FORUM

ISASI

Air Safety Through Investigation

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A nonhierarchical safety management system shared among organizations at Schipol Airport, Amsterdam, the Netherlands is an unusual joint program that has produced positive results (see page 4).

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AIR SAFETY INVESTIGATORS
INCORPORATED AUGUST 31, 1964

PRESIDENT'S VIEW

THE WORLD HAS CHANGED

People all over the globe are experiencing the COVID-19 pandemic, which is wreaking havoc on our lives and perhaps causing death to someone among our families, neighbors, friends, or work colleagues. We are all saddened by these terrible events. Our world has changed.

Despite the social distancing and the voluntary and mandatory quarantining that many of us must now endure at home, there are air safety professionals still required to respond to an aviation accident or incident who cannot do so remotely—who cannot work from a home office or through the Internet. These safety professionals must report to their worksites to maintain safety vigilance, to inspection sites to ensure ongoing safety maintenance procedures, and to onsite accident investigation sites. Some of these professionals cannot drive to their worksite. They must fly to the location, sometimes on a commercial airliner if that is still an option.

Using biohazard protections during an onsite accident investigation is not a new concept for us—ISASI and other organizations have offered training about safe investigation procedures and on the proper use of protective clothing for many years and have conducted seminars on the dangers that bloodborne pathogens present to investigators. Now there is an additional threat—the possible presence of a deadly virus. And unless we take proper precautions, this new threat can be present anywhere—on an accident site, in our workplace, in our communities, in our homes—locations people may gather, such as stores, places of worship, restaurants, theaters, and many more.

ISASI International Councilor Caj Frostel, center, participates in biohazard training during a 2018 seminar in Nigeria.

This virus not only adversely affects our work life and home life. ISASI must adjust how we conduct business. For the time being, ISASI's International Council and many of our state and regional societies and U.S. regional chapters are voluntarily canceling planned meetings and seminars. As I prepare this "President's View," we are considering what to do about ISASI 2020 in Montreal, Que., Canada, this September; how to handle 2020 Kapustin scholarships and the Jerome Lederer Award; how to, or if to, conduct Reachout seminars; and how to represent your interests among government regulatory and investigative agencies that must continue to serve the aviation industry.

Some ISASI business can be accomplished using online and electronic technology—virtual meetings via the Internet and using e-mail and phones to communicate with and among officers, standing committees, working groups, student mentors, and the ISASI business office. Our website will continue to provide local, national, and international information. *ISASI Forum* will continue to be published, both digital and print versions. This may be a good time for ISASI members to consider if getting the digital-only subscription is appropriate. The ISASI executive officer election will still be conducted from July 1–August 21 with nominations accepted via e-mail to the international headquarters from May 1–June 25. The election results may be announced only through the website and *Forum* if ISASI 2020 is postponed or canceled.

So I urge ISASI members to take all proper, appropriate, and available precautions to avoid or lessen exposure to COVID-19 in your work lives, family lives, and communities. There are many Internet sites and other sources where you can find accurate information about this pandemic and how to prevent or lessen its adverse consequences. Social media may not be your best option. Educate yourself and stay safe. I know I am trying to do so. ISASI's motto has long been "Safety Through Investigation." This motto must continue to be vigilantly applied to the aviation industry and now to everything else we do. ◆

Frank Del Gandio
ISASI President

INTEGRAL SAFETY MANAGEMENT SYSTEM AT SCHIPHOL

By Dr. Jasper Daams, Program Director, Integral Safety Organization, Schipol Airport, Amsterdam, the Netherlands

Several investigations of accidents and serious incidents show that the risks at the interfaces between organizations are an important factor in the further improvement of safety. At Schiphol Airport, airlines, ATC, ground handlers, refueling services, and the airport itself joined forces to manage these risks together. In this way, they followed up on recommendations of the Dutch Safety Board to strengthen cooperation on safety. The joint sector Integral Safety Management System (ISMS) applies the safety management principles of the International Civil Aviation Organization (ICAO) Annex 19 and the European Union Aviation Safety Agency (EASA) to the management of interface risks. The main difference compared to a "normal" safety management system (SMS) is that there is no accountable executive for the sector as there does not exist a hierarchical relation among the participating organizations. This paper describes the way ISMS is organized and how the lack of hierarchy has been overcome. Finally, the effectiveness of ISMS is demonstrated by several results.

Introduction

Since the early years of aviation, safety has been the top priority. Over the decades, technological advancements, human factors, and organizational improvements have led to a reduction of accident risks to a fatal accident rate of one accident per 2,520,000 flights in 2018. One of the more recent developments was the mandatory introduction of SMS for aviation service providers in 2013. In ICAO Annex 19, safety is defined as "the state in which risks associated with aviation activities, related to, or in direct support of the operation of aircraft, are reduced and controlled to an acceptable level." The assurance that the conditions of a safe operation are met is provided by SMS within the organization of the aviation service provider. The aviation safety providers operate within the context of a state safety program that provides legislation and oversight of the safety of aviation activities.

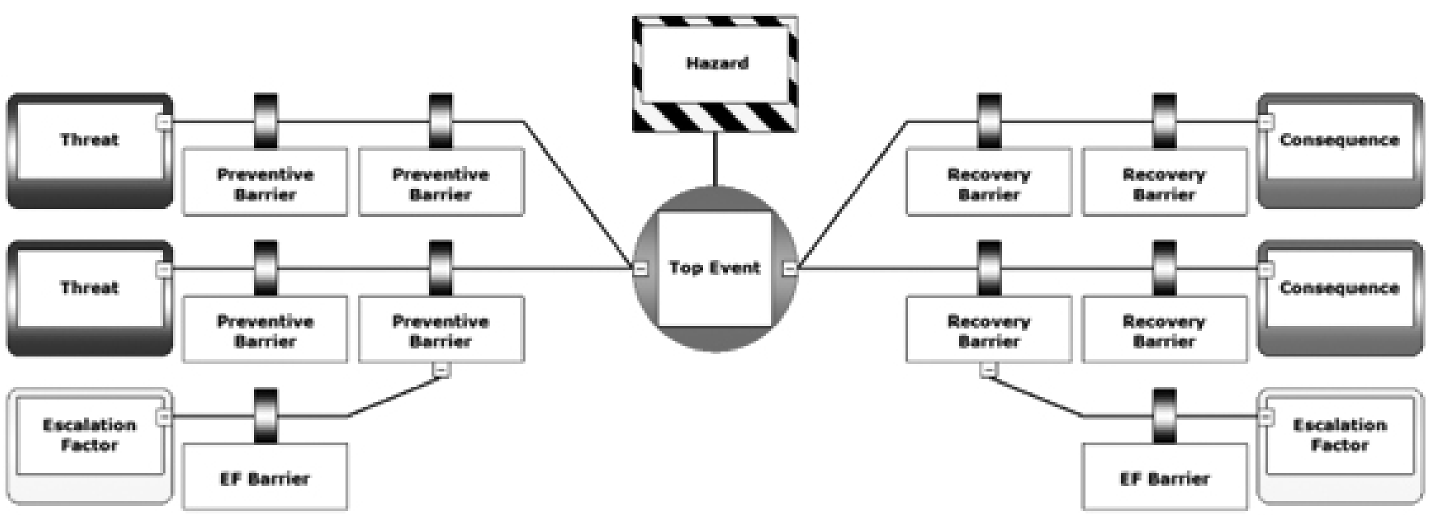
Since each aviation service provider has its own SMS, the natural focus of these management systems is the scope of the individual organization. However, certain risks are not completely within the scope of an individual organization but involve the interaction among organizations as well. For example, the risk of runway incursions involves the layout of the airport infrastructure, the handling of traffic by ATC, and the execution of flight operations by airlines. Hence runway safety does not only depend on the performance of each individual organization but also on the way the organizations interact.

ICAO and EASA have recognized the importance of interfaces and provide standards and recommended practices with respect to interface management. EASA prescribes that airport operators carry out safety programs, and ICAO gives guidance on the establishment of runway safety teams, for example. Furthermore, interfaces are made explicit in the safety regulation concerning changes to the functional system of air navigation service providers (EASA, 2017).

A useful concept for describing interface risks is that of the so-called "bowtie" shown in Figure 1. A bowtie is a digram that visualizes a risk with just one easy-to-understand picture. The diagram is shaped like a bowtie, creating a clear differentiation between proactive and reactive risk management.

Within organizations, bowties are used to identify the barriers available to prevent top events from occurring (preventive barriers) and the barriers available to reduce the impact of top events (recovery barriers). On this basis, the risk associat-

Figure 1. Example of a bowtie diagram.



ed with the top event can be systematically assessed and managed, for example, by interpreting the results of audits and incident reports in the bowtie structure and by next giving priority to improving relatively weak (strings of) barriers. In this way, an integral understanding of the available risk controls is achieved.

In the case of interface risks, not all barriers are within the managerial control of an individual organization. Moreover, the barriers may be distributed over several actors. To properly manage such risk, an integral view of the risk as a whole is necessary. Based on such integral view, the most effective measures to reduce the interface risk may be identified. Therefore, integral management of safety goes a step beyond properly managing the interfaces. Rather it is about getting an integral picture of the risk involved, including the safety barriers of the relevant organizations, which is the basis for taking the necessary and most effective measures to control the risk to an acceptable level.

In 2018, the aviation parties at Schiphol Airport started the joint sector ISMS, a new initiative to jointly manage their interface risks in a structure that mimics the makeup of an SMS of an individual organization. With ISMS, the aviation parties are following up recommendations of the Dutch Safety Board from 2017. This paper describes this new approach to managing interface risks. In particular, the following topics are described: the setup of ISMS, the way joint decision-making takes place, a number of results obtained thus far, and conclusions that have been determined.

Scope and structure of ISMS

The scope of ISMS has been defined (geographically) as extending from the facade of the airport terminal facilities toward and including the Schiphol terminal maneuvering area (TMA) airspace. This implies that platform safety as well as flight operations safety are within the scope. Within the geographical scope, the safety risks of the relations and interactions among the individual organizations operating at Schiphol Airport (interfaces) are considered. For practical reasons, a distinction is made between flight operations risks and ground handling risks.

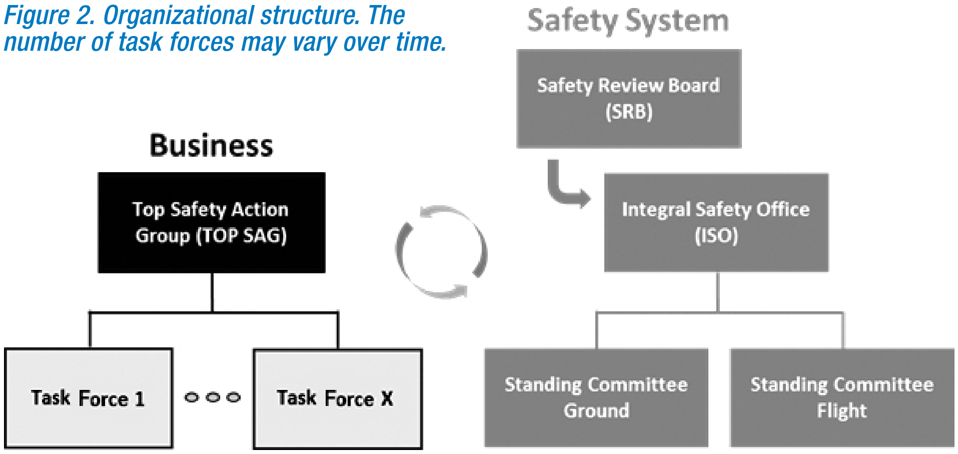
The organizations involved in ISMS are

- Amsterdam Airport Schiphol,
- ATC, the Netherlands,

(Adapted with permission from the author's technical paper Integral Safety Management System at Schiphol, *presented during ISASI 2019, Sep. 3–5, 2019, in The Hague, the Netherlands. The theme for ISASI 2019 was "Future Safety: Has the Past Become Irrelevant?" The full presentation can be found on the ISASI website at www.isasi.org in the Library tab under Technical Presentations.—Editor)*

Dr. Jasper Daams

Figure 2. Organizational structure. The number of task forces may vary over time.



- Royal Dutch Airlines,
- EasyJet,
- Swissport, and
- Gezamenlijke Tankdiensten Schiphol (GTS).

The latter three have a representative role: easyJet represents the home-based carriers (except KLM), Swissport represents the ground handlers (except KLM), and GTS represents the refueling services.

The approach to work with representation instead of inviting all organizations was motivated by the experience with earlier safety improvement programs, where meetings sometimes became less effective because of the large number of people at the table. In preparation for meetings, the representatives consult with their colleagues beforehand and bring a consolidated position.

The organizational structure of ISMS follows the guidance given in ICAO Doc. 9859. In Figure 2, the structure is shown schematically.

Structure of ISMS

The elements of the ISMS structure are briefly described below.

Safety Review Board (sector SRB)

The SRB is a high-level committee that sets the safety policy and strategic safety goals. The SRB is staffed by the accountable executives of the organizations involved plus the director of the Integral Safety Office. The sector SRB is chaired by the accountable executive of Schiphol Airport.

Top Safety Action Group (TOP SAG)

The TOP SAG is a high-level management group that assesses analyzed risks and ensures timely mitigating actions, if necessary. The TOP SAG consists of the accountable executives and a number of operational executives plus the director of the Integral Safety Office. The scope of the TOP SAG is the safety risks of the relations and interactions among the individual organizations operating at Schiphol Airport (interfaces). The TOP SAG is chaired by the accountable executive of Schiphol Airport.

Task forces

Task forces prepare and direct risk-reduction measures on specific topics, e.g., runway safety, ground movement safety, bird hazards etc. The task forces can be described as working groups on actual themes and report to the TOP SAG. The task forces can be initiated, augmented, canceled, etc., according to necessity. The task forces are chaired by executives or senior management of one of the organizations and sponsored by a TOP SAG member.

Integral Safety Office (ISO)

The Integral Safety Office is the operational function of ISMS. The ISO advises the sector SRB and TOP SAG, analyzes risks, takes safety initiatives, and assesses the effectiveness of risk-reduction measures. The ISO consists of the Core Team (managers of the Health, Safety, and Environment office of Schiphol Airport; ATC, the Netherlands; Royal Dutch Airlines; and a ground handler), a pool of safety analysts from the participating organizations, and program management support staff. Furthermore, consultants are contracted to execute specific tasks such as risk analysis or program management support of a task force. The ISO is led by a director who is employed by Schiphol Airport and who reports to the sector SRB.

Standing Committee Ground and Standing Committee Flight

The Standing Committee Ground and Standing Committee Flight have the following responsibilities with respect to ground handling risks and flight operations risks, respectively:

- Identify safety concerns related to the flight/ground process at Schiphol Airport.
- Provide input to the ISO related to joint safety investigations.
- Advise on the sector top five flight/ground risks.
- Share information about ISMS activities.

The standing committees consist of representatives of all organizations within the scope and are open to all stakeholders. The standing committees are chaired by a member of the ISO Core Team.

Decision-making

In contrast to an SMS of an individual service provider, ISMS does not have a single accountable executive with final responsibility. The safety accountabilities in aviation are defined by regulations, most of which originate in European law and worldwide standards. In this context, it seemed legally impossible to give ISMS formal authority over safety decisions, as parties are not allowed to transfer safety responsibilities. Decisions are instead made by consensus.

Decision-making in networks of mutually dependent actors has received ample attention in the literature. Because hierarchical relations are lacking, actors need to agree before joint actions can be taken. As agreement is not obvious in the light of different views and interests, attention is paid to overcoming potential hurdles for effective joint decision-making. In general, the main impediments to effective cooperation are

- incongruent goals,
- disagreement about the facts,
- absence of an effective working process, and
- lack of sound working relations.

Within ISMS, these potential impediments have been resolved while respecting the individual accountabilities of the actors involved. Solutions to these impediments are discussed below.

Congruence of goals

The main goal of ISMS is to improve safety, which has priority in aviation. Each organization involved in ISMS is represented by an accountable executive, who has final responsibility for safety in his or her organization according to aviation law and has a position on the board of his or her organization. Therefore, the individuals who participate in the sector SRB and the TOP SAG have 1) a shared personal commitment to safety and 2) the mandate of their organization to set strategic goals and accept the related consequences. The members of the sector SRB have stated their priority of safety and their commitment to ISMS in a policy statement that is compliant with ICAO Annex 19.

Agreement about the facts

Within ISMS, joint decision-making with respect to risks is based on shared information. The ICAO definition of safety risk is used: "The predicted probability and severity of the consequences or outcomes of a hazard." By gathering facts from occurrence reporting systems, databases with operational data (such as radar data and FMS data), expert judgement, and using safety models to evaluate accident probabilities, a common estimate of the probability of occurrence is determined. The Netherlands Aerospace Centre (NLR) makes a significant contribution with its specialized expertise in safety modeling.

To assess risks, a common risk matrix was developed in which the organizations plot the aggregated assessment of an interface risk. The application of the common risk matrix is shown in Figure 3.

The following steps are taken:

1. Identifying safety issues for assessment, including a fact base per safety issue (likelihood and severity of the event).
2. Assessing the safety issue against the individual risk matrices of the involved organizations.
3. Discussing the individual assessments, leading to an aggregated plot in the common risk matrix. The aggregated plot may reflect differences among organizations by drawing a box rather than a point in the common risk matrix.

Steps 2 and 3 are performed in a dedicated workshop in which several safety issues can be assessed.

Effective working process

The working process of ISMS strictly adheres to EASA and ICAO safety management principles, which are shared by all ISMS participants. In this way, many often theoretical discussions about the process are avoided. Within the EASA and ICAO framework, the working processes are detailed via a "learning-by-doing" approach: by starting to work together, the people involved develop effective working methods based on practical experience. Once a year, the developed ways of working are consolidated in an update of the ISMS manual.

The ISMS manual also contains the terms of reference of the sector SRB and the TOP SAG. To facilitate effective decision-making, the following terms were agreed upon:

- There are no replacements.
- Documents are distributed two weeks before the meeting.
- Meeting minutes are distributed within two workdays after the meeting.

These terms ensure that the right mandate is at the table and allow for thorough preparation and adequate follow-up of the meetings.

In addition, ISMS partners sign a covenant with the minister of Infrastructure and Water Management about the development of ISMS, including a milestone planning and yearly external evaluations of how ISMS is functioning.

Sound working relations

The parties at Schiphol are used to coordinating their operations in order to manage the airport. In the development of ISMS, the safety departments of the different organizations involved have become acquainted and learned to act as a team rather than as representatives from the own group. Within the task forces, a similar development takes place in which it becomes "normal" to work together on the basis of a joint mandate of senior management of different organizations. With the growth of aviation, the interdependencies among the aviation actors have increased. Therefore, the competence to establish productive working relations with other aviation parties has become increasingly important for the staff involved. This trend of "working within one's own organization" to "working within the sector" both supports and is reinforced by developments such as ISMS.

Road map safety improvement

In ISMS structure, safety risks are systematically identified, quantified, and resolved. The resulting safety improvement measures constitute the road map for safety improvement at Schiphol Airport, which is published on www.integralsafetyschiphol.com. The way the

Figure 3. Application of a common risk matrix.

measures address the Dutch Safety Board 2017 recommendations and a safety analysis performed by the NLR is presented on separate pages as well. The safety improvement road map is a document that aligns all parties on shared goals. It is also a working document, which means that new items will be added and statuses changed based on joint sector ISMS decisions and achievements. Road map items can be in different stages of development:

- Study phase: the measure is studied with respect to effectiveness of risk reduction, costs, duration, possible unintended consequences, etc. The result of this phase is a go/no-go decision by the TOP SAG on the implementation of the measure.
- Planning phase: the implementation plan of the measure is made, taking into account the dependencies with other developments.
- Implementation phase: the measure is being implemented.
- Evaluation phase: after implementation, the effects of the measure are determined and assessed.
- Status updates of the roadmap are published every half year. The first version of the road map contains studies and measures resulting from existing and new sector initiatives that originate from the recommendations of the Dutch Safety Board and measures proposed by the NLR.

Results

Since the start of ISMS, a number of results have been obtained. In June 2019 an evaluation of ISMS with the EASA Management System Assessment Tool (MSAT) was conducted by Baines Simmons safety consultants. The assessment concluded, "The overall performance of the management of safety within the ISMS, measured against present, suitable, operating, and effective as defined by the EASA Management System Assessment Tool is currently assessed as being at operating, which is above the global aviation industry average of high suitable, assessed by Baines Simmons with 22 assessments completed within the last three years. In the view of Baines Simmons, the current regulatory requirement [based on EASA Organizational General regulation] is at operating; however, few regulators are yet mature enough in their performance-based oversight programs to assess this accurately. Given the short amount of time that the ISMS has been in place to achieve an assessment of operating already is remarkable, and, furthermore, there are already some effective indicators in the ISMS that shows promise for the future development."

The following are examples of results obtained within ISMS:

- Joint incident investigations. Five incidents or accidents were investigated in ISMS. Not only are outcomes of individual investigations shared, but the facts and underlying analysis are carried out together. For example, in one case an airline human factors specialist made a situation awareness analysis of ATC in relation to a runway incursion. The joint investigations show that the involved organizations obtain a much richer understanding of the occurrence and that the investigations provide a common view on necessary improvements that may take place across organizations. Furthermore, it appeared possible that the organizations involved signed a nondisclosure agreement that precludes the shared information from being used for other purposes than improving safety. This is particularly important in the cases in which damages occur that may lead to claims between organizations involved.
- Joint risk analysis of flight operations and ground handling. For two large infrastructural investments at the Schiphol maneuvering area a joint risk analysis was carried out. This led to the initiation of two sector task forces to further reduce identified risks. In these risk analyses, several aspects are considered, such as workload for ground control, the complexity of the infrastructure for pilots, and options and limitations in the airport layout. As a result, safety issues are identified during the initial design stage that would normally become apparent when the project is in its implementation phase. This enables optimization of the design from an integral perspective rather than mitigating individual risks within constraints set by earlier design choices.
- Publication of more than 30 safety-improvement measures at Schiphol Airport. Some of these measures have already been realized; others are being implemented or under investigation. The following are examples:
  - Schiphol is equipped with a circumferential double-lane taxiway system, except for the current Quebec Taxiway on the A4 Highway. Schiphol and its partners will increase operational predictability, uniformity, and ground capacity by doubling the Quebec Taxiway. This will reduce the likelihood of on-ground safety occurrences.
  - ATC, the Netherlands is redesigning working stations in the tower. This will allow air traffic controllers to be positioned at the location most beneficial for their area of control, thereby reducing the likelihood of safety occurrences in the air and on the ground.
  - ATC, the Netherlands and Schiphol Airport have developed measures to further reduce the number of last-minute runway changes and the associated risks to prevent air and ground safety incidents. For instance, we maintain landing runways when an aircraft is in the Schiphol TMA. In addition, we use two departure runways when needed for a more stable traffic flow. We also use improved planning systems. These measures enable the percentage of last-minute runway combination changes to structurally decrease.
  - Aircraft following the routing to the beginning of Runway 18L (Aalsmeerbaan) pass intersection N2/E6. At that point, the traffic crosses Runway 09 (Buitenveldertbaan). Schiphol and its partners are creating a runway stop bar to prevent aircraft that erroneously turn right from taxiing via the Buitenveldertbaan Runway toward departing traffic. This will reduce the risk of runway incursions.
- The Runway Safety Team (RST) is a key component of ISMS. RST consists of a team of experts tasked with identifying ways to prevent runway incursions at Schiphol. According to ICAO, a runway incursion is any occurrence at an airport involving the incorrect presence of an aircraft, vehicle, or person on the protected area of a surface designated for the landing and takeoff of aircraft. The team continuously monitors trends to identify locations at the airport where there is a greater likelihood of runway incursions. This has resulted

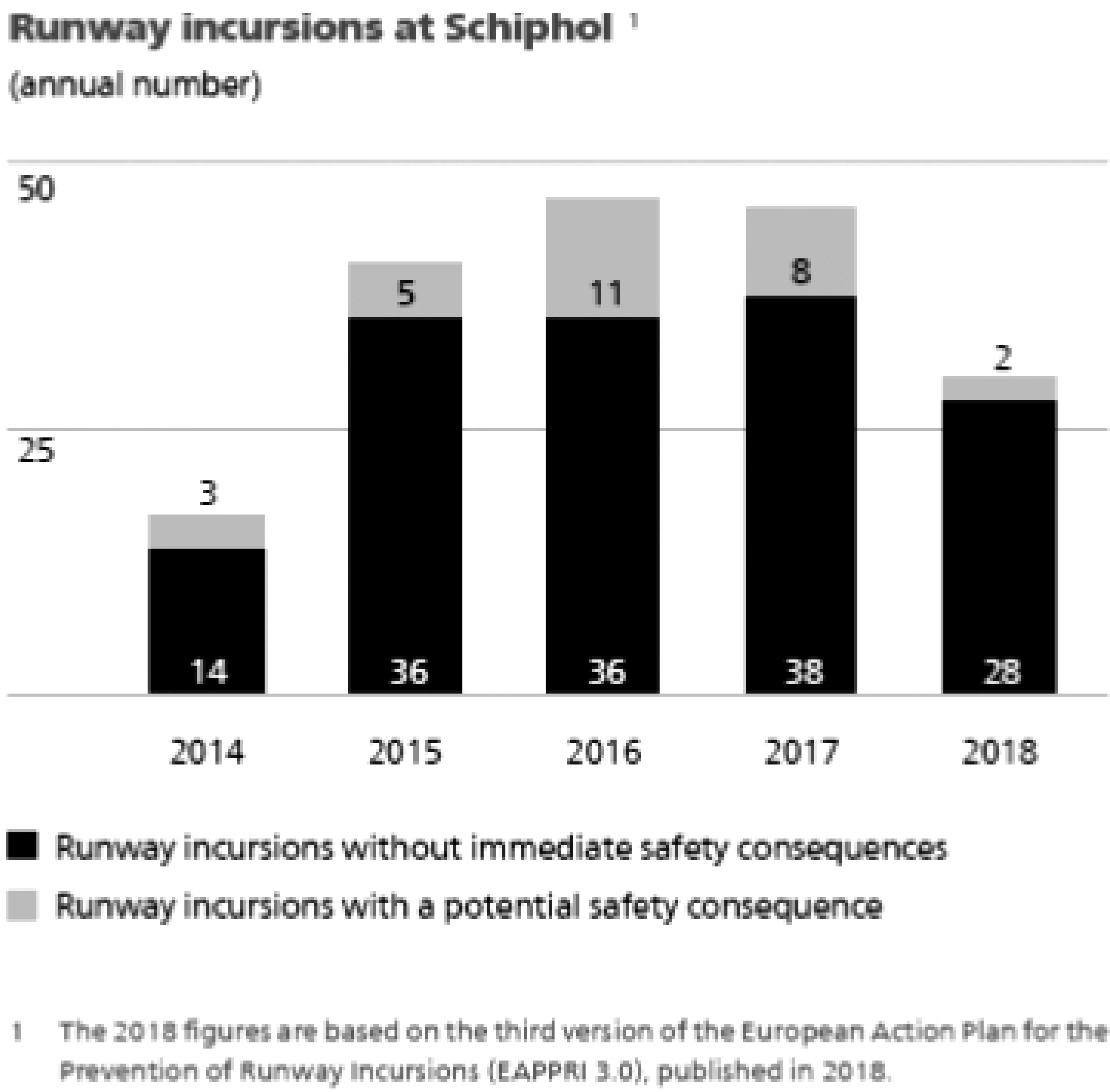


Figure 4. The number of runway incursions at Schiphol Airport.

in several ongoing studies and implementation projects aimed at structurally reducing the occurrence of runway incursions and the associated risks. In 2018, two runway incursions took place at Schiphol that had a potential safety consequence.

From Figure 4 it a can be concluded that the number of runway incursions has decreased since 2017. In 2019, a joint safety dashboard was further developed to monitor current safety performance, including the effects of safety improvement measures.

Conclusions

This paper detailed the development of ISMS at Schiphol Airport. It was shown that the aviation organizations at Schiphol have set up a cooperation framework to jointly manage interface risks across organizations. With respect to this cooperation, the following conclusions can be drawn:

- ISMS takes an integral approach to the management of safety interfaces at Schiphol Airport.
- The structure of ISMS mimics the best practices for SMS as described in ICAO Doc. 9859.
- Within ISMS, effective ways have been found to support multiactor decision-making on the basis of consensus.
- The overall performance of the management of safety within ISMS, measured against present, suitable, operating, and effective, as defined by the EASA MSAT, is currently assessed as being at operating.
- ISMS has produced significant output, including joint incident investigations, risk analysis, safety improvement measures, and initial safety performance improvements.

Based on the above, it can be concluded that ISMS is an industry-leading initiative, taking aviation safety at complex airports to the next level. ◆

SAFETY PROMOTION AT THE MANUFACTURER: ACKNOWLEDGING THE PAST HELPS ESTABLISH THE FUTURE

By Eric J. East, Air Safety Investigator, Boeing Commercial Airplanes

Introduction

Sharing safety information has been commonplace at Boeing Commercial Airplanes for half a century with the annual publication of Boeing's Statistical Summary of Commercial Jet Airplane Accidents. Dissemination of safety-related actions and procedures as they relate to our products is an integral part of our in-service safety process. Boeing participates in multiple industrywide proactive efforts across the global aviation community to share safety-related information and promote enhancements with organizations such as the Commercial Aviation Safety Team (CAST), the International Air Transport Association (IATA), the International Civil Aviation Organization (ICAO), state regulatory authorities, other manufacturers, and suppliers, as well as our airline customers. Although most of these efforts to enhance worldwide aviation safety culture are well known within the global aviation community, some aspects of safety promotion within Boeing may not be as apparent.

SMS—safety promotion

As a design and manufacturing organization in the United States, our voluntary SMS (safety management system) is based on the safety management framework defined in ICAO Annex 19, 14 CFR Part 5, and National Aerospace Standard NAS 9927. Safety promotion is one of the fundamental components of SMS as defined within ICAO Annex 19. Training, education, and safety communication are important elements of safety promotion intended to encourage a positive safety culture and enhance safety objectives within an organization. These elements of safety promotion are part of many existing business processes at Boeing Commercial Airplanes within our SMS. Through continuous communication, safety promotion enhances our proactive safety culture, which includes a commitment to both workplace and product safety. This core value is conveyed to employees in many ways. The opening of the Safety Promotion Center (SPC) at Boeing has allowed us a unique opportunity to both enhance our safety culture while sharing it with a broader audience outside of our company allowing others to learn more about aviation safety.

The SPC at Boeing

The SPC at Boeing was opened in Everett, Washington, U.S.A., in September 2017. Inspired by the Japan Airlines SPC, it combines content from significant aviation accidents as well as the history of safety within our processes and products since Boeing was founded in 1916. Sharing such safety information and lessons learned among different internal organizations that design, build, support, and operate our products is engrained in our safety culture. The center not only contains multiple exhibits that provide background on lessons learned from aviation tragedies and how they shaped the industry but also proactive activities including technological advancements and collaborative safety enhancement efforts across the industry. This helps to emphasize the importance of safety in all that we do as an industry by showing and discussing where we have been, where we are going, and why we must never be complacent in our pursuit of safety.

Guided and self-guided tours of the SPC are available to both internal employees and company visitors. Boeing safety professionals such as air safety investigators, airplane safety engineers, regulatory administrators, and environment health and safety specialists regularly serve as tour docents. The guided tours allow employee tour participants to learn how safety is embedded throughout the lifecycle of our products and the implications for their role no matter what their position is within the company (engineering, supplier management, quality assurance, etc.). The key components of SMS beyond safety promotion such as our safety policy and objectives, safety assurance, and safety

Figure 1. The Safety Promotion Center at the Boeing entrance exhibit.

risk management are also regularly discussed. Visitors are encouraged to share their perspectives on what safety means to them. These perspectives add to the displays available at the SPC. All visitors are encouraged to provide feedback not only to foster continual improvement of the experience but also to allow their safety messages to be shared with other visitors.

Safety is our responsibility

The first exhibit (see Figure 1) includes five watches that represent the moment when time stopped for the more than 1,400 lives who were lost in these aviation accidents: KLM Flight 4805 and Pan Am Flight 1736, Japan Airlines Flight 123, United Airlines Flight 232, American Airlines Flight 965, and Alaska Airlines Flight 261. Details of many of these events have been shared over the years through ICAO Annex 13 accident investigation reports as well as through excellent resources such as the Federal Aviation Administration's (FAA) lessons learned website. These events and others like them served as catalysts for implementation of safety enhancements to commercial airplanes and global aviation system. The circumstances of each accident are discussed during the tour, and insight is provided about the significance of the accident and how each changed our industry.

Many visitors (both internal and external to Boeing) have shared stories on how such events have affected their professional and personal lives and how important the commitment to safety is to them. Some share their experience and pride working to help design and build advancements on our products that arose from these events, while others have shared their difficult experience of being on site as part of these very accident investigations. Others have also shared the tragedy of losing a loved one in an aviation accident. This exhibit also contains an area that acknowledges recent tragedies such as the accidents in Indonesia and Ethiopia. The exhibit and the experience it evokes help convey the importance of safety in all that we do.

(Adapted with permission from the author's technical paper Safety Promotion at the Manufacturer: Acknowledging the Past Helps Establish the Future *presented during ISASI 2019, Sept. 3–5, 2019, in The Hague, the Netherlands. The theme for ISASI 2019 was "Future Safety: Has the Past Become Irrelevant?" The full presentation can be found on the ISASI website at www.isasi.org in the Library tab under Technical Presentations.—Editor)*

Figure 2. The safety evolution timeline.

PHOTOS: BOEING

Eric J. East

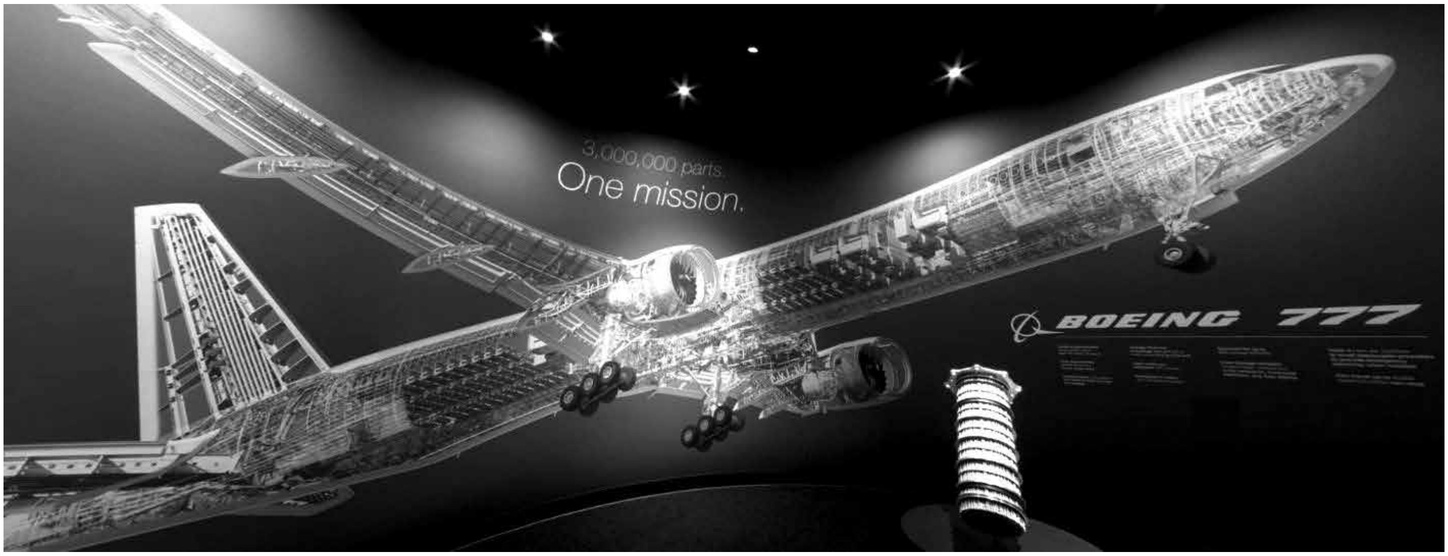


Figure 3. Safety as a mission exhibit.

Evolution of safety

The tour continues with an exhibit that shows how workplace and aviation safety has evolved at Boeing over its more than 100-year existence. A timeline format (see Figure 2, page 11) allows visitors to learn about safety innovations on our products such as instrument landing systems, flight data and cockpit voice recorders, ground proximity warning systems, traffic collision and avoidance systems, and electronic checklists. Some of these innovations are discussed in detail in other exhibits. Several historical artifacts are also on display in this area. One exhibit shows how employee innovations helped keep our employees safe during production in the 1940s, while another shares how the B-707 introduced commercial jet aviation in 1958. The advent of extended-range twin-engine operational performance standards (ETOPS) into commercial aviation is also discussed, including the design, maintenance, and operational aspects that work together to ensure reliability and safety.

One mission

The central exhibit includes a view of a B-777 airplane as well as a single fuel-oil heat exchanger (see Figure 3) in the center of a large theater-like room. This exhibit shares information concerning British Airways Flight 38, which landed short of the runway at Heathrow Airport in 2008. This event illustrates the collaboration that takes place during an accident investigation among the investigating authorities, the airline, regulators, and manufacturers. Discovering, understanding, and eliminating the circumstances of ice accumulation that occurred took a tremendous effort by all involved.

This effort, along with the laboratory replication of the system and environmental conditions, is conveyed to visitors. The interim operational actions taken to keep the affected fleet safe is discussed along with the redesign incorporated on

Figure 4. Safety by the numbers exhibit.

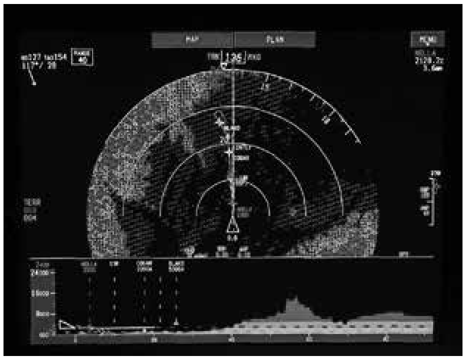


Figure 5. B-787 TAWS display.

Figure 6. Modern fuselage exhibit.

the hardware displayed in the exhibit. Visitors who may have little to no experience regarding Annex 13 investigations gain a greater appreciation for the collaborative process and the commitment it takes to understand what occurred in such an event and to prevent it from reoccurring.

Also included in this central exhibit are a series of quotes representing different employee roles that express the importance of safety in each role. This area is particularly impactful to help individuals new to the company and the more experienced employees share some of what they do in their jobs. This in turn prompts discussions about, and drives awareness of, the elements of SMS they use in their day-to-day work.

Exponential success

While the level of safety in commercial air travel is well understood by aviation safety professionals, the tireless work of maintaining and improving this safety record can be difficult to explain to those outside of our industry. The exhibit shown in Figure 4 illustrates the exponential growth of our industry and the dramatic reduction in the number of onboard fatalities in commercial aviation. This number continues to reduce by roughly half for every 200 million flights accrued by the commercial fleet. While this graphic shows data of 700 million commercial flights as of 2015, since that time the number of flights has grown by almost another 200 million. This continued growth reinforces the need for the industry to remain diligent in all that we do to work together proactively to prevent aviation tragedies no matter the current level of safety.

Collaborative success

One success story of how industry collaboration can affect change within the world of aviation safety is CAST. This team of industry and government stakeholders came together in 1997 with the goal of reducing the fatal accident risk in U.S. commercial airline operations by 80% within 10 years. This goal was achieved by reaching an 83% reduction, which was recognized by the National Aeronautic Association (NAA) by awarding CAST with the 2008 Collier Trophy that is on display.

This achievement and Boeing's continued participation in this combined effort, as well as the important efforts of some of the many other organizations that promote safety across the world, are shared with visitors. Details about these organizations such as CAST, the Flight Safety Foundation, ICAO, RTCA, SAE, as well as the FAA and the National Transportation Safety Board (NTSB) are available on touchscreens in the exhibit. These examples help to show the history of success in working together and that the aviation industry does not compete on safety.

Safety in technology and design

Throughout the SPC, many different areas of technology advancements are on display that have enhanced aviation safety across the industry. Some of the interactive displays include information on ground and terrain awareness. Information on related aviation accidents such as the Marshall University tragedy in West Virginia, U.S.A. (1970), Tenerife (1977), and Cali, Colombia (1995), are provided. The adoption of ground proximity warning systems (GPWS) over history and more recent enhanced GPWS and TAWS (terrain awareness and warning systems) are discussed. In addition, the huge impact these systems have had on the reduction of CFIT (controlled flight into terrain) accidents is shared along with how airplane systems detect and display this information on the B-787 flight deck (see Figure 5).

The adjacent exhibit highlights improvements in crashworthiness and the evolution of cabin interior design. Different aspects that work together to improve survivability of an accident are displayed. The structural strength of the airframe along with structures and systems that incorporate cargo smoke detection and suppression, fireworthiness and reduced smoke/toxicity of interior materials, engine fire detection, emergency lighting, seat strength, and evacuation systems all work together to help protect passengers and crew. An example of the effectiveness of these features is discussed in regards to a 2008 Continental Airlines accident in Denver, Colorado, U.S.A., in which an external fire consumed much of the airplane's aluminum skin while the cabin interior continued to be protected. Many individuals who do not have an engineering or airline operations background find this exhibit especially informative as much of this info is displayed in a fuselage cross section view (see Figure 6), which shows how the familiar and visible cabin interior fits within the overall airframe.

Safety begins with all of us

The final exhibits of the SPC provide information concerning safety in the workplace before transitioning to the sharing of safety messages. Several displays show the processes, procedures, physical controls, and areas of employee engagement that are utilized to help keep everyone safe in production environments such as the factory floor and flight line ramp. Innovations on display include an interactive fall-protection interlock device for working at height during paint hangar operations. Advancements in virtual-reality design tools are discussed along with how they are used in airplane development to help factory mechanics and airline maintenance personnel build and service airplanes. Video displays provide team member stories of recent aviation safety and workplace safety team success. There is an area dedicated to those recognized as our safety heroes such as the legendary Joe Sutter. Because the SPC was inspired by its dedication to safety, Japan Airlines donated a message that is displayed as follows:

> “Safety is our very foundation and social responsibility. We shall combine our utmost knowledge and capabilities to ensure safety in every single operation each day.”
> —Japan Airlines

Not only do we encourage all visitors to share their thoughts on their experience through an electronic survey, we also encourage visitors to share their safety message as Japan Airlines did so others can learn from it. A series of touchscreens are available that facilitate the entry of a safety message. The messages that others have left are also continually displayed on these screens (see Figure 7).

We end the tour by focusing on the importance of bringing everyone home safely. For Boeing employees, this includes a personal commitment to safety. Whether it be a workplace safety hazard or airplane safety issue, employees are encouraged to communicate their concerns to their leaders or through internal reporting system websites that are provided in the SPC.

Educating the future

Some internal groups utilize the SPC for safety meetings while others participate in guided tours as part of the training curriculum for their new employee onboarding process. New team members get to share the experience of learning about historical safety enhancements in the areas of an airplane they may help design, build, or support as well as those areas they may be less familiar with. This usually takes place in an environment in which both experienced leaders and peers help add to these discussions in an organic, nonprepared slideshow-free manner. From an accident investigation perspective, we utilize the SPC as part of the training curriculum for new investigators as well as the engineering personnel and leaders who support us.

There have also been many opportunities to share the information presented in the SPC with other partners and colleagues in the global aviation community as well as members of the local community. Many different airline customers, aircraft and engine manufacturers, foreign and domestic aviation regulators, suppliers, accident investigation authorities, and members of the ISASI Pacific Northwest Regional Chapter have visited the SPC since it was opened. NTSB members and legends in the aviation community such as Don Bateman have also visited and shared their feedback. Most of our external industry guests have commented that their organizations could benefit from such a safety-focused center. In the summer of 2018, the Boeing Everett site held an open house during which access to the SPC was provided to the families of our employees. There was no need to provide any guided tours as employees themselves actively shared their experiences and the importance of their work as they led their families throughout the exhibits.

Summary

Our hope is that visitors experience something meaningful that they can learn from and take back to their internal workgroup or external colleagues to ensure the lessons learned that have shaped our industry are not forgotten. Many of our diverse visitors have exhibited this through our safety message interface. By sharing what safety means to them, they help enhance our culture of safety as well as that of our future visitors. ◆

Figure 7. Safety message displays.

The following essay is the third of four from the 2019 Kapustin scholarship winners that were presented during ISASI 2019. 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

Challenges of Investigating Language in Aviation Accidents:

How Applied Linguistics Can Revel Subtle Communication Errors

By Alexander P. Hall, Embry-Riddle Aeronautical University

For Air Safety Investigators (ASIs), the 1977 tragedy of the collision of KLM Flight 4805 and Pan Am Flight 1736 at Tenerife is well known. The accident revealed the catastrophic consequences of miscommunication between pilots and air traffic controllers. In 1996, a mid-air collision of Saudi Arabian Airlines Flight 763 and Kazakhstan Airlines Flight 1907 led the International Civil Aviation Organization (ICAO) Assembly to discuss language proficiency requirements (LPRs) after the Lahoti Commission indicated that a lack of English language proficiency of the Kazakhstan flight crew was a contributing factor in the accident (Centre of Disaster Management). ICAO Resolution A32-16, Proficiency in the English Language for Radiotelephony Communications, was adopted by the ICAO Assembly in 1998.

A significant aspect of these two accidents is that the flight crews of both aircraft as well as the air traffic controllers were English as a second language (EL2) speakers. Past literature in aviation communications was focused on miscommunications of native speakers, but the focus has shifted to EL2 speakers as the number of multicultural flight decks is increasing in the aviation industry. Therefore, it is increasingly important to adequately identify language factors in accident and incident reports. Investigating language in aircraft accidents has posed a significant challenge for ASIs because of its complexity and the lack of a common investigative approach for recording and analyzing language factors. The future of aircraft accident investigation will need to incorporate applied linguistic subject-matter experts (SMEs) into investigations where language has potentially played a role.

Alexander P. Hall

Applied linguistics in aviation

Language can be understood as a system for conveying thought within a group of individuals. Linguistics, the study of language, seeks to "explain and describe how this system works, what are its components, what are relations between such components," etc. (Borowska, page 52). Furthermore, applied linguistics extends the field of linguistics by concerning itself with the "theoretical and empirical investigations in which language and communication are central issues," meaning it explores problematic language usage in real-world situations.

Applied linguists began researching aviation English (AE) after a series of fatal aviation accidents in the 1980s. AE is the de facto lingua franca (working language) used to communicate in aviation around the world. AE is a narrowly defined version of English that is generally divided into two categories—"standard phraseology" and "plain language." Standard phraseology is a "prescribed, highly constrained set of phrases to be used…in all radiotelephonic communications between controllers and pilots" and includes "special pronunciation and syntax, as well as discourse and dialogue structures" (Estival, Farris, and Molesworth, page 17). Phraseology was designed to efficiently deliver communication in short, disjointed phrases without losing clarity. Language proficiency requirements are not only a concern for commercial aviation, but for general aviation and other sectors as well. Plain language describes the use of English for communications that are beyond the scope of standard phraseology, such as in emergency or other unusual situations.

Challenges of implementing ICAO LPRs

Miscommunication has been an issue for a long time, but it wasn't until the 32nd session of the ICAO Assembly that language proficiency issues were acknowledged by the international community. Resolution A32-16 led to the development of the first edition of the ICAO Doc. 9835, Manual on the Implementation of ICAO Language Proficiency Requirements, in 2004, which sought to assist member states' efforts to comply with the new LPRs (Popa, 2019). However, the issue that persists today lies in the implementation of the LPRs.

As indicated by Popa, "users of the Manual on the Implementation of ICAO Language Proficiency Requirements have indicated that more detailed guidance on language testing

Language Skill Required:	Speaking / Listening	Reading	Writing
Personnel	Only those communication requirements in BLUE are governed by ICAO Standards		
Pilots: Professional	• Pilot-controller • Pilot-pilot, CRM and flight deck communications • Pilot-PAX • Pilot-ground crew • Pilot - Sim instructor	• Aircraft and Operating Manuals • Quick Reference Handbooks • Safety updates and briefings • CBT training devices • Safety materials. • Training materials • Datalink • Flight Management Systems.	• Datalink • Maintenance reports
Pilots: ab initio	• Cadet - ground instructor • Cadet - flight instructor • Cadet - controller	• Training materials • Aircraft Manuals • Safety updates and briefings • CBT training devices • Safety materials.	• Tests
Maintenance Technicians: Professional	• With pilots • Other ground crew • Aircraft manufacturer representatives • Maintenance controllers	• Aircraft manuals • Safety updates and briefings • Training materials • CBT training devices • Safety materials • Training materials	• Records and reports
Maintenance Technicians: ab initio	• Instructors	• Training materials	• Tests
Controllers: Professional	• Controller-pilot • Ground staff • Emergency services	• Training materials • Safety updates and briefings • CBT training devices • Safety materials	• Reports • Datalink
Controllers: ab initio	• Cadet - instructors	• Training materials	• Tests
Cabin crew: Professional	• Passengers • Pilots	• Manuals and learning materials. • Equipment instructions. • Safety updates.	• Reports
Cabin: ab initio	• Instructors	• Training materials	• Tests

Table 1: English Use in Aviation, Where English Impacts Safety

Note: Data is unpublished from Elizabeth Matthews (2019).

is needed to effectively implement the language proficiency requirements" (2019). Civil aviation authorities (CAAs) are not familiar with English language training and testing, and these industries are largely unregulated. Moreover, there is a lack of standardization of these industries if ICAO member states have different levels of implementation.

The only obligation that CAAs have in order to comply with ICAO standards is to certify that personnel have at least an operational language proficiency Level 4. In the Brazilian Aeronautical Accident Investigation and Prevention Center's final report on the 2006 midair collision between Gol Transportes Aéreos Flight 1907 and an Embraer Legacy 600 business jet, Brazilian ASIs documented that many of the air traffic personnel received English training at different providers.

More importantly, a majority of the air traffic controllers and supervisors received nonsatisfactory English evaluations. Elizabeth Mathews, a core contributor to the ICAO English LPRs, states, "The information regarding controller English language proficiency [in the report] is unclear and nonstandardized" (2012). This is due to the absence of a global, comprehensive system in place to ensure that all English testing and training providers operate under similar definitions for English language proficiency. ASIs do not have the resources or the knowledge to evaluate language training and testing, so citing potential weaknesses of an English-training or English-testing provider is beyond the scope of a typical investigation. An applied linguistic SME can assist in these evaluations, and recommendations addressing these weaknesses can be produced.

ICAO has issued standards and recommended practices (SARPs) on verbal communication in ICAO annexes related to pilot and air traffic controller licenses, yet many other aspects of language remain unaddressed in ICAO policy (Mathews, Pacheco, and Albritton, 2019). As we can see in Table 1, ICAO has only issued SARPs pertaining to pilot-controller communications; however, ab-initio training, quick-reference handbooks, training manuals, etc., are usually presented in English, but there are no English testing requirements for reading or for flight training.

Not only is this problematic for aviation safety, but ASIs cannot determine if deficiency in English reading skills played a significant role. For example, the investigation report for the Merpati Nusantara Airlines Flight 8968 accident cited that the "flight crew operation manual and aircraft maintenance manual used nonstandard English aviation language" within its findings (National Transportation Safety Committee). There is no evidence to support that this had any significance, but it is an issue that cannot be overlooked.

Cockpit voice recorder transcripts

Typically, cockpit voice recorder (CVR) audio recordings are not released publicly, so a transcript is produced for documenting the last 30 minutes of communication. Consequently, transcripts are accompanied by a loss of information because there are several linguistic elements left out of the final written account. Farris cites that accident investigation CVR transcripts have limitations in research as "transcripts are not created by researchers for the specific purpose of studies in controller-pilot communications, and are therefore perhaps not sufficiently accurate and detailed for a full analysis of language-related miscommunication events" (Estival, Farris, and Molesworth, page 126).

Evidence such as speech rate, intonation, speech intelligibility, phrasing, and degree of accent are not recorded in the report. Mathews reported that the cockpit voice recording of the Embraer flight over Brazil "revealed brief but compelling evidence of probable English language insufficiency" during an exchange between the Sector 5 controller and the Legacy pilots that was not noted in the CVR transcript (2012). The message provided by the controller was standard phraseology but included long, drawn-out pauses and hesitations, which was further complicated by "an accent not easily understood by the Legacy pilots" (Mathews, 2012). An applied linguistic SME can record this communication difficulty by using special symbols to denote pauses and various other elements. The communication difficulty was made apparent when one of the Legacy pilots exclaimed, "I've no idea what the hell he said" (Mathews, 2012). CVR transcripts can be rich sources of evidence if an applied linguistic SME provides support in the transcription; otherwise, evidence of language as a contributing factor may be lost.

Conclusion

Miscommunication has and will continue to play a role in aviation accidents and incidents. Great strides have been made in the international civil aviation community to address concerns of how to successfully implement the ICAO LPRs. Organizations like the International Civil Aviation English Association hold conferences and workshops emphasizing best practices for training and testing of AE. Additionally, more literature concentrated on an applied linguistics approach to analyzing AE has been increasing in recent years. ASIs, however, are still left with a monumental task of relating language proficiency to the series of latent failures leading to an accident. If ASIs employ applied linguistics in the investigation of language factors, then useful data and analysis can be provided for further research into the effect of language in miscommunication. ◆

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THEMES AND SYSTEMS SAFETY INVESTIGATIONS

PROACTIVELY INVESTIGATING FOR SYSTEM SAFETY IMPROVEMENTS

By Daniel Foley and Matt Harris, co-developers of the Civil Aviation Authority of New Zealand's Themes and Systems Safety Investigation Methodology and New Zealand Civil Aviation Authority Safety Investigators

Aviation safety has seen major improvement over the last century due to the undertaking of safety investigations. The early focus was toward technical issues, with developments in design and manufacturing providing improved reliability.

As safety investigation matured, the focus shifted toward understanding human error, leading to crew resource management (CRM). We then began to understand that organizational latent factors were contributing to accidents (the Swiss cheese model).

Traditional investigation approaches are effective at identifying what barriers failed and what particular set of circumstances led to the accident.

As a risk-based regulator, the Civil Aviation Authority (CAA) of New Zealand uses the themes and systems safety investigation (TSSI) methodology to help it understand complex problems.

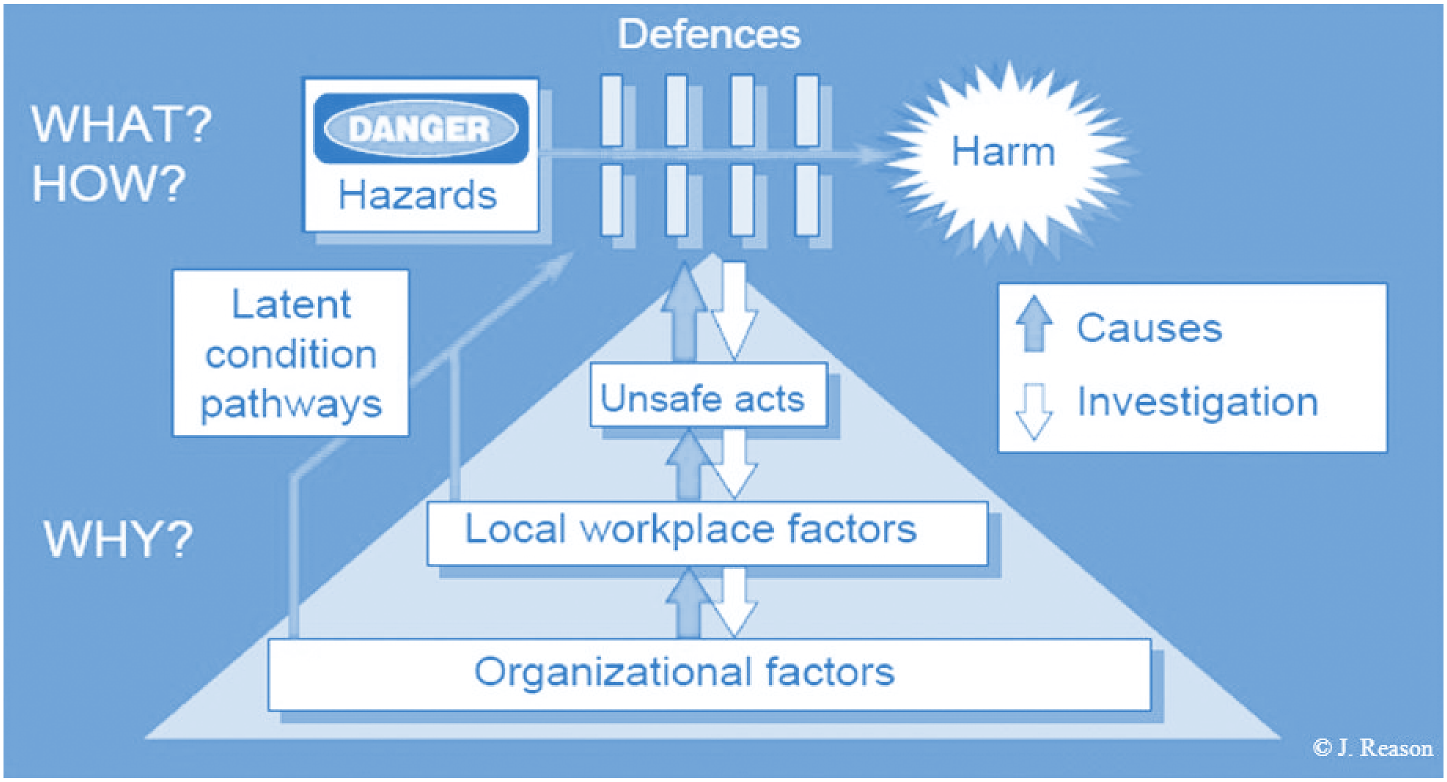
The CAA conducts approximately 350 event-based safety investigations annually from a reported 9,500 occurrences. The benefits that can be gained from these event-based safety investigations, however, have their limitations. Safety investigators may wish to consider that greater safety benefits can be realized beyond the constraints of the causal chain of events. As such, the CAA developed the TSSI methodology.

Introduction

As a regulator, the aim of the CAA is to improve aviation safety before accidents happen rather than retrospectively after they occur. As such, the safety investigation unit at the CAA has been developing an approach that is more proactive rather than reactive. To this end, we have developed TSSI, which complements and works symbiotically with the traditional event-based Annex 13 investigation that still forms a crucial part of our work.

In this paper, we outline the process of initiating and conducting proactive TSSIs and the benefits such investigations can deliver. We describe the TSSI approach and explore the indicators that point to where such an approach is warranted. We conclude with a case study from New Zealand that showcases the TSSI process: the unravelling of a complex problem, the identification of the way the system is working in practice, and the tailored interventions employed.

Figure 1: Model of organizational accidents.



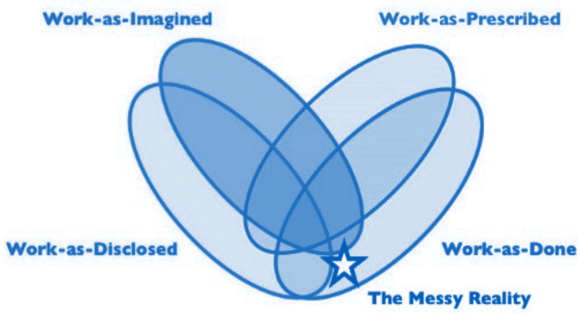


Figure 2. Types and perception of work.

Traditional safety

The CAA of New Zealand is slightly different from other regulators and accident investigation bodies around the world. All aviation accidents, serious incidents, and many other aviation occurrences have to be reported to the CAA under the provisions of Civil Aviation Rule Part 12. Part 12 provides a level of protection to aviation participants that report their occurrences to the CAA. This is done in line with just culture principles. As such, the CAA receives approximately 9,500 reported occurrences a year. That makes the CAA data rich, with a relatively sterile pool of information. Out of the 9,500 occurrences reported annually, the CAA conducts approximately 350 event-based safety investigations and upward of four TSSI investigations annually. In New Zealand, this data has facilitated proactive engagement between the CAA and industry, enabling threats to the system to be tackled in a collaborative manner.

The CAA aims to be an intelligence-driven, risk-based regulator and as such looks to identify and manage risks to the aviation system through its regulatory safety management system. The TSSI dovetails with this work, providing the CAA with a way to examine and investigate complex problems, facilitate the implementation of tailored interventions, and provide the intelligence with which to measure the effectiveness of those interventions.

Taking a wider look at the global and historical context, we can see that worldwide aviation safety has seen major improvement over the last century due to the undertaking of safety investigations. That's great news and a reflection of the commitment over the years that safety professionals have made. Early safety focused on technical issues with developments in design and manufacturing providing improved reliability. As safety investigation matured, the focus shifted toward understanding human error, leading to improvements like CRM. We then began to understand that organizational latent factors were contributing to accidents.

Figure 1 illustrates a traditional investigation approach that is effective at identifying what barriers failed and what particular set of circumstances led to an accident. We would typically see failed barriers such as inadequate oversight, poor procedures, human error, and the list goes on. This type of accident investigation model is outcome-focused, which makes sense; there has been an accident or an incident so we want to know what caused it.

However, this outcome focus has led to a worldwide game of "whack-a-mole," reacting to problems as they pop up, focusing on individual events and only sometimes grouping outcomes together to look for trends. There is a heightened focus on human error and the overly simplified view that if we control people's behavior, and they pay attention and comply, all will go well. More recent thinking in the safety sector suggests that this view is outdated.

Professor Sidney Dekker, in his book *A Field Guide to Understanding Human Error*, argues that human error is not a cause, but a symptom, of wider system issues, and we would agree. If we want to move away from the reactive game of whack-a-mole and gain a deeper understanding of what went wrong, we need to look at things differently. If we, as safety professionals, hear the term human error, it should raise a flag that we need to take a deeper look. This is where we can gain safety benefit. This is a starting point, not an end point.

As an industry, we have, in theory,

(Adapted with permission from the authors' technical paper Themes and System Safety Investigations (TSSI): Proactively Investigating for System Safety Improvements *presented during ISASI 2019, Sept. 3–5, 2019, in The Hague, the Netherlands. The theme for ISASI 2019 was "Future Safety: Has the Past Become Irrelevant?" The full presentation can be found on the ISASI website at www.isasi.org in the Library tab under Technical Presentations.—Editor)*

Daniel Foley Matt Harris

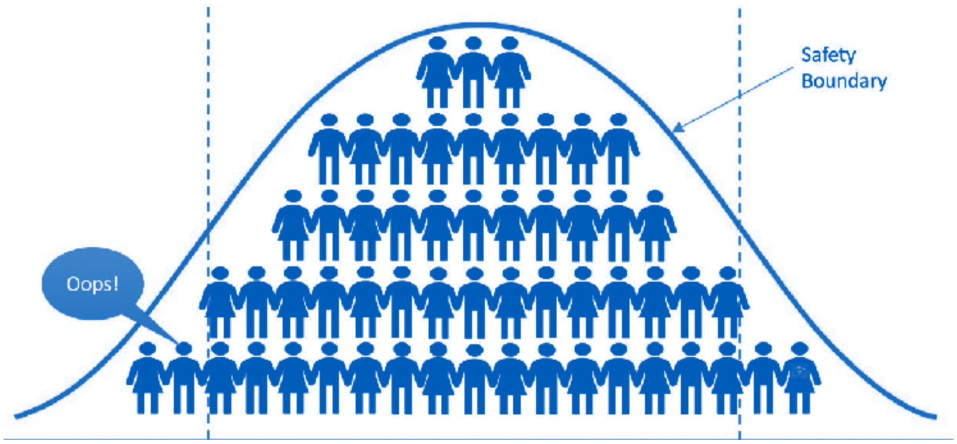


Figure 3. Safety I to Safety II.

moved on from terms like pilot error or more generally human error. This is in recognition of the fact that the term "error" is hindsight-biased. It has no explanatory power and fails to account for the fact that people do things that make sense to them at that time. An action can only be judged as an error after the fact and knowing that the outcome was adverse. We believe that the raw term human error, as well as terms like "should have," "could have," and "would have" are not helpful in safety investigation. They attribute blame or fault, and blame is the enemy of safety. In practice, however, statements such as "the pilot lost situational awareness" or "the PIC became complacent" still find their way into aircraft accident reports. Based on the criteria above, these phrases are essentially just another way of saying human error. A pilot can only be judged to have lost situational awareness retrospectively and if the outcome was adverse.

A different perspective

Safety professionals need to take a more mature viewpoint and understand that individuals and teams will adapt to the dynamic environments that they work in and that people make decisions that make sense to them at the time. This is known as "work-as-done." To be a higher performing industry, we need to be mature enough to realize there is a difference or "drift" between what we think should be happening (work-as-expected) and what is actually happening (work-as-done) and that this drift is due to system factors.

Figure 2, page 19, illustrates the overlap and, perhaps more importantly, the discrepancies between the way work is conducted in complex systems: work-as-expected, work-as-prescribed, work-as-disclosed, and work-as-done. Note that "messy reality" often sits somewhere near the intersection of all of these but may not cross into the "prescribed" area, suggesting that merely having the controls in place and expecting people to comply is unrealistic and insufficient for improving safety.

We need to understand work-as-done from the point of view of the individual doing that work, not just what we think should have happened. This will help us gain a deeper understanding and provide us with an appropriate amount of clarity of what is actually happening so that we can be proactive in our approach.

We can, of course, investigate and determine that people are not working as expected—"not following the rules, etc." and train them to do so the next time. But perhaps we need to begin to shift our perspective to gain a more comprehensive understanding of why they are not working as expected.

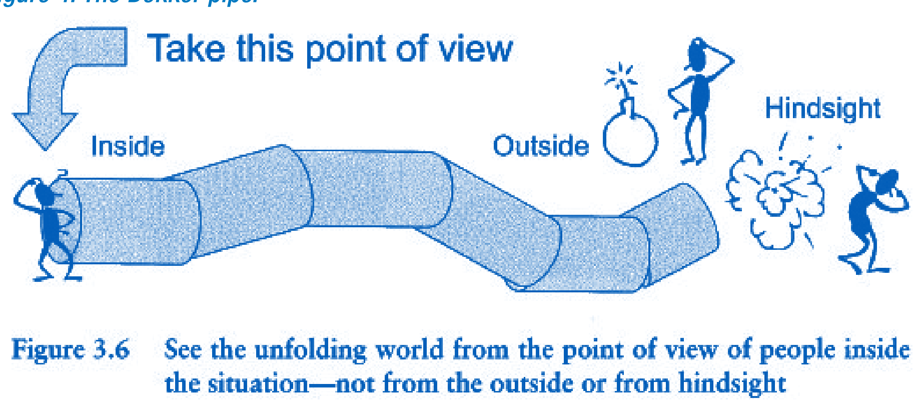
We have identified five themes underpinning the complex system safety thinking that have informed this approach:

1. Safety is created through practice and proactively equipping people to succeed.
2. People are both important safety barriers and sources of recovery.
3. The system is not inherently safe, but people can create safety in complex systems.
4. Success and failure come from the same source—normal/ordinary work.
5. Accidents are often the result of interactions among components in complex systems that are all satisfying their individual requirements. This does not mean the components themselves have failed. Failure is an emergent property of the overall system factors.

Consider Figure 3, remembering that success and failure come from the same source—normal/ordinary work. We normally look at what went wrong on the left-hand side of this diagram. Or we consider the positive outcomes on the right-hand side. Capt. Chesley "Sully" Sullenberger is a prime example of this. However, both viewpoints are outcome-focused. What we need to understand is the actual work-as-done and identify precursors to indicate whether things are moving left, toward failure, or right, toward success. We need to consider things from the point of view of those involved in the actual operation.

We stated previously that people do things that make sense to them at the time. This encapsulates what is known as the "local rationality principal"—people do the most reasonable thing in a given context according to their goals, knowledge, and focus of attention. To understand why a person might have made a

Figure 4. The Dekker pipe.



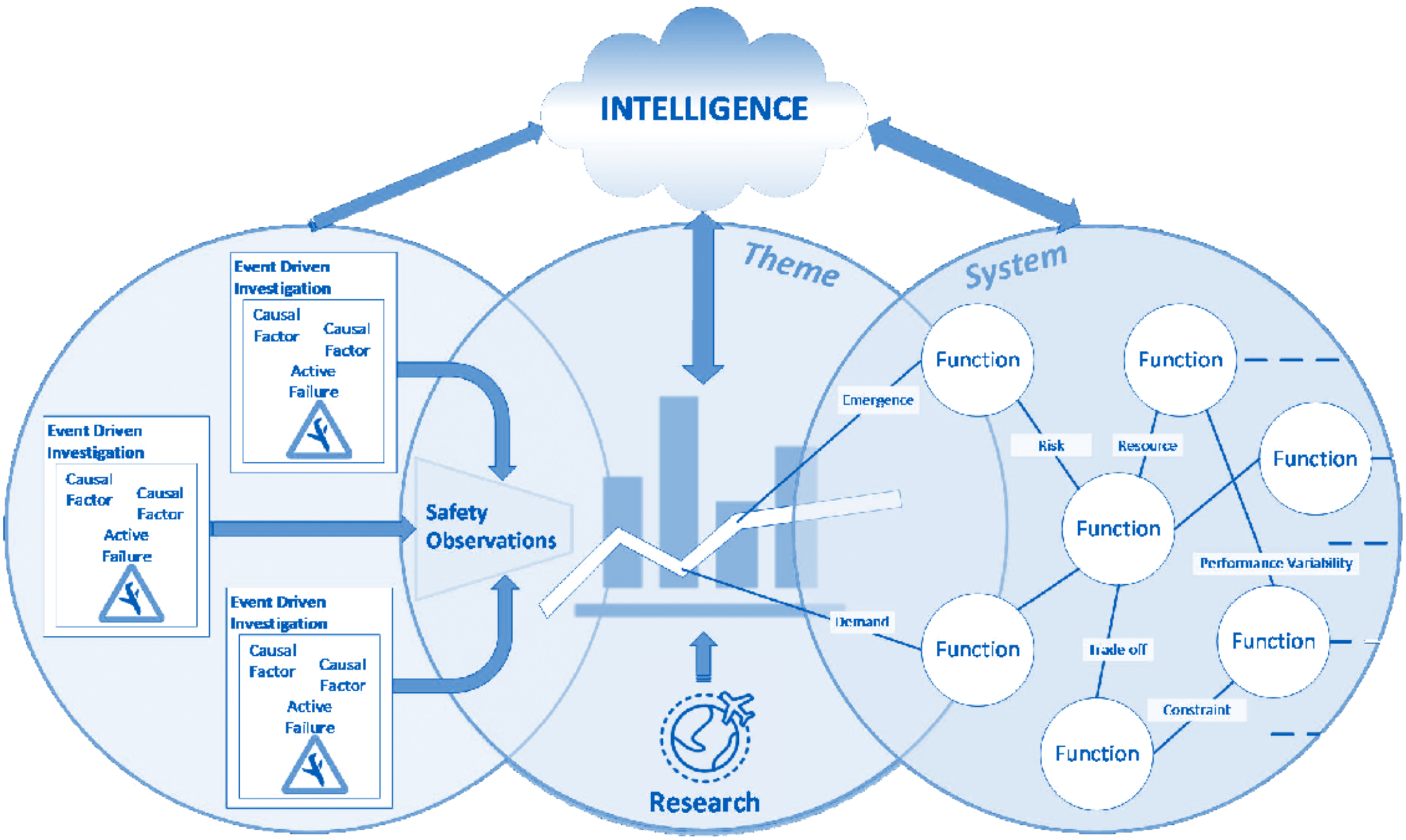


Figure 5. Emergent problem investigation lenses.

particular decision, we therefore need to understand

– What the person was trying to achieve (and whether there were multiple goals in conflict with one another).

– What knowledge the person possessed at the time.

– How the system influenced the assessments and actions being carried out.

"The Dekker pipe," shown in Figure 4, illustrates what we need to do to gain this crucial understanding of why a certain decision was made.

For instance, after an accident we can look retrospectively at the event—taking the outside view in the top and bottom right side of the diagram. If we take this view, it leaves us susceptible to the two predominate biases: hindsight and outcome bias.

Hindsight bias is exemplified by questions such as: "They had all this information, why didn't they just do that?" while outcome bias is shown, for example, by categorizing something as "a poor decision." It is easy to identify a decision as poor when we can also see the adverse outcome; however, no one sets out to make a poor decision. Indeed, they may have made similar decisions previously that did not have the negative outcome, and thus based on the evidence of their previous experience, their decision may not appear to be "poor" at the time.

To understand the rationale behind a decision, we need to take the "inside" view. To do that, we must attempt to put ourselves in the person's position, to see things from his or her perspective, and to find out what made sense to them at the time. We need to reconstruct the actual changing circumstances or environment that the person was working in. We need to be aware that there is a strong two-way relationship between circumstances and behavior.

> "Hindsight is a wonderful thing, but foresight is better, especially when it comes to saving life, or some pain!"
> —William Blake

A different perspective in practice

The CAA safety investigators use these principles when conducting either an event or a TSSI-based safety investigation. When conducting an event-based investigation, we focus on what has happened and why for a specific event or events. This is similar to the Annex 13 approach, and we acknowledge that this is the foundation of safety improvement. A TSSI compliments and builds on this approach.

During a TSSI investigation, the team of investigators takes a holistic view, often without an accident occurring. A TSSI investigation can be commenced to understand what impact there may be if, for instance, the system is modified and determine if there will be any unintended consequences. It will also allow the monitoring of the system change. This is proactive in nature.

There is no standard road map for a TSSI investigation. The beginning of a TSSI starts with designing the approach or structure to be employed in each case. It also involves using historic data, reclassifying the data to make it consistent and relevant in today's context.

Moving now from the theoretical to the practical, we will explore the ways

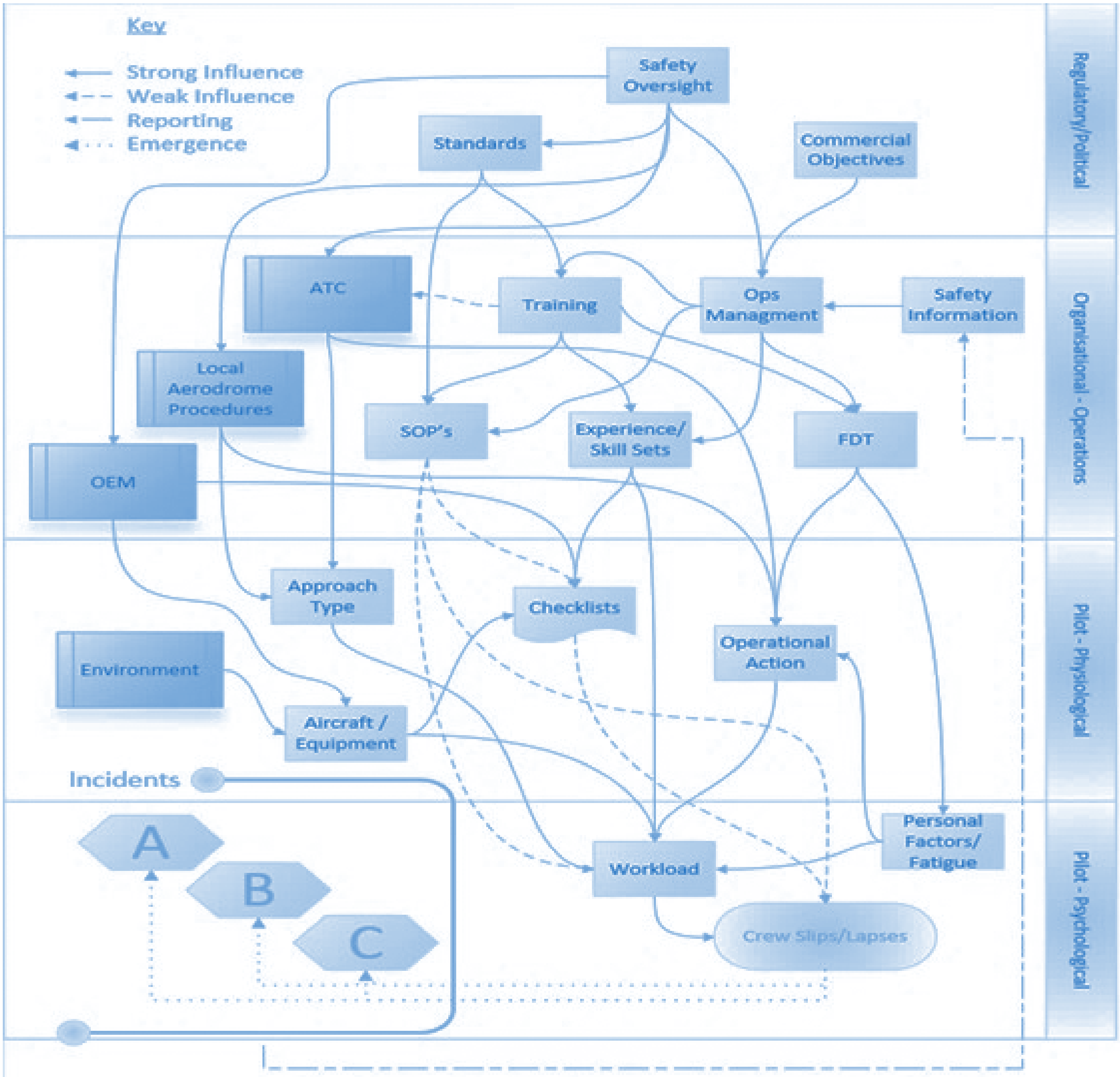


Figure 6. System influence map.

in which the CAA conducts investigations or, more specifically, how we solicit information to provide clarity about a problem, which is then applied to our risk-based principles.

When faced with a problem, we have three possible lenses we can apply to it, as seen in Figure 5, page 21. These are an event lens, a themes lens, and a systems lens. We can employ any or all of these lenses to a given problem in order to provide clarity on how that problem has emerged.

Let us first look at the event lens. Following an occurrence, the team will conduct a safety investigation, in a similar manner to the traditional Annex 13 type of investigation. We would typically look at the human, the machine, and the environment and how these pieces of the puzzle interact and the potential survivability of the occurrence. We identify the active failure and any latent failures that may have been present. Any safety deficiencies are addressed through safety actions or interventions to fix the problem. Where we may differ from other investigating agencies is that we also seek to identify precursors. Precursors can be defined as those factors that preceded an event and may have adversely affected an element or elements involved in the event but on their own may not necessarily cause the event. Precursors are generally grey in nature and as such are harder for safety investigators to deal with. They lack the black and white evidential level on which safety investigators base their conclusions

In a themes investigation, we start to group precursors together and look for patterns. We are not outcome-focused. For example, say we investigate a runway

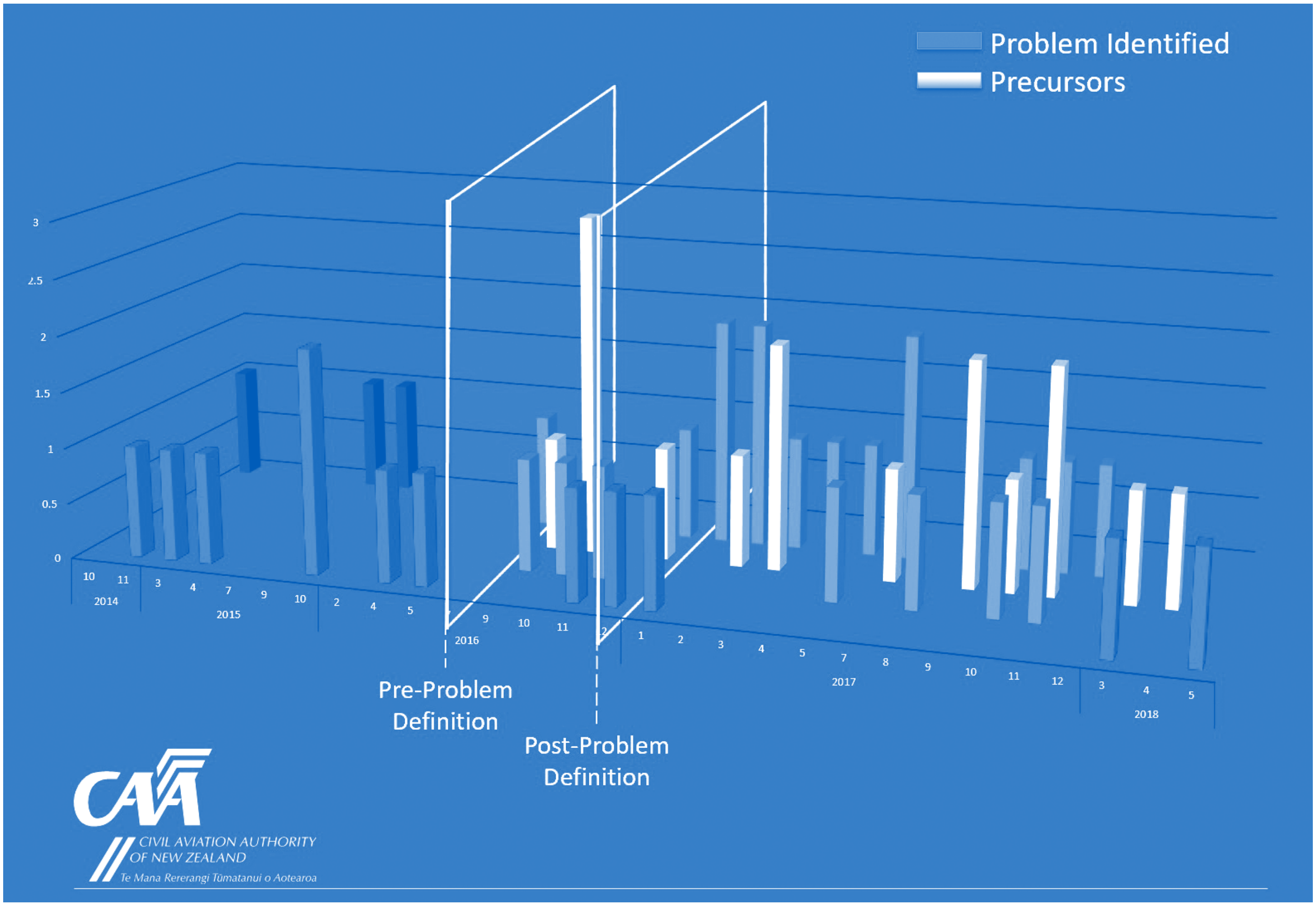


Figure 7. Operator's occurrences pre- and post-TSSI implementation monitoring.

excursion and find it occurred as a result of the pilots being distracted due to ATC tasking. During another safety investigation we found that a pilot was distracted while conducting a deer recovery operation, and the helicopter's main rotor blades contacted a shrub. The outcome of these occurrences is totally different, yet the precursor that led to them was almost identical—the pilot's distraction. This leads to the questions: Why were pilots distracted and what were the trade-offs the pilots were dealing with? The distraction may be another symptom of a deeper problem, e.g., both pilots were fatigued, having little sleep opportunity over the previous 48 hours.

Once we have grouped the occurrences and precursors, and sliced and diced them using analytical tools, we look for common themes. A theme might be: In New Zealand a helicopter pilot is seven times more likely to depart a controlled airport without a departure clearance than a fixed-wing pilot. If the CAA has enough clarity about why this occurs, then an intervention may be applied at this stage. If there isn't sufficient clarity about why this is occurring, or if there is a concern that an intervention that is to be employed may have unintentional consequences, then a systems investigation is commenced.

A systems investigation could be viewed as the real "deep dive" methodology of the three investigative lenses. As such, it provides the highest level of clarity about a problem. Systems investigations involve identifying who the system players are and working with them on system influences and relationships. The problem becomes clear over the course of the investigation, and appropriate interventions become obvious and are adopted by those system players. In this way, the people who are actually part of the system, that is, those who have the most potential to influence safety in everyday work, have buy-in to the interventions.

During the process of conducting a TSSI, it is important to get input from all of the system players. When faced with a problem, diversity of thought with multiple views will allow you to truly identify the problem. This kind of deep-dive methodology is so effective in aviation safety because we are so often dealing with complex systems. As we saw previously, problems and risks often emerge out of complexity. It is not one individual part of the system but the complexity of the system as a whole that is causing the problem to emerge, and the solution to complex problems is having transparency of the system factors.

Some of the tools that are utilized in a TSSI may be quite different from traditional investigation tools. These tools may include word pictures, surveys, focus groups, and also engaging in observational tools such as LOSA. This helps gain industry buy-in, bring about diversity of thought, and create understanding of work-as-done. We have diversified our skill set and work closely with a group of CAA analysts to turn data into intelligence.

Another element of a TSSI investigation

is mapping the system players as well as the influences within the system to determine the emergent properties. Figure 6, page 22, depicts a system influence map.

The system is explored from an individual, team, organization, regulatory, and governance level perspective. Typically, this is done by getting a proportion of representatives together in a workshop forum. The diagram shown in Figure 6 depicts the complex system influences generating high workload on the crews in a New Zealand organization. This high workload led to crews dynamically adapting to the situation, making trades-offs to accomplish tasks. Due to the complexity of the situations, slips and lapses were made and different incidents emerged. What this shows us is that the errors are not the root cause of any occurrences that may have resulted, but rather the symptom of a deeper system problem—the high workload.

Following a TSSI investigation, the CAA has significant clarity around a problem, has identified the system factors that need to be modified, and will be able to monitor the system to make sure that the changes have indeed had the desired effect.

In practice, the Safety Investigation Unit at the CAA recently identified an operator that was having multiple serious incidents. Over a short period, the operator had 10 serious incidents, which could have led to accidents. The operator had tried multiple interventions and had erected more safety barriers, yet these serious incidents kept occurring. When approached, it became evident that the operator was trying to address each occurrence in isolation and had not identified the precursors. The operator was playing a game of whack-a-mole, with a limited understanding of the actual problem.

Collaborating with the operator's safety team, a TSSI was conducted that identified the precursors, grouped them, and derived two underling themes. This provided clarity about the actual problem. Gaining the intelligence of the system factors and understanding how the system is operating has led to the reduction of serious incidents in this case. This is a clear example of working proactively to prevent accidents.

Figure 7, page 23, presents some of the actual data from that TSSI investigation. This shows that leading up until early 2016, the serious incidents kept occurring, even though each of the serious incidents had been investigated and safety actions had been put in place. In mid-2016, a TSSI was initiated. From this time, we began to identify the precursors and understand the themes behind the serious incidents and other incidents reported. By the end of 2016, we had a thorough understanding of the problem and the system factors generating the emergent outcomes. From here, tailored interventions were put in place to influence the emergent properties and mitigate the problem.

In early 2018, there were two further serious incidents reported. This demonstrates the concept of emergence quite well. These two serious incidents again emerged from the complex interactions and system factors, including those factors changed as part of the outputs from the TSSI. However, having clarity and understanding of the system factors enabled further refinements to be made, which ensured that these unintended consequences were addressed. Since mid-2018, there have been no serious incidents of this type reported by the operator, even though reporting in general has increased significantly with the number of flights steadily increasing.

This is the first time that the CAA has been able to conduct a full TSSI Investigation, implement an intervention, and monitor the effectiveness of that intervention. Today we are still actively monitoring this operator and the interventions.

Conclusion

In conclusion, we as an industry of safety professionals need to look deeper than human error and challenge ourselves when we may be using hindsight bias. We are a mature industry and should not encourage terms like should have, could have, and would have. It is important to remember that blame is the enemy of safety, but also to put this into practice by searching for deeper understandings of how problems emerge. We have the potential to lead the world in a more proactive and positive manner. Complex system safety improvements need a proactive approach to understanding how the system operates.

For further information on TSSI or to conduct the first TSSI training module, which is free and online, visit https://www.caa.govt.nz/resources/TSSI/index.html.

We welcome any feedback or thoughts you may have on the model. You can contact us at Dan.Foley@caa.govt.nz and Matt.Harris@caa.govt.nz. ◆

"We as an industry of safety professionals need to look deeper than human error and challenge ourselves when we may be using hindsight bias. We are a mature industry and should not encourage terms like should have, could have, and would have. It is important to remember that blame is the enemy of safety, but also to put this into practice by searching for deeper understandings of how problems emerge."

DOES WHAT HAPPENS IN AIRCRAFT MATTER?

By Dr. Nathalie Boston, Senior Transport Safety Investigator, Australian Transport Safety Bureau

Although investigations are conducted with continually increasing rigour, we continue to see similar accidents occur. The identification of occurrence factors and in-flight human factors remain integral to our investigations, but we need to do more if we want to move our investigation findings from reactive to preventive.

The investigation of organizational issues is common practice. However, organizational factors traditionally have been explored only where they were a direct contributor to a factor in the accident sequence. The aim of this paper is to show some of the challenges to this methodology. Sometimes, what occurs inside the aircraft fundamentally may not be the whole story. The big lessons, and those with wider-reaching preventive benefits for the aviation industry, might come from exploration of matters beyond the accident itself.

The purpose of accident investigation

At the back of each Australian Transport Safety Bureau (ATSB) report is the following statement:

"The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings."

The intended purpose of investigating transport accidents and incidents in order to prevent future accidents and incidents is not new to the ISASI community. However, when a report is released—following months or years of investigative work—the communicated message often risks becoming oversimplified in the public domain, with a focus on reactive questions of "what went wrong" or "how it happened" rather than the preventive question of "why it happened" and how the risk of reoccurrence can be reduced. When this is the case, it diminishes the role of the investigation report in communicating the safety-related risks that the investigation has revealed.

Indeed, too often a new investigation reveals contributory factors that are similar to those we have seen in previous investigations. In these cases, the question raised is why did these further accidents occur when we identified the risks previously? Further, there is the continued challenge of accidents for which we cannot uncover the full details of what occurred.

In addressing the ISASI 2019 seminar topic "Future Safety: Has the Past Become Irrelevant?" this paper puts forward the position that although the past has not become irrelevant, the lessons of the past might be insufficient for the purpose of further mitigating risk. They must be challenged and reexamined if we are to make improvements in the future.

Quality assurance in ATSB investigations

In fulfilling the requirement to "include factual material of sufficient weight to support the analysis and findings," ATSB investigators follow a published methodology, the fundamental concepts of which have been presented at previous ISASI seminars. This methodology requires us to take a link-by-link approach building through levels of safety factors (see Figure 1, page 26): from occurrence events (including technical failures) to individual actions and local conditions and then up to risk controls and organizational influences.

In identifying the various safety indicators and safety issues that contribute to an accident, we consider all available evidence in order to test the existence of each reasonable hypothesis ("Did the potential safety factor exist?"). If the factor is shown to exist at the time of the accident, then the next step is to test for influence

(Adapted with permission from the author's technical paper Does What Happened in the Aircraft Matter Anymore? *presented during ISASI 2019, Sept. 3–5, 2019, in The Hague, the Netherlands. The theme for ISASI 2019 was "Future Safety: Has the Past Become Irrelevant?" The full presentation can be found on the ISASI website at www.isasi.org in the Library tab under Technical Presentations.—Editor)*

Dr. Nathalie Boston

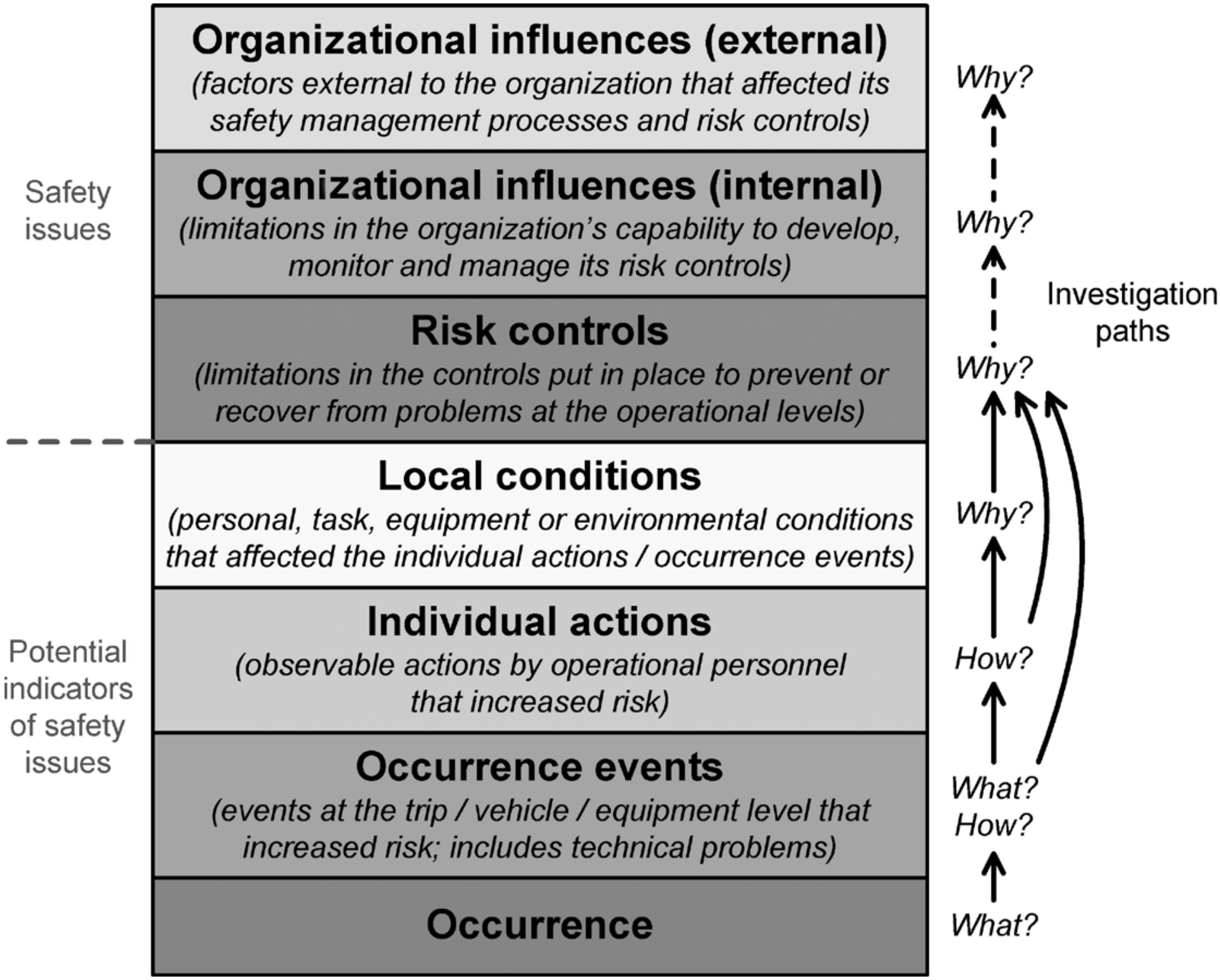


Figure 1: Levels of safety factors.

("Did the proposed safety factors have an influence on the occurrence or a known contributing factor?"). If the hypothesis passes both these tests, it is generally considered to be a "contributing factor."

If a hypothesis passes the test for existence at the time of the accident but a direct influence on the occurrence or on another safety factor cannot be demonstrated, then it will undergo a test for importance (asking "Is the proposed factor worth including in the final report's findings, even though it cannot be demonstrated to have had a influence this time?"). Any hypotheses that pass a test for importance despite not passing a test for influence are included in the findings as "other factors that increased risk."

The investigation of risk controls and organizational influences is not a new concept, but, like all safety factors, it requires demonstration of the link between how a risk control may have influenced the operation or how the organization influenced the risk controls or the operation. For example, an investigator might review an operator's flight crew rostering practices only after first identifying that a pilot was fatigued and thus made an error that contributed to an accident or incident.

Demonstrating these links clearly in our reports has been a way we have validated and documented the factual contribution of organizational factors to an accident.

This investigation process has been in place at the ATSB for many years. The 2014 independent review of our methodology by the Transport Safety Bureau of Canada concluded that the approach represented best practice and produced sound results when applied consistently.

Challenges to the methodology

Two of the challenges we face in applying the published methodology to reach the declared objectives of our investigation reports are when we cannot identify the exact occurrence events of the accident and when we keep seeing the same kind of accident reoccurring.

First, in the current world of advancing technology and constant monitoring of processes and events, there is an expectation that the sequence of events of any accident or incident should not be difficult to establish. This supposition is indeed true for the majority of accidents for which we typically have multiple sources of available data such as flight data recorder, cockpit voice recorder information, other recorded data (from radar, GPS, or other sources), video recordings, or witness interviews to piece together and validate other sources.

Nevertheless, in one recent ATSB investigation, the lack of available data presented a significant challenge to investigators. This was a fatal accident with no survivors in a remote area of Australia outside radar coverage. There were no recording devices fitted to the aircraft, and much of the aircraft was unrecoverable or unexaminable postimpact. There were no witnesses to the accident.

In a second accident, the flight was captured on radar, and there were many witnesses; but there was no evidence from inside the aircraft to account for the fact that it deviated from its intended flight path before impact.

In a third investigation, survivors presented different and conflicting recollections, but there was no source of onboard data to validate any of their accounts. There is a long list of such challenges, including investigations into missing aircraft. While we might be able to piece together the flight path of an aircraft from available evidence, it is often difficult to identify the specific events and conditions (let alone the particular in-flight human factors) that may have contributed to an accident.

Clearly, however, lessons can be learned. It would not be appropriate or acceptable for such investigations to conclude with no findings because of our inability to identify any directly contributing events from the accident sequence. While our methodology sets us up to build hypotheses from these events, the development needed for future safety lies in how to factually demonstrate an influence without the occurrence factors being available to direct us.

The second challenge is that, despite conducting investigations with continuously increasing rigour, we continue to see similar accidents reoccur. Some examples of these include

- flights from visual flight rules into instrument meteorological conditions leading to a loss of control.
- stall training accidents.
- simulated engine failure training accidents.
- descents below minimum safe altitude.

Accidents resulting from these types of occurrence have been investigated many times, including current active investigations. In addition, there is repetition in investigations involving particular operators, particular areas of the aviation industry, or particular aircraft types.

All these investigations have been conducted in accordance with the ATSB investigation methodology and ideally should have identified all the findings and reduced the safety-related risk. But when similar outcomes to similar risk happen repeatedly, we are forced to reconsider both the scope with which we have explored potential safety issues to do with risk controls and organizational issues and the way the safety issues identified in our reports are being communicated, and addressed, by those most exposed to the safety-related risk.

In responding to both these challenges, where we have limited knowledge about an accident sequence, or have seen the accident sequence occur before, we need to systematically sharpen our focus on organizational and other factors outside the aircraft, while also staying within scope and evidence based, to maximize the benefit of our work.

The future

The fundamental purpose of a safety investigation is preventive, not reactive. There is a challenge in setting the scope of an investigation: it cannot be limitless, yet it must be broad enough to reveal all lessons that might need to be learned. It is our responsibility as an investigation agency to communicate the results of the investigation to those bodies and organizations that have the capacity to reduce the risk of the accident or incident occurring again; it is then their responsibility to take such action as is necessary to improve transport safety as a result.

At the ISASI 2018 seminar, ATSB Executive Director Nat Nagy outlined the vision 2025 plan for the ATSB and made the point that we focus on investigating and researching the safety issues that others do not. Our 2018–2019 corporate plan develops this further: "As the independent safety investigator, the ATSB is in a position to provide information on safety issues, particularly broader systemic ones, which may not otherwise be apparent to operators and other organizations who have done their own internal investigations."

Conducting more safety studies will enable us to work beyond a single investigation and to compare the evidence about organizational and risk factors identified across a range of investigations that may not be directly linked to one occurrence but to a range of different occurrences. Safety studies published this year include "Analysis of Wake Turbulence Occurrences at Sydney Airport 2012–2016" and "Exploration of Change in Aviation Gasoline Lead Content in Northern Australia on Reported Engine-Related Occurrences." There are more similar investigations under way.

Such safety study reports and investigations in which the sequence of events and safety-related risks leading to these are not obvious are our challenges for the future. The big lessons for future safety might not lie in the precise story of what occurred inside the aircraft but in the wider-reaching preventive benefits for the aviation industry that come from exploration of topics outside the scope of the accident itself. ◆

NEWS ROUNDUP

ISASI Goes to WIA 2020

ISASI representatives attended the 31st annual Women in Aviation (WAI) International Conference held at Disney World's Coronado Springs Resort in Florida, U.S.A., on March 5–7.
At the gathering,

- nearly 4,500 attendees took part, of whom 70% were women and 30% men.
- the exhibit hall hosted 180 separate companies and organizations representing all aspects of the aviation community, including drones.
- a total of 151 scholarships were awarded to WAI members at every stage of their career. The $831,365 in scholarships awarded this year put the total of all WAI scholarships awarded since 1995 at more than $13,200,000.
- the WAI chapter network reached 139 global chapters in 21 countries worldwide.

A special thanks goes to U.S. Society of Air Safety Investigators Dallas/Fort Worth Chapter President Erin Carroll, Southwest Airlines, for providing Ann Schull, ISASI office manager, transportation to the conference and to the ISASI volunteers who worked nonstop at their own expense. These dedicated volunteers signed up more than 30 new ISASI members, five renewals, and one upgrade. This year, Ally Melick, a student at Metropolitan State University of Denver, won ISASI's ME Makeover Essential door prize

The next WIA Conference is planned for March 11–13, 2021, at the Reno-Sparks Convention Center in Reno, Nevada, U.S.A. ◆

At ISASI's booth during the Women in Aviation International Conference are, from left, Ruth Ann Bledsoe, Craig Bledsoe, Kathy Carl, Ann Schull, Denise Davallo, and Erin Gormley.

SERC Postpones Annual Meeting

The 2020 meeting of ISASI's Southeast Regional Chapter (SERC) scheduled for July 24–26 in Memphis, Tennessee, U.S.A., has been postponed to 2021 due to the impact of COVID-19. A date, which will likely be mid to late April 2021, will be announced as soon as negotiations are made with the hotel.

Bob Rendzio, president; Anthony Brickhouse, vice president; and Alicia Storey, secretary/treasurer, hope that you're safe and healthy and look forward to seeing you in 2021. ◆

MENASASI Makes Tentative Meeting Plan

Tom Curran, secretary of the Middle East North Africa Society of Air Safety Investigators (MENASASI), reported that the annual MENASASI seminar is tentatively scheduled to take place in Cairo, Egypt, in October. The regional society is also planning to hold a Reach Out event toward the end of the year.

Curran added that MENASASI will work to improve its communication systems with MENASASI members and to seek new individual corporate members. He noted that the society's website continues to evolve and that more topics and information to attract new members will be added to the site. ◆

PNRC Chapter Officer Receives Who's Who Recognition

Pacific Northwest Regional Chapter Secretary-Treasurer Jeanne Elliott recently received the Albert Nelson Marquis Lifetime Achievement Award from Marquis Who's Who in recognition of her 50-year career in aircraft cabin safety and air accident prevention.

The award announcement cited Elliott's efforts on behalf of flight attendants throughout her career to promote aircraft cabin safety, accident prevention, aviation security, crew training and emergency response, incident/accident investigation, aircraft security, and personal protection. The announcement also lauded her efforts to bring volunteer safety reporting through the FAA's Aviation Safety Action Program to flight attendants at Delta Air Lines. ◆

ISASI Participates in International Seminars

ISASI International Councilor Caj Frostell reported that he taught classes and participated in several international seminars in early 2020 during which he also provided information about Society member's efforts to promote air safety.

He had the opportunity to meet with civil aviation authority officials and aviation industry representatives in Male, the Maldives, January 20–29. The Maldivian Ministry of Transport has initiated arrangements to separate the civil aviation authority and the safety investigation functions. Frostell met with the designated heads of the safety investigations to discuss the practical details involved. He also assured the authorities of ISASI support in their endeavors. In addition, he conducted two three-day courses in incident investigation for the aviation industry. Frostell added that the Maldives has a very active aviation industry with 70 de Havilland Canada DHC-6 Twin Otters on floats, carrying up to 19 passengers between the main airport in Male and the outer islands.

Frostell participated in the Aircraft Accident Investigation Management course at the Singapore Aviation Academy on February 24–28 that provided training for 32 participants from 20 countries and included virtual-reality accident site training. The course was strongly supported by the Singapore Safety Investigation Bureau.

Also in Singapore, from March 9–13 the Incident Investigation and Safety Risk Management course at the Singapore Aviation Academy attracted 14 participants from 10 countries, including Africa and South America. ◆

Participants of a three-day accident investigation seminar that the Maldivian Ministry of Transport sponsored pose for a group photo.

During the Aircraft Accident Management course in Singapore, participants used virtual-reality accident site training techniques.

Participants from 10 countries attended the Incident Investigation and Risk Management course in Singapore.

ESASI Reschedules 2020 Meeting

Steve Hull, secretary of the European Society of Air Safety Investigators (ESASI), reported that ESASI has rescheduled its planned 2020 regional seminar. The 10th ESASI regional seminar will take place in Budapest, Hungary, on March 18–19, 2021. The conference is scheduled to start at 09:00 on March 18 and end at 13:00 on March 19. In addition, the meeting of the Military Investigator Group is scheduled to take place on the afternoon of March 17.

The aim of the seminar is to keep the European air safety investigation community abreast of current developments and evolving best practice in aircraft safety investigation. As in previous years, the seminar will include presentations on case studies, the European environment, challenges of modern air safety investigations, and human factors in aircraft accidents and incidents.

Please go to the ESASI website at www.esasi.eu for further information. ◆

In Memoriam

ISASI is sad to announce that on Jan. 12, 2020, Capt. Douglas Cavannagh suddenly passed away at the age of 71. ISASI President Frank Del Gandio noted, “Capt. Cavannagh joined ISASI 10 years ago. He was an avid participant in many of the annual seminars. In addition, he was the co-chairman of the General Aviation Working Group. Capt. Cavannagh always had a very friendly smile and a passion for aviation safety. Many of the ISASI annual seminar companions will remember his wife Helen who was a most cheerful and entertaining participant.”

Cavannagh, a former Royal Air Force officer who qualified in both fast jets and helicopters, transitioned to civil aviation in a flying career that spanned decades. From exploratory drilling in Turkey in the 1970s to precision long lining and onscreen work in the burgeoning film industry in Hong Kong in the 1980s, no job was too dirty or too glamorous.

He was an experienced safety leader and senior manager (chief executive officer to the chief pilot) with a demonstrated history of working in the international aviation community. Cavannagh had vast experience in helicopter operations in the Middle East and Asia-Pacific region and had a background in military aviation, flight training, helicopter OEMs, corporate and executive aviation, MRO, aircraft sales and leasing, and aviation insurance claims and risk management.

Over the last decade, he had dedicated his time to pursuing greater aviation safety, something he was very passionate about. Cavannagh had recently focused on risk management/aviation safety and was a practicing safety auditor with the International Business Aviation Council, the Flight Safety Foundation, and the Helicopter Association International safety oversight programs. ◆

Capt. Douglas Cavannagh

Greetings to all ISASI members.

We hope this message finds you, your family, friends, and associates doing as well as possible in these difficult times. We are sure you have been wondering about the 2020 conference in Canada and assure you we have been working extensively with all involved for some time.

The annual symposium is a critical event in our international community, and decisions to change it are not made lightly. In conjunction with the international executives, we have concluded that ISASI 2020 in Montréal, Qué., Canada, will not go forward as per the original dates.

At this point we have several options that are dependent upon the hotels in both Montréal and Brisbane, Qld., and their willingness to be flexible and work with us. It is our hope that we can push our plans forward by one year, with 2021 being in Montréal and 2022 being in Brisbane. We will be posting the new information as soon as it is available.

For those of you who submitted abstracts, the papers selection process is proceeding as planned. Once the Selection Committee has finished its work, we will be advising everyone of the successful candidates. It is our hope that those who were chosen will be able to participate next year regardless of location. For those of you who have already registered and paid for the seminar, we will be in touch with each of you soon regarding refunds.

Please know that this decision was not taken lightly. The health and safety of our delegates was first and foremost on our minds and could not be put in jeopardy. On behalf of the ISASI 2020 Planning Committee, I would like to thank you for your understanding and cooperation during these difficult times.

Best regards,
Barbara Dunn
President, Canadian Society of Air Safety Investigators

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____

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

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Education and Training Center for Aviation Safety
EL AL Israel Airlines
Embraer-Empresa Brasileira de Aeronautica S.A.
Embry-Riddle Aeronautical University
Etihad Airways
EUROCONTROL
European Aviation Safety Agency (EASA)
EVA Airways Corporation
Executive Development & Management Advisor
Finnair Plc
Finnish Military Aviation Authority
Flight Data Services Ltd.
Flight Data Systems Pty. Ltd.
Flight Safety Foundation
Fugro Survey Middle East Ltd.
Gangseo-gu, Republic of Korea
GE Aviation
General Aviation Manufacturers Association
German Military Aviation Authority, Directorate of Aviation Safety Federal Armed Forces
Global Aerospace, Inc.
Grup Air Med S.A.
Grupo Regional de Investigación de Accidentes de Aviación
Gulfstream Aerospace Corporation
Hall & Associates LLC
Hawaiian Airlines
HNZ New Zealand Limited
Hogreen Air
Honeywell Aerospace
Hong Kong Airline Pilots Association
Human Factors Training Solutions Pty. Ltd
Independent Pilots Association
Insitu, Inc.
Interstate Aviation Committee
Irish Air Corps
Irish Aviation Authority
Japan Transport Safety Board
Jones Day
Junta du Investiación de Accidentes Aviación Civil (JIAAC)
KLM Royal Dutch Airlines
Korean Air
Korea Aviation & Railway Accident Investigation Board
L-3 Aviation Recorders
Learjet/Bombardier Aerospace
Lion Mentari Airlines, PT
Lockheed Martin Aeronautics Company
Middle East Airlines
Midwest University
Military Air Accident Investigation Branch
Military Aircraft Accident & Incident Investigation Board
Ministry of Transport, Transport Safety Investigation Bureau, Singapore
National Aerospace Laboratory, NLR
National Institute of Aviation Safety and Services
National Transportation Safety Board
National Transportation Safety Committee-Indonesia (KNKT)
NAV CANADA
Netherlands Defence Safety Inspectorate
Ocean Infinity
Pakistan Air Force-Institute of Air Safety
Pakistan Airline Pilots' Association (PALPA)
Pakistan International Airlines Corporation (PIA)
Papua New Guinea Accident Investigation Commission (PNG AIC)
Parker Aerospace
Petroleum Air Services
Phoenix International Inc.
Plane Sciences, Inc., Ottawa, Canada
Pratt & Whitney
PT Merpati Nusantara Airlines
Qatar Airways
Rademan Aviation
Republic of Korea Air Force Aviation Safety Agency
Republic of Singapore Air Force (RSAF)
Rolls-Royce PLC
Royal Danish Air Force, Tactical Air Command
Royal Netherlands Air Force
Royal New Zealand Air Force
RTI Group, LLC
Saudia Airlines-Safety
Scandinavian Airlines System
Sikorsky Aircraft Corporation
Singapore Airlines Limited
Southern California Safety Institute
Southwest Airlines Company
Southwest Airlines Pilots' Association
Spanish Airline Pilots' Association (SEPLA)
State of Israel
Statens haverikommission
Swiss Accident Investigation Board (SAIB)
Taiwan Transportation Safety Board (TTSB)
The Air Group
The Boeing Company
The Japanese Aviation Insurance Pool (JAIP)
Transportation Safety Board of Canada
Turbomeca
Ukrainian National Bureau of Air Accidents and Incidents of Civil Aircraft
UND Aerospace
United Airlines
United States Aircraft Insurance Group
University of Balamand/Balamand Institute of Aeronautics
University of Southern California
Virgin Galactic
WestJet ◆

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WHO'S WHO: JUNTA DE INVESTIGACIÓN DE ACCIDENTES DE AVIACIÓN CIVIL (ARGENTINA)

(Who's Who is a brief profile prepared by the represented member organization to provide a more thorough understanding of the organization's role and function.—Editor)

An Investigation Model for Continuous Improvement

When an air accident occurs, the traditional news media tends to ask the same question: Was it the pilot's fault or a mechanical failure? This has happened due to a long history of lineal investigations both in Argentina and overseas that focus on finding the "active failures" that caused an accident—either a human error or mechanical defect—according to Junta de Investigación de Accidentes de Aviación Civil (JIAAC) President Ana Pamela Suárez. However, in 2013 Argentina decided that civil aviation accident investigation should play a relevant role in state safety and as a result should challenge the investigation history and find deeper responses to the causes of accidents.

As a new organization, JIAAC accepted the challenge and chose a new investigation model based on a systemic approach that changed how civil aviation occurrences are investigated in Argentina. The "systemic model" goes beyond active failures as they aren't considered a conclusion themselves but the starting point of an investigation. The main objective of this approach is to conduct investigations that transcend the simple determination of "human error" to track the deep causes of accident and thus to take actions that can solve the nuclear problem of safety deficiencies.

Since 2013, JIAAC investigations have "failures of the system" as the main point. JIAAC investigations consider not only active failures triggering an event but also the latent conditions contributing as external factors of regulations, standards, airport infrastructure, operators, and institutions or failures in any of the other existing barriers of the aeronautical system in general. The idea is to determine the causes that brought about or contributed to the event with the sole objective of preventing similar future events or creating current risk situations.

The JIAAC investigation model proposes taking into consideration all of these elements to determine the deep causes of an accident and to establish a series of recommendations based on correcting the errors found and including them in the last chapter of each final report.

The role of safety recommendations and their follow-up were reevaluated, as well as their impact in terms of their contribution to safety. The model requires not only an investigation process that deepens its look into the system but also safety recommendations that, through the commitment of all the actors, ensure the continuous improvement that the civil aviation system needs.

As to the question of whether it was the pilot's fault or a mechanical failure, JIAAC teams respond that for safety to improve, fault doesn't need to be assigned. Instead, deficiencies in the system that cause mechanical failures or human errors that lead to an accident need to be identified.

The aeronautical system is constantly growing and deeply challenges accident investigators. Only a systemic investigation model allows continued development and ensures continuous learning. ◆