again in new locations and orientations. These changes to the wreckage field were variously detrimental and beneficial to the team. In some cases, the original location or orientation of a piece of wreckage could not be determined with certainty, but in others the movement provided additional and useful data about the state of a component after the accident.

Summary

Collecting perishable evidence is a key step in the first hours and days of any accident investigation. Timely access to the accident site for the firsthand collection of information about the wreckage field should remain the gold standard in the professional, methodical investigation of an aircraft accident. However, not all circumstances around an accident scene can be controlled by the investigator in the first hours and days after an accident. Further, communication between states as prescribed in ICAO Annex 13 may take time to be fully established.

The methods described in this paper should not be considered an adequate substitute for traveling to an accident site and making observations in person. But in the event that access to a site is hindered for cultural, geographical, or political reasons, public and social media images and video can provide the opportunity to make key observations about the state of an accident site and the wreckage within it, even without setting foot at the site or seeing the wreckage firsthand. ◆

Figure 8: The vertical tail included key fire evidence. The image on the left was posted in the first 24 hours after the accident but was not republished by many other news agencies. The image on the right, posted later, saw wide distribution. Sources: Anadolu Agency/Getty (left); Hossein Mersadi/FARS News Agency (right)

A Look at Recent ICAO Activities

By Steve Creamer, Director, Air Navigation Bureau, ICAO

(The author presented this keynote address during ISASI 2021, a virtual seminar hosted from Vancouver, B.C., Canada, from Aug. 31–Sept. 2, 2021. The theme for the seminar was "Staying Safe, Moving Forward."—Editor)

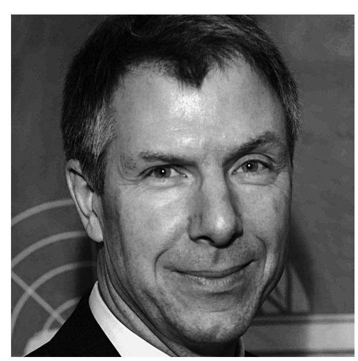
On behalf of the International Civil Aviation Organization (ICAO), I would like to thank the International Society of Air Safety Investigators for hosting this virtual annual seminar. It is a high point on the ISASI calendar, and ICAO thanks the organizers for providing me with this opportunity to address such a prestigious group of aviation investigators. Close relations exist between ISASI and ICAO, and the support ISASI provides to the Accident Investigation Panel (AIGP) is appreciated. I would also like to thank ISASI for taking the initiative to bring together investigators from all aspects of the aviation industry to discuss issues relating to the organization, infrastructure, and management of accident and incident investigations.

As you are aware, the global aviation industry was seriously impacted by the pandemic. ICAO established alleviations to standards of the annexes as interim measures to support continued operations. As interim measures, these alleviations cannot sustain safe operations indefinitely, and a return to normal operations, referred to as a "new normal," is required. ICAO is cautiously moving toward the new normal where these alleviations, and the guidance for use, will slowly be withdrawn. They will be superseded with planning tools and approaches for the recommencement of operations in line with the requirements of standards and recommended practices, accessed through the Roadmap to OPS Normal homepage. The link to this webpage is https://www.icao.int/safety/OPS/OPS-Normal/Pages/default.aspx.

During the beginning of the pandemic, ICAO engaged with the accident investigation community to provide guidelines for conducting investigations in pandemic conditions. These guidelines were updated and are available on the road map webpage under the Aircraft Accident & Incident Investigations tab. Investigation procedures and guidelines addressed include participation of states in investigations, when the state of occurrence is a member of a regional accident and incident investigation organization, delay in readout of flight recorders by another state due to travel restrictions, and delay in carrying out tests of aircraft parts in other states. Protocols developed by two air accident investigation authorities are also available on this webpage.

These guidelines and protocols assisted with the arrangements for the investigation of an Airbus A320 accident on May 22, 2020, in Pakistan in which accredited representatives from France were able to travel to Pakistan to participate in the investigation. Similar protocols were applied for the download of the flight recorders for the investigation of the Ukraine International Airlines B-737 Flight PS-752 accident on Jan. 8, 2020, in Iran. The flight recorders were taken to France for the French BEA to assist with the download of these recorders. This was an investigation in which ICAO provided assistance, and an ICAO technical officer was present during the downloading of the flight recorders.

Safety is aviation's top priority. The Global Aviation Safety Plan (GASP) sets forth ICAO's safety strategy in support of the prioritization and continuous improvement of aviation safety. The purpose of the GASP is to continually reduce fatalities, and the risk of fatalities, by guiding the development of a harmonized safety strategy and the implementation of regional and national aviation safety plans. The GASP promotes the implementation



Steve Creamer

of safety management and a risk-based approach as the core tools to help manage increasingly complex aviation systems. It also encourages the use of harmonized safety enhancement initiatives to address gaps in effective implementation of the critical elements of a state's safety oversight system. GASP's vision is to achieve and maintain the aspirational safety goal of zero fatalities in commercial operations by 2030 and beyond.

In line with the GASP, each state is encouraged to develop a national aviation safety plan and participate within their corresponding regional aviation safety plan. The strategic direction for the management of safety for a set time will be presented within those plans. Each plan should be developed in line with the GASP goals, targets, and high-risk categories of occurrences. The national aviation safety plan demonstrates commitment to the implementation of key activities to improve safety in the state, for example, strengthening the state's accident and incident investigation capabilities to meet the state's safety objectives.

Accident and incident investigations continue to be featured as key safety enhancement initiatives and are an essential part of the GASP goals related to "achieving a continuous reduction of operational safety risks" and "strengthening states' safety oversight capabilities." Recent events have once again shown that the global aviation community and the traveling public consider that Annex 13-type investigations shed light on safety concerns and continuously improve safety.

Indeed, accident and incident investigations have provided lessons of indisputable importance on how to improve aviation safety, noting that new strategies may need to be developed to further reduce the overall accident rate. As you may be aware, the investigation community has been attentive to the needs of the aviation system and increasingly incorporates a systems approach during investigations. To this effect, much effort has been made on the proper implementation of investigation provisions in states. It is noted that more and more independent accident investigation authorities are being established in member states, to name one such advance.

Regional Accident and Incident Investigation Organizations

ICAO has been encouraging states to form regional accident and incident investigation organizations (RAIO), or what is known as investigation cooperative mechanisms (ICMs), in certain regions of the world. States that formed or joined into such organizations would be able to assist each other with implementation issues as well as with resources when one of the states has to investigate an accident that requires additional resources the state does not have. Some of these organizations have been in operation for many years, such as the Interstate Aviation Commission, and others are currently being formed in South America and the Middle East. As an implementation support effort, ICAO also initiated a RAIO cooperative platform to assist RAIOs and ICMs. In this cooperative platform, sharing of experiences and documentation is being encouraged. ICAO guidance material for RAIOs is available in the *Manual on Regional Accident and Incident Investigation Organizations*, Doc. 9946.

Release of Factual Information

Touching on an old subject is cooperation with the media. I would submit to you that this is an area known to be related to the public and political pressure for instantaneous information about an accident. While acknowledging some concerns on the part of investigation authorities regarding the impact on the accuracy of investigation information, it is my firm belief that accident investigation authorities need to reassess their communication strategies to proactively face this challenge, recalling that the needs of the media should not interfere with the proper conduct of the investigation. The overall goal would be to promote dissemination of factual information and to minimize speculation and rumors about the occurrence. This concern surfaced again in the aftermath of the Ukraine International Airlines Flight 752 accident and investigation when families of victims were expecting information. If the factual information is not released in a structured, formal way, the families resort to all kinds of ways, which may contribute to misinformation shaping the public narrative about the accident. This was a topic for an AIGP working group, and recommendations were made by the AIGP during the May 2021 meeting to amend Annex 13 and related guidance material.

AIGP Work

ICAO remains dedicated to the advancement of investigation techniques and procedures, aiming to further help investigation authorities meet their obligations called for in Annex 13. In November 2020, a new definition and standard for "safety recommendation of global concern" and revised provisions on recorded data for accident and incident investigations became applicable in Annex 13. These amendments were recommendations of the AIGP, of which many of you are members. I would like to, once again, reinforce our gratitude for your assistance in helping us advance the AIGP's work program.

Allow me to highlight a few of the current work program elements under consideration by the AIGP. Some of these elements have reached a level of maturity to be recommended for the consideration of the Air Navigation Commission as proposed amendments to Annex 13, whereas others are still being considered.

Investigating RPAS Accidents and Incidents

Due to the advances of remotely piloted aircraft systems (RPAS), the AIGP drafted and recommended provisions for the investigation of RPAS accident and incidents. This was a complex process that required coordination with the RPAS panel to understand the intricacies of RPAS and how best to approach and investigate accidents involving these aircraft systems.

Availability and Protection of Flight Recorder Data as a GADSS Requirement

With the requirement for timely availability of flight recorder data under the global aeronautical distress and safety system (GADSS), options such as transmission of flight recorder data, or deployable flight recorders, became realities. The concern with this is the protection of the sensitive flight recorder data if it is transmitted or how data on a deployable flight recorder is protected during the recovery process. The AIGP recommended amendments to Annex 13 addressing this topic.

Publication of Final Reports

The 2015 High-Level Safety Conference acknowledged that many investigations may not be conducted or may go unreported and recommended that ICAO review relevant provisions in Annex 13 and take appropriate action. During the initial research by the AIGP, reviewing more than a thousand fatal accidents that occurred between 1990 and 2016, data indicated that almost 60% of the final reports had not been published. After further research and follow-up with states, with the assistance of ICAO regional offices, many more final reports became available. In May 2021 during the AIGP meeting, it was reported that the number of final reports becoming available had increased to 63%. For at least another 10%, there was some reason why they were not published. The AIGP working group is progressing with this research to obtain responses from states that still need to reply.

Other Topics

Some of the other topics the AIGP addressed include accident/incident data reporting, investigator training guidance material, regional accident and incident investigations, trust framework, and conflict-zone-related investigations.

A Challenge

I would like to challenge you as an ISASI group with members on the forefront of new investigation techniques to consider methods for investigating accidents involving new technologies. We think of RPAS on the one hand, but even more interesting are the investigation of occurrences where new technologies are fitted to current aircraft. And in the near future, dynamic updating of aircraft software—maybe even in real time—could be enabled to address the real challenges for the security of these systems as they become connected. Or imagine an autoland system for current aircraft in the case of pilot incapacitation. Think of the challenges for an investigator if an aircraft with such a system is involved in an accident.

Conclusion

Annex 13 is a mature document used as a global reference, mainly in complex investigations involving numerous states and different parties. Your discussions, which feed the participation of ISASI in the development of ICAO investigation provisions, are undoubtedly what makes this annex a benchmark to investigations worldwide. ICAO reaffirms its wish to count on your valuable contributions toward the progress of safe international air transport.

ICAO would like to express its gratitude to Marcus Costa, a long-standing member of ISASI, who retired from ICAO after 17 years as chief of the Accident Investigation Section. His dedication to the work of ICAO and to the accident investigation community is well known.

I have noticed your comprehensive program in the next days and wish you fruitful discussions. ◆

Pakistan Society Elects Slate of Officials

In December 2021, the Pakistan Society certified a slate of officials. Election Commissioner Syed Saeed Akhtar reported that only one nomination was received for each position and "therfore all the nominees are declared elected unopposed." The council officials are

- President, Wing Cdr Naseem Ahmed
- Vice Prsident, Major General Mohammad Azam
- General Secretary, Air Cdre Nayyar Faruqui
- Finance Secretary, Capt. Moshin Ausaf Kahn
- Executive Member, Capt. Rizwan Ahmed
- Executive Member, Air Cdre Qaswar Naqvi. ◆

Elections, Focus On…, and ESASI 2022

Over the last two years, the European Society (ESASI) has developed a new constitution, reflecting modern practices and replacing the less formal 1983 ESASI founding document. In January 2021, ESASI became a registered Charitable Incorporated Organization (CIO). This was endorsed unanimously at the annual general meeting following the ESASI 2021 virtual seminar in July.

The constitution states that following the first annual general meeting of the new CIO, at least one-third of the ESASI Committee (formally "Charity Trustees") should retire from office or stand for reelection. And that happened, with the two longest-standing of ESASI's six committee members standing for reelection, with the intent at the time to expand to a committee of eight.

During autumn 2021, there was a call to the ESASI membership for candidates. A total of six hopefuls responded by the October 31 deadline and submitted their "motivation statements," which were posted on the ESASI website for members to view before the November voting. The candidates were a strong field: Olivier Ferrante and Brian McDermid (existing committee members) plus Nuno Agdhassi, Arben Dika, Kate Fitzgerald, and David King.

In addition, the next Focus On… virtual session was being prepared. The first, Focus On…Aviation Insurance in spring 2021, had been a success, with five presenters giving different angles on the topic followed by a Q&A session. Focus On…Protected Information, the second in the series, scheduled for Dec. 7, 2021, (the anniversary of the signature of the Chicago Convention on International Civil Aviation) looked at the protection of evidence during a safety investigation.

The background? International Civil Aviation Organization (ICAO) Annex 13, the European Union Regulation (EU) No 996/2010, and national regulations specify evidence that is not permitted to be released outside of an investigation without the investigator-in-charge being instructed to do so by the "appropriate authority" after a "balance test." However, plenty of stakeholders contend that there is a need for protected information to be released for various reasons. For instance, regulators request evidence to support continuing airworthiness, and lawyers and victims' families ask for the disclosure of sensitive information (e.g., cockpit voice recorders) for a variety of purposes. Journalists want to inform the public quickly and accurately and may seek privileged information.

For Focus On…Protected Information, ESASI was fortunate to gather an excellent slate of presenters. First were lawyers. Annemarie Schuite, senior legal officer at the Dutch Safety Board, opened with a very clear description of the legal basis for the protection of investigation information, particularly within a European setting, acknowledging the differences in legal practices between EU states. This was complemented by Rob Lawson of the UK (Clyde & Co.) with a description of how these balancing-test provisions have played out in the relatively rare UK legal cases in which the test has been applied.

The Focus On... participants then heard presenters give a viewpoint from a manufacturer's perspective (Bernd Osswald & Michel Martin, both of Airbus Helicopters) and from the European regulator, the European Union Aviation Safety Agency (EASA) (Alessandro Cometa). Although there may be differences in viewpoint, a common theme among these presentations was the need to support continued airworthiness (ICAO Annex 8) while still respecting the protections enshrined in ICAO standards and recommneded practices and European and national law. Closing out the presentations, Tim Hepher of Reuters gave a balanced view as a practicing aviation journalist of many years, noting how few professional aviation journalists are employed by major outlets now and how the responsible journalist does need to balance the public appetite for accurate news stories with legal protections.

There was great attendance, with over 100 sites logged into this second Focus On…session, and the reviews were very positive. There is clearly a good appetite for this sort of length of virtual event (90 to 120 minutes) on particular topics.

And the ESASI election results? In November, there was good voter turnout and all six candidates, including the four new ones, were well supported. The remaining committee considered this, balanced with the plans ESASI has over the next few years. The result was that the committee voted to expand the ESASI

committee to a total of 10 (details are on the ESASI website). This broadens geographic and gender balance and allows a new distribution of duties, including the preparation of a bid to host the ISASI international seminar in 2024. The next election? At alternating ESASI annual general meetings, one-third of the Charity Trustees shall retire from office or stand for reelection so the next ESASI election should be in autumn 2023.

Looking ahead, the next ESASI major event will hopefully be in person—the delayed Budapest, Hungary, event of ESASI 2022 (April 6–7). The event is planned to be at the same impressive Danube location originally scheduled for the postponed 2020 and 2021 events. The Call for Presentations is out, and there are more details on the ESASI website. As at the ESASI seminar in Derby in May 2019, the event will be preceded by a one-day meeting (April 5) of the European Civil Aviation Conference Investigation Experts Group at the same venue. And this time, also planned on April 5 is a half-day of the Military Air Safety Investigation Group. ◆

Australian Society Announces 2021 Scholarship Recipients

The Australian Society (ASASI), in conjunction with the Flight Safety Foundation–Basic Aviation Risk Standard (BARS), awarded the Macarthur Job Scholarship 2021 to Madeline Higgins of the University of Southern Queensland. Her successful submission, *The Impact on Aviation Safety of Pilot Currency and Recency During the COVID-19 Pandemic*, will help her to attend an ASASI or ISASI seminar of her choice in the future.

ASASI also awarded an annual ASASI membership to Tash Shayer of Sharp Airlines of South Australia following her selection by the Australian Chapter of Women in Aviation at its awards function in December 2021. ASASI looks forward to their active participation going into 2022. ◆

EASA Publishes European Plan for Aviation Safety 2022–2026

In January, the European Union Aviation Safety Agency (EASA) released the 11th edition of the European Plan for Aviation Safety (EPAS), which, Curt Lewis reports in the *Flight Safety Information* newsletter, EASA says, "sets out the strategic priorities and major risks affecting the European aviation system and defines the actions needed to mitigate them, with the primary objective of improving aviation safety." EPAS is the regional safety plan (RASP) of EASA member states, supporting safety management at the state level and constituting the main source of the European RAPS for the International Civil Avation Organization European region.

As detailed by EASA, this edition features a focus area on the impact of the pandemic on the aviation sector and how to initiate recovery from the crisis without severely affecting safety levels.

Other salient points include 19 new research projects in technologies such as remote flight instruction, risk assessment of complex systems, the use of machine learning in certification, and electric or hybrid propulsion. Regarding drones, EPAS continues the line of work to foster the development of a drone ecosystem in Europe, taking into account how the pandemic accelerated the use in some tasks such as the delivery of medical supplies, humanitarian aid, and response to emergencies and disasters. The environmental aspect covers efforts to increase fuel efficiency, preparation for the use of electric and hybrid propulsion, sustainable fuels, carbon offsetting, and the development of an environmental label. ◆

In Memoriam

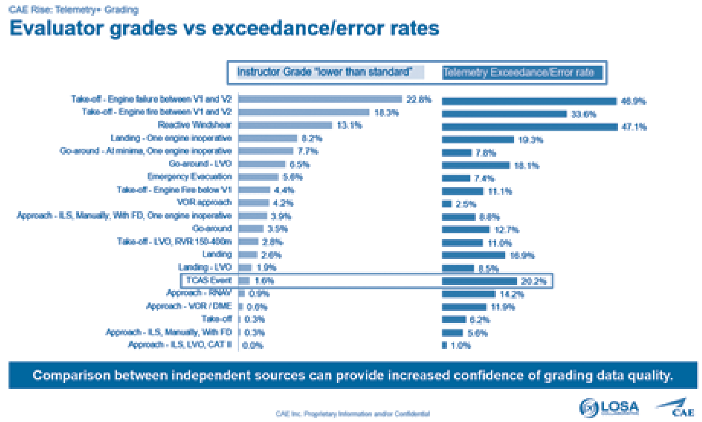
Ludwig Benner, an ISASI member since May 1980, died on Nov. 15, 2021, in Oakton, Virginia, at the age of 94. He was among 10 members granted ISASI Fellow status in 1993 when the Society created the Fellow membership category. Benner served on the Fellow Committee since May 1995 and in other ISASI positions. He became a Life ISASI member in January 2001.

Benner was the division chief of the U.S. National Transportation Safety Board's Hazardous Materials Division from 1976 to 1982. A retired registered professional safety engineer, he served on the editorial board of the J*ournal of Safety Research* and participated in the System Safety Society. He published more than 90 articles and papers on safety, system safety, risk analysis, accident investigation, hazardous materials, and regulation and coauthored *Investigating Accidents with STEP*. Open-source archives of his works can be accessed at www.ludwigbenner.org. In 2006, the International Association of Fire Chiefs' Hazardous Materials Committee presented him its highest award, the Level A Award, for his "leadership, service, and support to the hazardous materials response and training program." Benner hosted the investigation process research resource site (www.iprr.org), a pro bono website with hundreds of resources for safety investigation.

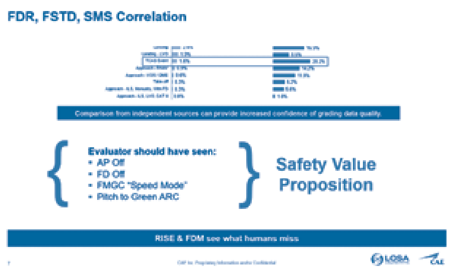
ISASI President Frank Del Gandio said, "Ludi contacted me many times over the years to seek information and ask questions about aviation safety and accident investigations. He was always writing papers about safety. He knew that I was once the Federal Aviation Administration's go-to person for hazardous materials training and an on-scene air accident investigator. In fact, Ludi called me last September with questions as he was writing yet another paper. His expertise went far beyond aviation safety. He helped to ensure our investigation techniques improved and our safety efforts enhanced."

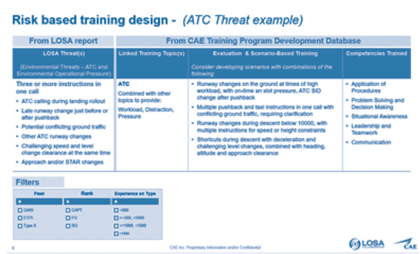
ISASI Treasurer Bob MacIntosh noted he was saddened to learn of Ludi's death, "as Ludi was a formidable councilor to many of our colleagues, and a warm friend and advisor to me. I will always cherish our discussions. Ludi enriched us all." ◆

(Continued from page 11)



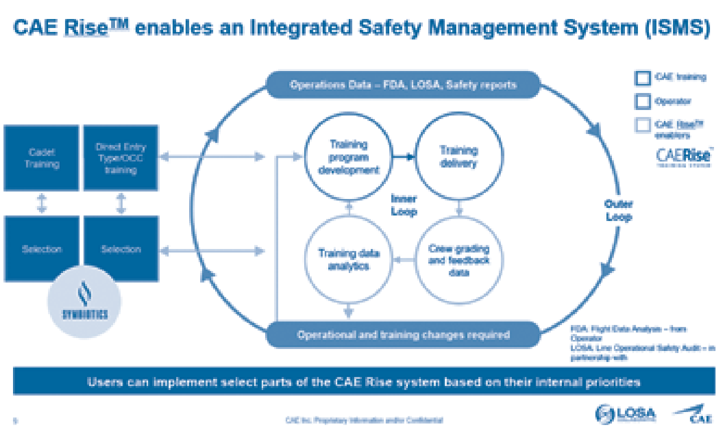
The bottom line is that data often sees what humans miss. Once the analysis of what happened and why using the data from all sources is completed, the safety action group can contemplate the mitigation. In this case, we see an ATC threat example. We can also see from a LOSA report the actions the courseware developers performed linking the data to the training topics and entering the information into evaluation and scenario-based training. Frustratingly, telemetry captures mistakes but does not provide a record of positive crew behavior, but LOSA gives you the most complete look at the data to identify positive behavior because it looks for specific competencies for the crew to resolve. This would complete the process up until the continuous measurement point.





So here we are back at our original inner/outer loop, only this is more colorful denoting how the system works. The gray color is data or data enablers being exchanged in various parts of the process. The light blue color is the responsibility of the operator to provide data and to participate in the process. Finally, the dark blue color is something the training system, in this case CAE training, provides.

We also have a new symbiotics logo on this chart, an important part of the equation. It is a psychology test instrument used to collect a lot of data. It enables us to look at cadets and entry-level pilots and their demographics and biases to see how it affects both training and outcome data.



Users can select whether they want to use parts or all of the process depending on their internal priorities. But big data—operations data, flight data recordings, LOSA data, and voluntary safety reports coupled with the inner and outer loops—can be leveraged to enhance the training system, make it more efficient, and improve the safety outcome. This is what it takes to move the needle. ◆

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Each member should at all times conduct activities in accordance with the high standards of integrity required of our profession.

2. PRINCIPLES

Each member should respect and adhere to the principles on which ISASI was founded and developed, as illustrated by the Society's bylaws.

3. OBJECTIVITY

Each member should lend emphasis to objective determination of facts during investigations.

4. LOGIC

Each member should develop all accident cause-effect relationships meaningful to air safety based upon logical application of facts.

5. ACCIDENT PREVENTION

Each member should apply facts and analyses to develop findings and recommendations that will improve aviation safety.