FORUM

ISASI

Air Safety Through Investigation

APRIL-JUNE 2021

Journal of the International Society of Air Safety Investigators

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ABOUT THE COVER

Due to travel and meeting restrictions brought about by the global pandemic, ISASI societies and the International Council have begun to meet virtually to conduct business, provide training opportunities, and communicate with one another. ESASI, for example, recently began a regular virtual presentation titled "FocusOn…" to discuss issues and subjects that require communication between annual meetings (see page 28). This year, ISASI 2021 will be conducted in the same fashion—a virtual gathering on a global scale—rather than in person.

FORUM

Air Safety Through Investigation

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AIR SAFETY INVESTIGATORS

INCORPORATED AUGUST 31, 1964

"Please continue to adhere to all air safety policies and rules as we emerge from the pandemic--everything by the book."

INTERNATIONAL COUNCIL MEETS ONLINE

On Feb. 25, 2021, ISASI held a virtual International Council meeting attended by 20 participants representing most societies.

The focus of the meeting was the financial state of ISASI. Treasurer Robert MacIntosh gave an excellent overview of the revenues and expenses. As to be expected during the ongoing global pandemic, individual and corporate membership renewal is down. However, we continue to gain new members, including four new corporate members. He laid out a solid budget projection for this year. The bottom line shows a projected loss of $28,000. Keep in mind that this projection is based on historical data and a number of sound estimated expectations. The final profit and loss numbers for 2021 will mainly be based on the financial success of the ISASI virtual seminar scheduled for August–September 2021. Registration for this seminar is now open on the ISASI website or through a link provided in an e-mail sent to all members. Information can also be found on page 32 of this issue.

ISASI Forum is one area in which members can help the Society improve its financial status. For the January-March issue, ISASI mailed 929 hard copies, and 393 individual and corporate members received electronic copies. Please send the office an e-mail (ann.schull@isasi.org) if you'd like to switch to an electronic issue. You'll save ISASI money and receive the *Forum* weeks before a mailed copy arrives. In addition, in areas where mail service has degraded or is unreliable, you can ensure that you get your magazine.

Australian Society President John Guselli and the Application Process Working Group in cooperation with SRCA, our website hosting company, is designing and has submitted to the International Council a proposal for an electronic application process. The International Council authorized the team to proceed with a 30-day trial of suggested software with the cooperation of the ISASI office manager and the SRCA contract analyst. A key element of this proposal requires the active participation of the ISASI Membership Committee. National societies that process their own membership applications and dues collection shouldn't be adversely affected by this change. More information will be forthcoming as the trial proceeds.

During the past year, I made a few appointments to ISASI committees. Mid-Atlantic Regional Chapter President Frank Hilldrup is joining the Membership Committee. Roger Cox is serving as the Audit Committee chair. David King is a member of the Kapustin Scholarship Committee.

I'm pleased to report that $2,450 has been donated to the Rudolph Kapustin Scholarship Fund in memory of Toby Carroll. As there were few applicants during 2020 and the seminar was postponed, we decided to roll the annual scholarships over to this year. The scholarship recipients' essays will be included as part of ISASI 2021 presentations and will be published in the Forum.

The ISASI 2021 virtual seminar is scheduled for Aug. 31–Sept. 2, 2021. The theme of the seminar is "Staying Safe: Moving Forward." The 2020 seminar in Montréal, Québec, Canada, was canceled due to the pandemic. The virtual seminar will be a departure in format and procedure from our typical seminar but necessary due to the pandemic. Even with efforts to develop and distribute vaccines, many nations still have travel restrictions in place and reduced in-person gatherings that adversely affect work life, business meetings, and social events—and rightly so. The lower registration fee for the seminar will enable members who usually cannot attend the international seminar to participate. The proposed broadcast schedule will take multiple time zones into consideration so that most participants can log in without having to attend in the middle of the night. More information is available on ISASI's website.

Please continue to adhere to all air safety policies and rules as we emerge from the pandemic—everything by the book. In addition, take every possible precaution to remain healthy and safe both at home and on the job. ◆

Frank Del Gandio
ISASI President

Analysis of Aviation Accident Videos at NTSB

By Dan T. Horak, Mechanical Engineer, National Transportation Safety Board, Washington, D.C.

Video Analysis Background

Over the last several years, videos became a major source of information for aviation accident investigations. To date, the NTSB analyzed more than 30 aviation accident videos. In these accidents, videos were one of the main sources—and often the only source—of information for estimating trajectories, altitudes, speeds, and orientation angles of crashing airplanes. These videos were recorded by cameras mounted on airport structures, on commercial buildings, on private homes, on crashing airplanes, and on airplanes that recorded crashing airplanes. We also analyzed automobile dashboard camera videos and traffic camera videos that recorded crashing airplanes. An increasing source of aviation accident videos we analyze are cameras and smartphones hand held by bystanders on the ground and even by a passenger in a crashing airplane.

The number of analyzed accident videos has been increasing from year to year, primarily due to the increasing number of installed high-resolution and high frame–rate security cameras and the increasing number of bystanders who record accident events with phone cameras. Since 2008, the NTSB has been developing methodology, algorithms, and software for analyzing aviation accident videos. We have reached a point where accurate estimates of trajectories, altitudes, speeds, and orientation angles can be derived quickly and successfully handling the increasing rate at which aviation accidents requiring video analysis occur.

Aviation accidents that require video analysis come in many flavors. Many aviation accident videos require only a basic factual summary report that does not involve estimation of numerical quantities. This paper does not discuss such cases, and the more than 30 cases previously mentioned do not include such straightforward video analyses.

Video Analysis Cases Classified by Complexity

In some runway accidents, the airplane passes by reference points seen in videos recorded by airport cameras. Speed estimates in such cases can be derived by dividing the traveled distance, usually along a runway, by the time it took to travel that distance. Analysis of such low-complexity cases is not discussed in this paper.

The more than 30 cases mentioned earlier are in the medium-complexity or high-complexity categories. They involve airborne airplanes that do not pass by reference points seen in the videos. Analysis of such accidents requires the use of mathematical models of camera optics. Such models are calibrated using reference points on the ground. Once calibrated, the models can project points in the 3-D field of view of a camera onto video frames acquired with that camera. The calibration and use of such camera optics models will be described in detail later in this paper. Video analysis cases can be classified by type and complexity based on the four criteria described next.

Interpolation vs. Extrapolation

If the ground reference points used for camera model calibration are surrounding the airplane or are close to it, the analysis can be viewed as interpolation. Even if the calibrated parameters of the camera optics model are somewhat inaccurate, if the camera optics model can accurately project the calibration reference points onto video frames, it will also accurately project points on the airplane onto the video frames.

The extrapolation cases involve available calibration reference points that are all near the camera, such as 50 meters from it or closer, and the estimation of trajectory, altitude, and speed of an airborne airplane that can be 500 meters or farther away from the camera. Most of the 30 cases mentioned earlier are in the extrapolation category.

The main problem facing the analyst of extrapolation cases is that small angular errors of the camera optics model parameters, i.e., the camera model yaw, pitch, roll, and horizontal field of view angles, result in large trajectory, altitude, and speed errors of the airplane that is far away. These small angular errors are not detectable during camera model calibration if all the reference points used for calibration are near the camera. In other words, the model can handle accurately the reference points or airplanes located near the reference points, but it cannot accurately handle airplanes that are far from the reference points that were used for camera calibration.

Fixed Camera vs. Moving Camera

The scenarios in which the trajectory, altitude, and speed of an airplane are being estimated can also be classified according to the location of the camera that recorded the video. The simplest cases are those in which the camera location is fixed, typically because it is mounted on a building. A higher level of complexity involves smartphones and cameras that are hand held by videographers on the ground. While the camera location is approximately constant, the camera orientation is changing because the camera is being rotated to keep the airplane in its field of view. Smartphones and cameras allow zoom adjustment while a video is being recorded. Analysis of videos with changing zoom requires recalibration of the field of view angle in addition to recalibration of the camera orientation angles for each analyzed video frame.

Video recorded by a camera mounted in an airplane can also be used for estimating the trajectory, altitude, speed, and orientation angles of that airplane. Analysis of such videos requires the use of a large number of ground reference

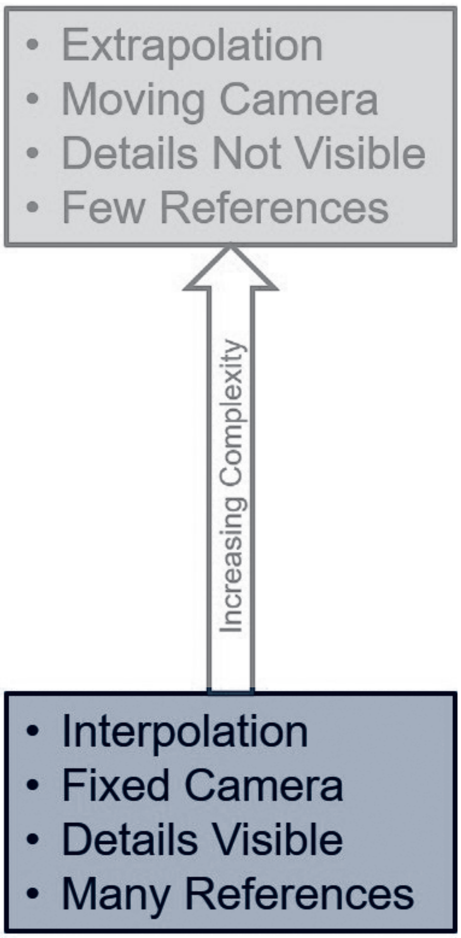

Figure 1. Classification of video analyses by complexity.

points along the ground track of the airplane because as the airplane moves, the reference points located in the camera field of view change. The analysis can be further complicated if the camera is hand held by a passenger in the airplane and is changing its orientation with respect to the airplane. Analysis of such videos requires the recalibration of the camera orientation with respect to the airplane for each analyzed video frame, followed by the estimation of the airplane location and orientation with respect to ground reference points visible in that video frame. The NTSB has the methodology and the tools for analyzing videos recorded by fixed or movable cameras whether they are on the ground or inside flying airplanes.

Airplane Details Visible vs. Airplane Details Not Visible

When the image of the airplane in video frames is sufficiently large so that its details such as nose, fuselage, tail, and wings are visible, analysis can be based on wireframe model alignment. A 3-D wireframe model of the airplane is constructed and projected onto a frame from the video using the camera optics model. The wireframe model is then

(Adapted with permission from the author's technical paper Analysis of Aviation Videos at NTSB 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)*

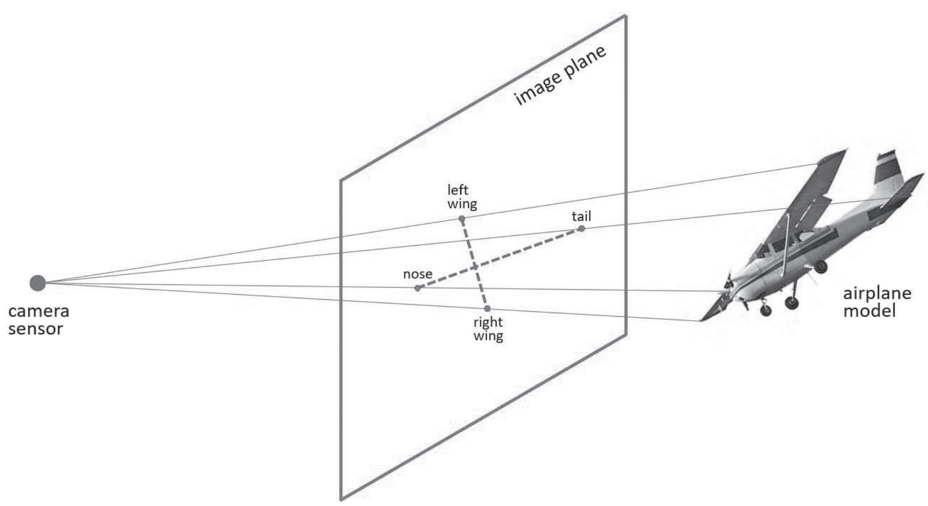

Figure 2. Projection from 3-D field of view onto a 2-D video frame.

Dan T. Horak

moved and rotated until the projected image matches the image of the airplane in the video frame. Once an optimal match is achieved, the location and orientation angles of the wireframe model are the optimal estimates of the location and orientation angles of the airplane at the time the analyzed video frame was recorded. The movement and rotation of the projected wireframe model is managed by an algorithm that uses the mathematical model of the optics of the camera. This model is described in detail later in this paper, and an example later in this paper uses the wireframe model method.

When the airplane is far from the camera, its image in a video frame can be as small as one or several pixels. In such cases, the wireframe model approach cannot be used, and the orientation angles of the airplane cannot be estimated based on the video. Estimation of the location and altitude of the airplane is usually possible, but it requires some additional information, such as the ground track of the airplane. An example later in this paper uses radar-based ground track to supplement the information in a video that does not show airplane details.

Many Reference Points Available for Camera Calibration vs. Few Reference Points

Video analysis is based on the mathematical model of camera optics. As described later in this paper, the model requires seven parameters that must be estimated in a calibration process that is based on ground references. When there are many available reference points that are distributed throughout the field of view of the camera, calibration is relatively simple and the resulting calibrated camera optics model is accurate.

In many cases, however, there are few reference points, and they may not be distributed throughout the field of view of the camera. Calibration in such cases is time consuming, and it results in camera optics models that may have lower accuracy.

Based on the criteria described above, it is possible to classify video analysis cases by their overall complexity. Figure 1 illustrates this classification. On the bottom, in blue, is the simplest case in

Figure 3. Frame from the parking garage camera video.

Figure 4. Barrel-distorted frame from the airport tower camera video.

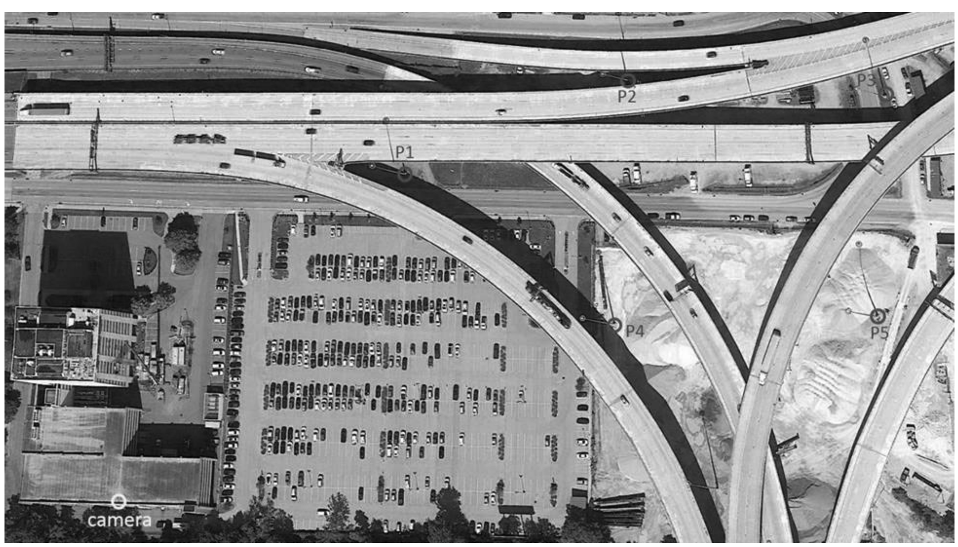

Figure 5. Light poles P1-P5 used for calibration of parking garage camera video.

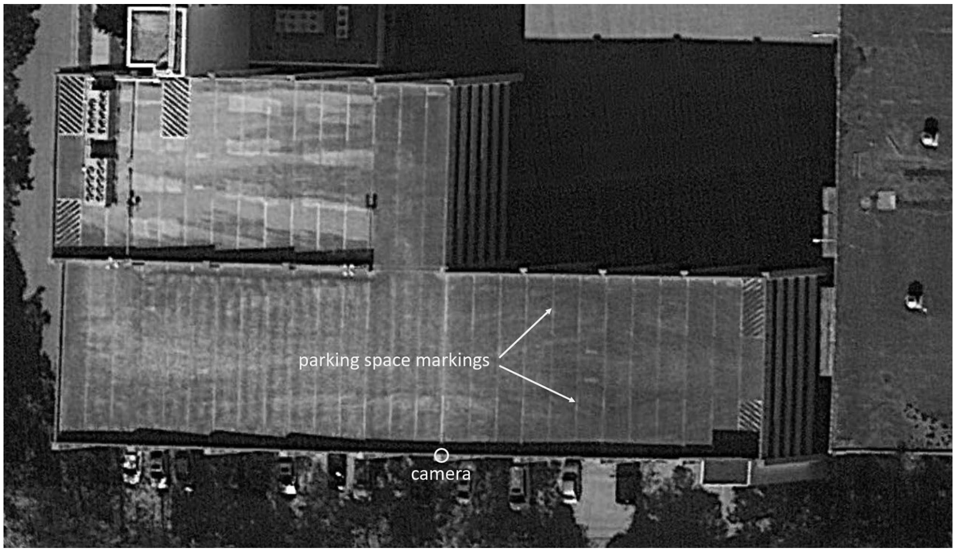

Figure 6. Parking space marking lines used for calibration of garage camera video.

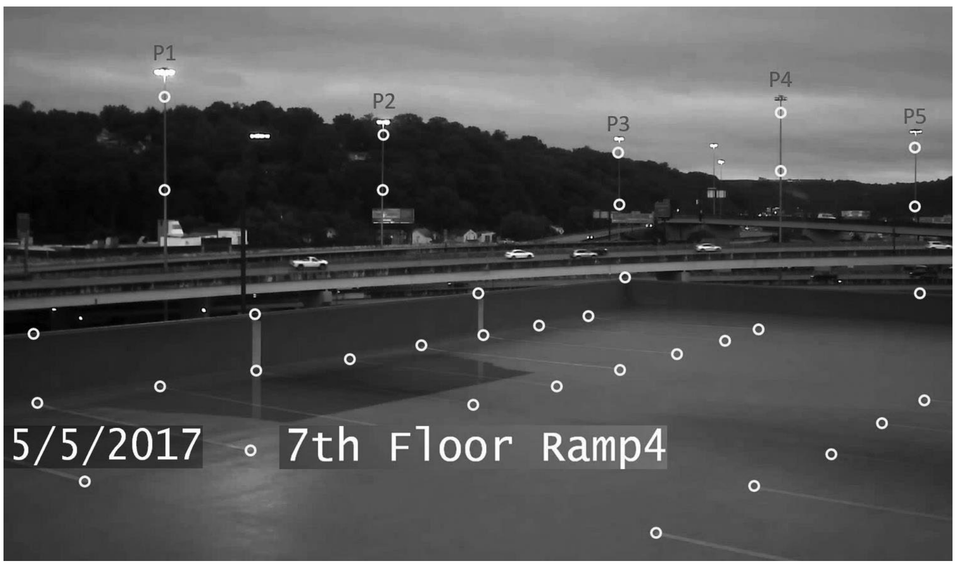

Figure 7. Frame from the parking garage camera video with marked reference points.

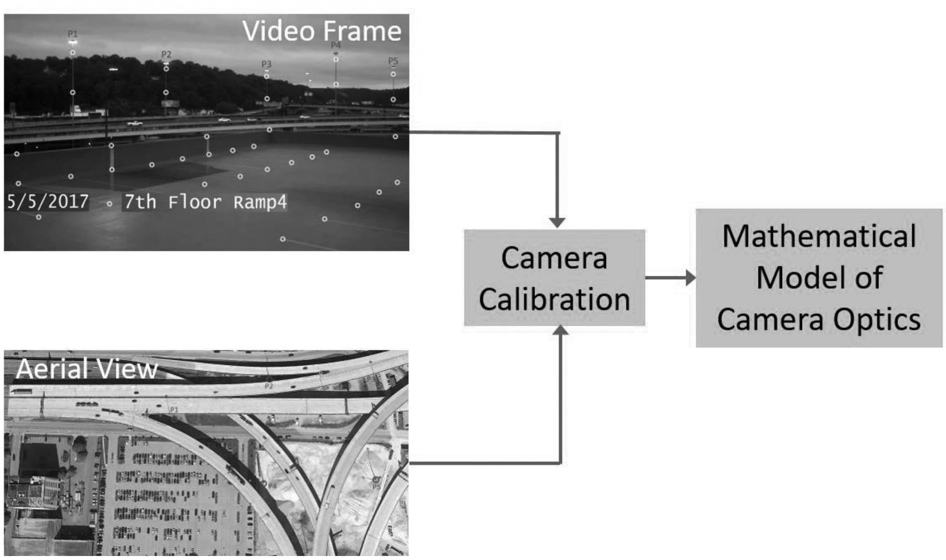

Figure 8. Block diagram of the calibration of the parking garage camera model.

which all four complexity criteria point to a low-complexity case. On top, in grey, is the most complex case in which all four criteria point to a high-complexity case. Most cases are in the medium-high–complexity range, where two or three criteria point to a high-complexity case.

Mathematical Model of Camera Optics and Its Use for Analysis

Video analysis aimed at estimating trajectories, altitudes, speeds, and orientation angles of airplanes is based on the use of mathematical models of camera optics. The strategy behind the use of such models is quite simple. Assume that a 3-D model of the airplane, with its dimensions specified in units of distance such as meters, is placed and oriented by an analysis program at a 3-D location in the field of view of a camera. The 3-D location is specified in meters, and the airplane orientation is specified by its Euler yaw, pitch, and roll angles. The analysis program is then used to project points on the airplane model onto frames from the analyzed video using the mathematical model of camera optics. These points can be located on the airplane nose, tail, and wingtips and on the fuselage and the wings, depending on the visibility of airplane details in the video.

Figure 2 illustrates the computational process of projecting points in the 3-D field of view of a camera onto 2-D video frames, simulating the process cameras use to record video frames. The camera sensor in the figure is at the location of the camera that recorded the video. The airplane model is located and oriented in the 3-D field of view of the camera. The image plane is placed in front of the camera sensor and is oriented according to the orientation of the camera. A point on the airplane model is projected onto a point in the video frame that is at the intersection of the image plane with a line from the camera to that point on the airplane model.

If the projected airplane model points are accurately placed on the images of these points on the real airplane as recorded in the analyzed video frame, then the airplane model 3-D location and its Euler angles used by the analysis program are the accurate estimates of the

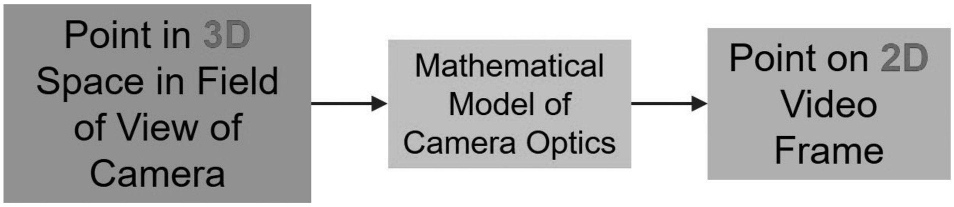

Figure 9. Camera model projection capability from 3-D to 2-D.

Figure 10. Video frame recorded when the airplane first became visible.

real airplane location and orientation angles. The process of aligning the projected points with their images has two stages. First, the mathematical model of camera optics must be calibrated. The model has seven parameters. Three are the X, Y, and Z location coordinates of the camera. Three are the yaw, pitch, and roll orientation angles of the camera. The seventh parameter is the horizontal field of view angle of the camera.

The seven camera model parameters are estimated in an iterative calibration process where they are varied until reference points on the ground, projected onto a video frame, are optimally aligned with their images in the video frame. At that time, the values of the seven camera parameters are their optimal estimates. The references used for calibration typically include points on buildings, roads, runways, and taxiways. These points must be visible in the video frame, and their ground coordinates must be known from aerial images or from an optical survey of the area. The resolution of Google Earth aerial images has become sufficiently high in recent years so that optical surveying is needed

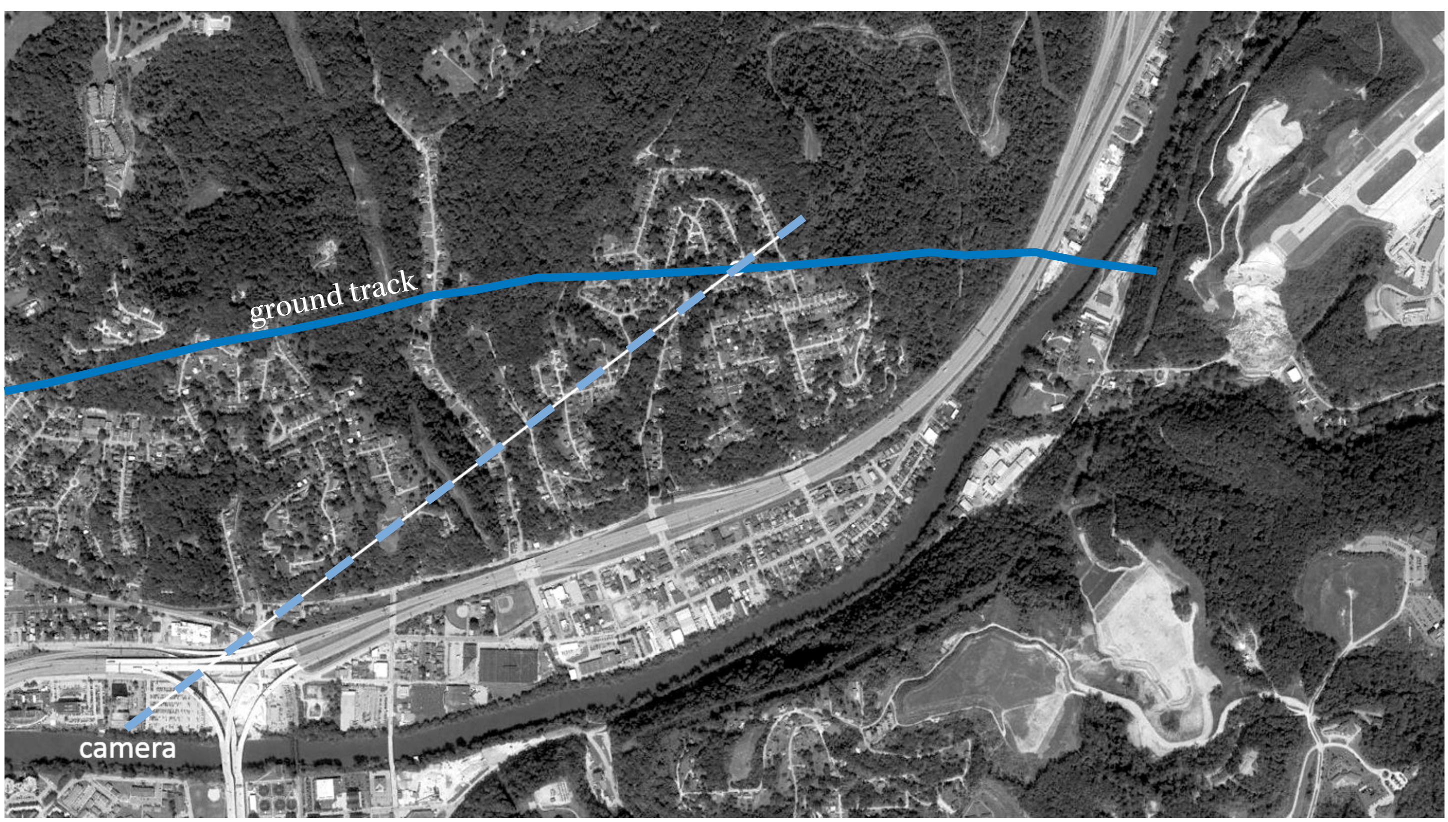

Figure 11. Accident area with superimposed ground track and azimuth direction from the parking garage camera to the airplane.

only infrequently.

Once the camera is calibrated, the location and orientation of the airplane is estimated in the second stage of the analysis process. The location and the orientation angles of a 3-D wireframe airplane model are varied in an iterative process until the points on it, projected onto a video frame, are optimally aligned with their images in the video frame. At that time, the three location coordinates and the three Euler angles are the optimal estimates of these parameters of the airplane at the time the analyzed video frame was recorded. This airplane location and orientation estimation process is repeated for each analyzed video frame.

In many cases, the details of the airplane are not visible in a video frame. The wireframe model of the airplane in such situations is just a point. While it is not possible to estimate the orientation angles of the airplane based on an image that is just a point, partial information on the location of the airplane can be derived and fused with information from other sources to derive an estimate of the location of the airplane.

The calibration and the use of mathematical models of camera optics is illustrated next using the analysis of a recent accident. It involves both the use of the wireframe model approach and the fusion of information from a video that does not show airplane details with radar information.

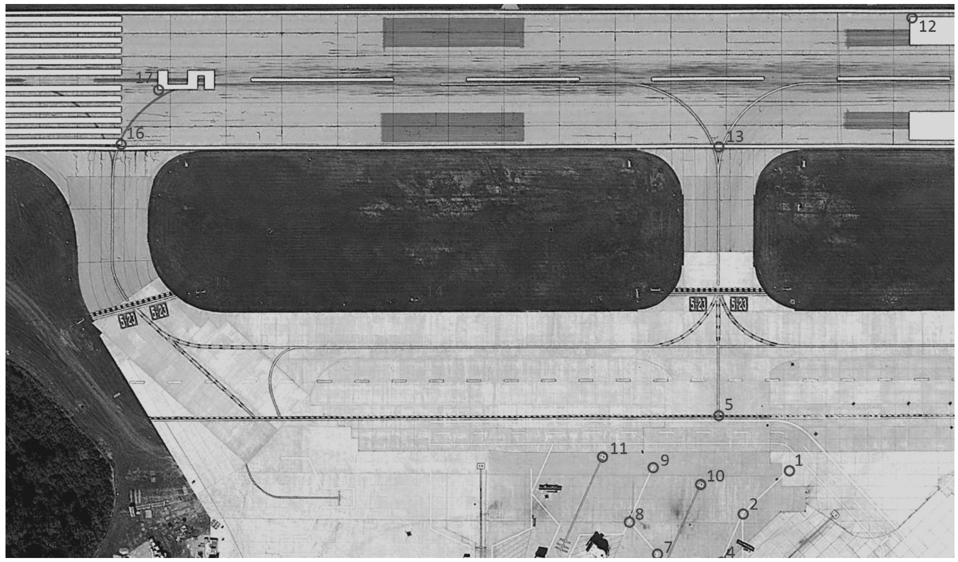

Figure 12. Aerial view of the airport with marked reference points.

Figure 11. Accident area with superimposed ground track and azimuth direction from the parking garage camera to the airplane.

Description of the Analyzed Accident

NTSB accident number DCA17FA109 is used to demonstrate the video analysis process. A Shorts SD3-30 airplane crashed during landing on May 5, 2017, on Runway 5 at Charleston Yeager International Airport (CRW) in Charleston, West Virginia. The airplane was destroyed and the two pilots suffered fatal injuries. The flight was a scheduled cargo flight from Louisville, Kentucky. At the time of the accident, weather was reported as an overcast ceiling at 500 feet (152 meters). Two cameras recorded the airplane as it was approaching the runway. One camera was on the top floor of a parking garage building in the city of Charleston, about 2 miles (3.2 kilometers) from the airport runway. Its frame rate was 6 frames per second. The other camera was on the airport control tower. It displayed new video frames at the rate of 2.857 frames per second.

Figure 3 shows a frame from the parking garage camera video. It was taken before the airplane became visible. Figure 4 shows a top segment of a frame from the airport tower camera video. It was taken before the airplane became visible. The airport tower camera video frame shows severe barrel distortion caused by the wide field of view angle of the camera.

Accident Analysis

The two videos recorded information that was extracted and analyzed to provide insight into two aspects of this accident. The parking garage video recorded the descending airplane as it emerged from the cloud cover. The estimated altitude of the airplane when it became visible in the video for the first time was considered an estimate of the overcast ceiling. This video-based estimate was used to determine whether the reported 500-foot (152 meters) overcast ceiling was accurate.

The airport tower video recorded the airplane as it impacted the ground on the runway. Analysis of this video provided estimates of the airplane speed and orientation angles at the time of ground impact. The analyses of the two videos are described next.

Camera Calibration

The analysis of this accident required

a calibrated mathematical model of the camera optics of each camera. The mathematical model of camera optics requires seven parameters. Three are the X, Y, and Z camera location coordinates. Three are the yaw, pitch, and roll camera orientation angles, and the seventh parameter is the camera horizontal field of view angle. The X and Y location coordinates of both cameras in this accident could be measured in Google Earth. The other five parameters of each camera had to be estimated.

The estimation was based on reference points that were visible both in video frames and in aerial images. The references used for the parking garage camera calibration included five highway light poles and parking space markings. The light poles were located between 575 feet (175 meters) and 1,200 feet (366 meters) from the camera. They are marked on the Google Earth aerial image in Figure 5. The parking space markings were located 130 feet (40 meters) or less from the camera. They are shown in the Google Earth aerial image in Figure 6.

Figure 7 shows a frame from the parking garage video with marked reference points that were used for calibration. The two points on each light pole were placed at fixed heights above ground because the heights of the light poles were not known.

Camera optics model calibration of each camera was performed as follows. A computer program that simulates camera optics was used to project the reference points onto frames from the video in an iterative process in which the five unknown camera parameters were varied so as to align the projected references with their images. When the projected references were aligned optimally with their images in the frame, values of the five parameters were their optimal estimates. At that point, the mathematical model of the camera optics was calibrated.

Figure 8 shows a block diagram of the calibration process of the parking garage camera where a frame from the video and an aerial view of the scene covered by the camera are analyzed to generate a mathematical model of the parking garage camera optics. The calibration of the airport tower camera followed the same logic and will be described later.

Figure 9 illustrates the capability of the mathematical model of camera optics to project points from the 3-D space in the field of view of a camera onto a 2-D video frame. It shows that the model can project from the 3-D space that includes large amount of information onto a 2-D video frame that includes much less information.

However, this is not what is needed for analysis of accident videos. We need information to flow in a direction opposite to what is shown in Figure 9, from the small amount in a 2-D frame to the 3-D space where three coordinates are needed to specify a location. This may initially look like an impossible task. However, it becomes possible when the 3-D to 2-D projection capability of the camera model is combined with additional information. That information can come from sources such as wireframe model alignment or a known ground track or a second camera. The example below illustrates the use of such additional information sources.

Analysis of Parking Garage Camera Video

Once the parking garage camera model was calibrated, it could be used for analysis of the video. Figure 10 shows the first frame from the video in which the descending airplane could be seen. It is marked by the yellow circle. Because of the distance from the camera, no airplane details are visible. The estimation of the distance of an airplane from a camera is ideally based on the dimensions of the airplane image in a video frame using the wireframe model approach. However, since the airplane image in this case was only a dot in the video frame, the distance could not be estimated this way, and without a distance estimate the altitude of the airplane could not be estimated either. Estimating the altitude was the goal because it was an estimate of the overcast ceiling. The only quantities that could be estimated without any additional information were the azimuth direction and the elevation angle from the camera to the airplane.

The additional information that made estimating the altitude of the airplane possible as it emerged from the cloud cover was radar data. Analysis of radar data provided the ground track of the airplane as it was approaching the airport.

Figure 11 shows an aerial view of the accident area. The ground track of the airplane derived based on radar data is shown with a solid line in the figure. The dashed line is the azimuth direction from the parking garage camera to the airplane that was estimated with the camera optics model based on Figure 8, as described above. The video analysis estimated the azimuth angle and the elevation angle from the camera to the airplane but not the location of the airplane along that direction. Fusing the video information and the radar information made it possible to estimate the ground coordinates of that location. That location is at the intersection of the radar-based ground track solid line and the video-based azimuth dashed line seen in Figure 11.With the ground coordinates of the airplane location estimated, the altitude of the airplane could be estimated by multiplying the ground distance from the camera to the airplane by the tangent of the elevation angle. The estimated altitude was 683±60 feet above the airport runway. This estimate is based on cloud cover at a location about 3,800 feet (1,158 meters) west of the landing spot on the airport runway.

Analysis of Airport Tower Camera Video

Figure 12 shows an aerial image of the airport with marked reference points that were used for airport tower camera calibration. Figure 13 shows the frame from Figure 3 after the barrel distortion was mathematically corrected. When compared to the distorted video frame in Figure 3, the pixels near the corners of the frame in the corrected frame are located farther away from the center of the frame. Marked on the frame are the reference points that were used for airport tower camera calibration. These points correspond to the reference points marked in Figure 12. The calibration process was similar to the calibration of the parking garage camera, i.e., using the block diagram shown in Figure 8 with Figure 13 and Figure 12 being the video frame and the aerial view, respectively.

The airport tower camera video was used for estimating the speed of

Figure 14. Frame from the airport tower camera showing the airplane and its wireframe model shortly before ground impact.

ground impact and the orientation of the airplane as it impacted ground. The airplane was visible in seven frames in the video over approximately 2.4 seconds. Only the last three frames showed the fuselage and both wings. In earlier frames, part of the airplane was not in the field of view of the camera.

Analysis of the airport tower camera video was based on a wireframe model of the airplane. Such models can consist of points on the fuselage, the tail, and the wings. The points can optionally be interconnected with lines. The wireframe models are dimensioned in units of distance, such as meters or feet, corresponding to the actual dimensions of the analyzed airplane.

In this case, because of the distance from the camera, only points on the nose, tail, and wingtips could be pinpointed in the video. Consequently, only these points were used in the wireframe model. The model nose was marked in grey, the tail in black, the left wingtip in white, and the right wingtip in blue. The nose and tail markers were interconnected with a light blue line, and the wingtips were interconnected with a dark grey line.

The calibrated camera model was then used to project the wireframe model onto frames from the video. The model automatically projected the 3-D wireframe model dimensioned in units of distance into its 2-D image in a video frame, dimensioned in pixels. The camera model was then used to iteratively move and rotate the wireframe model until its projection coincided optimally with the image of the airplane in a video frame. At that time, the location and orientation of the wireframe model were the optimal estimates of the location and orientation of the accident airplane at the time the analyzed video frame was recorded.

Figure 14 shows the last video frame before the left wing of the airplane contacted the ground and broke. It shows the wireframe model optimally superimposed on the image of the airplane. The previous and the next video frames were analyzed in a similar process. The three estimated locations of the airplane were then used to estimate the magnitude of the velocity vector of the airplane. It was estimated as 92±4 knots. The left-wing–down roll angle was estimated as 42 degrees at the time of ground impact and the nose-down pitch angle of the fuselage was estimated as 14 degrees.

Conclusion

This paper described the aviation accident video analysis activities at the NTSB. The analyses were classified based on their type and complexity. The core component of the tools used for video analysis, the mathematical model of camera optics, was introduced and explained. The analysis of a recent case was then described in detail. The accident involved an airplane that crashed at an airport while attempting to land. Videos from two cameras were used for estimating the overcast ceiling at the time of the accident, the speed of ground impact, and the orientation of the airplane at the time of ground impact. The analysis required calibrated mathematical models of the optics of the two cameras and used fusion of video and radar information for extracting airplane altitude data from one of the videos. ◆

Breaking Airlines' Flight

(Adapted with permission from the author's technical paper Breaking Airlines Flight Data Monitoring Barriers: A Pilot's Perspective 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)*

Some Flight Data Monitoring Pioneers

If someone tells you that fog in France and the UK helped to develop the first flight data monitoring (FDM) program in the early 1970s, you'd probably not take that very seriously. Yet this is part of the real story.

Until the mid-1960s, flight data recorders (FDRs) were exclusively used for accident investigations. This started to change when data recorders began to be used for aircrafts airworthiness aspects related to autopilot performance. New separate digital recorders apart from crash recorders were developed together with software on the ground to automatically monitor and detect specific parameters or flight path exceedance. This use was soon extended to certifying the first CAT III autoland operations for the Caravelle in France and the Trident in the UK. Thanks to this data monitoring program, passengers could be flown into foggy airports on days when manual landings would have been impossible.

The use of FDRs soon went much further, as it appeared that the nature and the amount of data made available could be used to monitor much more types of exceedances. Therefore, why not use it to detect near accidents of many types? This was an excellent idea, but in the early 1970s, human factors knowledge as well as "just culture" were not as mature as they are today.

The notion of airline pilots having the "right stuff" was dominant. Events detected through these programs had to necessarily be the result of a bad pilot's decisions and actions. Such a tool could have been very efficient to detect, judge, and discipline those bad pilots—the perfect way to prevent future accidents. These perception and fears, which were a bit caricatural, were nevertheless widely shared, and, therefore, pilots' fears were not totally unfounded.

Using recorded data for the benefit of CAT III operations was not an issue, but doing so to monitor all phases of flight from all flights meant something different for the pilot community. Any flight (i.e., any pilot) could be monitored by anyone who had access to the records, even by those who had little or no flight operations expertise.

FDM programs had great value and deserved to be implemented, but this had to be done with great precaution. This was discussed within the IATA Safety Advisory Committee and more particularly among British Airways, Air France, and TAP representatives who were all from airlines involved in CAT III autoland certification programs at that time.

Eventually, people of goodwill from pilots' organizations and airline managements were able to overcome these very real obstacles. They were deeply convinced that, if properly used, recorded data could contribute efficiently to prevent accidents.

At Air France, an FDM agreement was signed in April 1974. To demonstrate to all pilots the value of the program, an FDM bulletin was created and published

Data Monitoring Barriers

By Capt. Bertrand de Courville, ISASI Member, Retired Captain, and Corporate Safety Manager, Air France, Safety Risk Management Consultant

four month later, in August 1974, to share the most interesting events. But without input from the pilots involved, the lessons were limited and sometimes only hypothesis.

In 1984, the FDM agreement was modified in order to have access to pilots' feedback. A nonpilot trusted person—at this time there was no notion of gatekeeper—was assigned to contact pilots and was responsible for keeping their anonymity.

At British Airways, a very similar program and solutions were developed—still in use today—known as SESMA (Special Event Search and Master Analysis). An agreement was made with the BALPA union stipulating that only the fleet-specific BALPA SESMA representative was able to identify the pilot. In fact, an independent trusted flight ops manager had the ability to find out which crew was involved in a SESMA event and pass that name to the union rep.

This was a major innovation for flight safety. Nevertheless, it remained limited to a small number of airlines, mostly European, for decades before beginning to be adopted slowly across the world. This process required onboard equipment as well as software and human resources on the ground. And above all, it needed strong internal rules to maintain a minimum level of trust. FDM worked, but most pilots still perceived it as a threat. While pilots understood the need for recorded flight data analysis in case of accidents, they were very cautious about its use for daily flights. But beecause "confidentiality" and "anonymity" barriers were robust enough, they simply trusted the program.

As necessary as they were, these barriers had serious drawbacks mainly regarding FDM information sharing and innovations. FDM rules in place within the agreements were so efficient and so well respected that no one dared to change anything. Many initiatives to make FDM more flexible for the benefit of safety or to introduce some innovation were always feared because they might undermine the precious agreement. It took 10 years for Air France, one of the FDM pioneer airlines, to be able to communicate FDM events to the interested crews and get in return, anonymously, their valuable feedback.

Having in mind that any misuse could jeopardize the whole program, what had been put in place was most often considered as enough and interesting suggestions were dismissed. Although these FDM programs worked well at some airlines, they were nearly frozen and stayed resistant to any change.

In the meantime, digitalization was transforming all aspects of flight operations, including many other safety processes. As a result, during more than 40 years of the Air France, British Airways, and TAP initiative, individual pilots were kept from their flight data. Only when something wrong had happened, and an FDM event had been identified, pilots could receive their data. It is no surprise that pilots' and airlines' attitude regarding everything related to flight data monitoring remained defensive to the point that FDM potential stayed largely underexploited.

Who Owns the QAR Data?

During the recent EASA/FAA conference in Cologne, Germany, a participant to a conference session dedicated to safety intelligence asked, "Who owns the QAR data?" The question is simple, but the

Capt. Bertrand de Courville

answer is not. The session panelists did not really answer it. However, it deserves more attention, at least in the context of this article. One pragmatic approach is to say that recorded flight data belongs to those who use it. So let's have a look at these users. First, we have experts from airline safety departments who may process the data either directly through their own program or through FDM subcontractors. We also have experts from large organizations such as the FAA through its ASAP where its subcontractor is processing large amounts of aggregated data provided by airlines. Experts from manufacturers are also collecting and processing operational recorded data as well as experts from research teams working closely with airlines on very specific safety topics. There are also consulting companies specializing in fuel cost reduction that have contracts and agreements to use aggregated data. All these programs and contracts are formally defined to guarantee the anonymity of data. Individual pilots are never identified, and airline anonymity is also part of the agreements in programs such as ASAP in the U.S. and more recently EASA's Data for Safety (D4S). All experts involved in these activities can be considered as users and as detaining a part of a shared data ownership, but not the pilots.

Pilots of These Flights Are Not Users

Some may say that pilots benefit from this flight data indirectly and collectively through training programs oriented through or safety awareness bulletin based on deidentified data analysis. Regarding individual access to data, some may also say that pilots may ask their airline whenever they want to look at part of their data. This is true for only a limited number of airlines, and these airlines have no resource to respond if requests become too numerous. When this happens, pilots are often given nonintuitive lists of figures and curves with little explanations. This does not encourage pilots to ask again.

In some cases, pilots could visit the department and have a look at the 3-D animation tool used by the safety department, when the safety managers have time to do so. Yet pilots are also hesitant about asking for recorded data coming from their own flights, even when there is no deviation, because they fear being suspected of having made some errors and not reporting them. Again, the same defensive attitude regarding recorded data is dominant.

The truth is that well into the digital age, more than 40 years after the first FDM programs, individual airline pilots still do not have a direct access to their own flight data. Today, even general aviation pilots can look at a record of their flight path on their tablets.

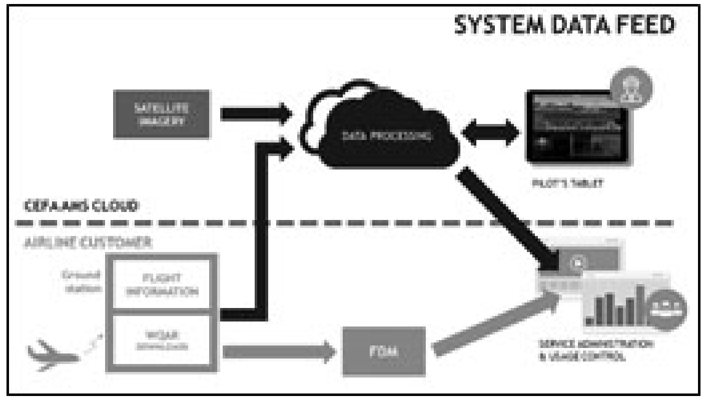

Figure 1: QAR data processing for both mobile service and FDM program.

Photo: Courtesy CEFA Aviation

Breaking the Barriers

In 2017, All Nippon Airways broke the barriers by giving its pilots a direct access to their flight data on their professional tablets. This was made possible thanks to a powerful and well-thought-out combination of Internet and data processing tools. Flight data is translated and displayed under an intuitive format consisting of detailed video animations of the cockpit instruments simultaneously with the aircraft flight path. Thus, each of the 3,000 All Nippon Airways pilots could freely replay key animated periods of their own flights. Since then, a daily average of 200 video animations are reviewed.

In the future, in addition to the very first users (All Nippon Airways and Ryanair), other airlines will use similar programs. This can be considered as a major and long-awaited step, comparable to the birth of FDM in the early 1970s in Europe.

First, how does it work? After each flight or series of flights, QAR data is sent as usual to the airline FDM server through a wireless communication channel. But in addition, this QAR data is now encrypted and uploaded into a dedicated, secured server in which high-performance video animation software is placed. When a pilot needs to review their take off or approach and landing, the pilot just opens the list of previous flight numbers displayed on a tablet through the application and clicks on the specific flight. The software then creates the animation in the cloud and makes it accessible (see Figure 1).

Each commercial aircraft type is available in this mobile service in order to make images as realistic as possible, particularly regarding cockpit controls and instruments displays.

Various security measures have been developed. Pilots have access only to their own flights on a personal account. No one else can see it. The animations must be reviewed on a streaming mode and cannot be downloaded on a tablet. Data is deidentified. The airline FDM program remains unchanged: FDM events are monitored and addressed by the safety team the same way. The same confidentiality and anonymity rules that made possible the very first FDM programs at Air France, British Airways, and TAP in 1974 are still in place. Individual pilots are still protected from any misuse. More protections can be applied depending on each airline policy.

How is such an innovation justified? Pilots could say that hundreds of experts from various organizations are looking at "their data" so why not us? If it is technically feasible today, at a reasonable cost while complying with anonymity and confidentiality rules, pilots' access to their own flight data will be perceived as a "right" and does not need to be justified further. But there is more than this.

A premonitory article published in 1966 by Flight International suggested that more use should be made of FDRs in normal service to "monitor pilot approach performance" and that airline managements should be persuaded that "flight recorders are not just crash recorders…they are pilot training aids." Today, we could write it this way: "QARs tool are not only there to detect FDM events, they are pilot training aids." This is exactly the point.

From their very first flight hours, pilots are mentally reviewing each of their flights to understand what went well and what did not. When it relates to a first solo flight, it is not exaggerated to say that it is a very personal question of life or death. Pilot culture is made of that. Airmanship, experience building, and learning processes are based on this capacity to question one's own performance and identify potential ways to improve. After a flight, this process is essentially based on a pilot's memory, and when it comes to flight training it is based on the flight instructor's memory.

In modern and complex aircraft, many situations happen in such a way that they are impossible to be memorized correctly. Even experienced flight instructors are missing significant aspects of a pilot's performance. As an example, autopilot mismanagements scenarios are often very dynamic and complex. By having access to their own data, pilots can review and better understand a sequence of actions, not only by memory but from what has really been recorded. Doing so while the crew is still together will make debriefing possible and much more efficient. We are not far from evidence-based training principles, brought to an individual level. In a way, such a tool can be compared to videos used in sports to make progress. Any better understanding of things that went well or not help an individual to improve and to build the right level of self-confidence sooner.

This "digital-age approach" is going to be beneficial to pilot performance at the front line. Because it is much less visible and difficult to measure, we may tend to underestimate it, but we must recognize it as a key component of airline safety performance.

On the other hand, at the safety management level and as regards to possible benefits to reporting programs, we may use the same example. Automation mismanagement is hardly reported on when there are no visible effects on a flight either because they are detected and corrected early enough or because the circumstances at the time prevented them from having any consequence. Being able to replay a sequence of events will give factual evidence and encourage pilots to report.

What About the Future?

Hideo Morioka, All Nippon Airways senior director of safety promotion and flight data analysis, said, "It has revolutionized the company culture regarding the debriefings and the use of flight data…. It has freed pilots' speech."

Empowering pilots around the world to learn from their own flight data, daily, and not only after a visible incident or a deviation detected through FDM/FOQA programs, has the potential to change pilots' attitude regarding recorded flight data. From defensive, it could become more constructive. Not only because they are now sharing part of the flight data "ownership," but also because they are benefiting directly from it. In addition, new generation of pilots are more familiar and positive about new IT tools, which make them more autonomous. This could unlock historical barriers and make possible future developments beneficial for airline SMS. ◆

RAISING THE BAR ON SAFETY:

REDUCING RISKS FOR CANADIAN AIR-TAXI OPERATIONS

By Glen Whitney, Regional Senior Investigator (Ontario), Transportation Safety Board of Canada; Heather Parker, Senior Human Factors Investigator, Transportation Safety Board of Canada; Doug McEwen, Regional Senior Investigator (Atlantic), Transportation Safety Board of Canada; and Pierre Gavillet, Regional Senior Investigator (Québec), Transportation Safety Board of Canada

Introduction

Safety in the air-taxi sector has been the subject of concern, as well as numerous studies and reviews, for more than 27 years. The air-taxi sector, in simple terms, is comprised of smaller aircraft, both helicopters and airplanes, having nine or fewer passenger seats providing scheduled and nonscheduled service. It is a challenging sector of commercial aviation, given its complex operating context, and it experiences a high number of accidents, especially fatal ones. In the 15 years between 2000 and 2014, the Canadian air-taxi sector experienced 716 accidents resulting in 227 deaths. These accidents represent 56% of all commercial aviation accidents in Canada and account for 64% of commercial aviation fatalities.

This paper summarizes the results of a recent safety issues investigation conducted by the Transportation Safety Board (TSB) of Canada. The investigation examined in detail the state of safety in the air-taxi sector and identified where the safety bar can be raised to reduce the number of accidents, particularly fatal ones. Data was collected, analyzed, and combined from accident summaries, investigation reports, and interviews with industry participants. The highest number of fatalities in both airplane and helicopter air-taxi accidents resulted from flights that started in visual meteorological conditions and continued to a point where the pilot lost visual reference with the ground.

There were two key categories of underlying factors: the acceptance of unsafe practices and the inadequate management of operational hazards. Nineteen safety themes were identified from the large dataset. All results were further analyzed within a model called the safe operating envelope. Recommendations to address the safety risks in the air-taxi sector are presented.

Background

The air-taxi sector provides a diverse array of air services to Canadians. These include helicopters to transport injured or ill patients to hospitals; floatplanes to take commuters from harbor to harbor in coastal cities; and airplanes to bring workers to remote areas, provide search and rescue, or deliver food, equipment, and passengers to communities. These vital air links have helped build Canada and sustain its people. In 2015, approximately 550 companies in Canada held an air operator certificate for air-taxi operations.

Although air-taxi operations are diverse, they are all covered under the same regulations: Subpart 703 of the Canadian aviation regulations (CARs). The CARs were drafted to recognize the differences among segments of the industry, with smaller aircraft (defined by certified seating capacity) being subject to less-stringent regulation. The technical definition of air-taxi operations in the CARs is the operation by a Canadian air operator, in an air transport service or in aerial work involving sightseeing operations, of any of the following aircraft:

(a) a single-engined aircraft;

(b) a multiengined aircraft, other than a turbojet-powered airplane, that has a MCTOW (maximum certified takeoff weight) of 8,618 kilograms (19,000 pounds) or less and a seating configuration, excluding pilot seats, of nine or less;

(b.1) a multiengined helicopter certified for operation by one pilot and operated under VFR (visual flight

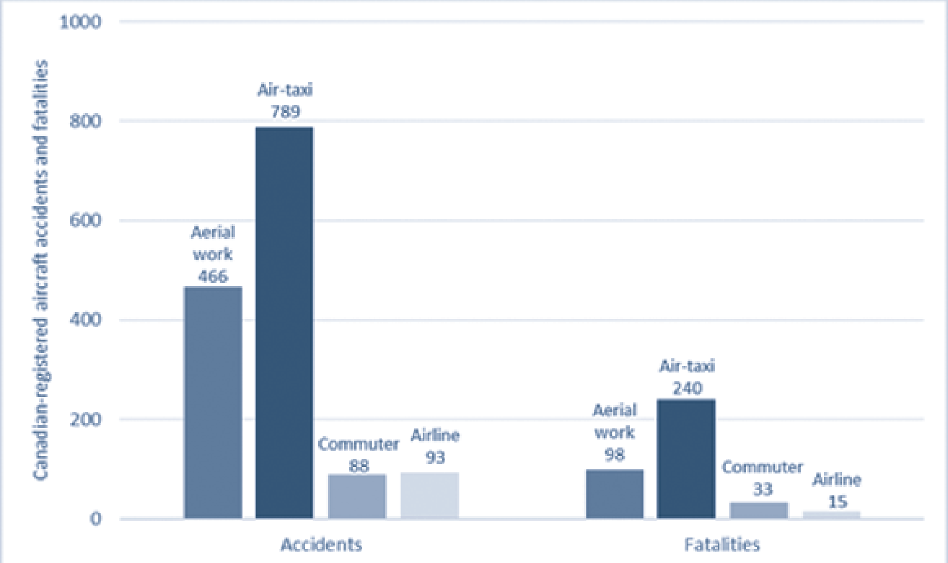

Figure 1. Total number of accidents and fatalities involving Canadian-registered aircraft by operator type, 2000 to 2017. (Source: TSB)

(Adapted with permission from the authors' technical paper Raising the Bar on Safety: Reducing the Risks Associated with Air-Taxi Operations in Canada *submitted for ISASI 2020 in Montréal, Québec, Canada. ISASI 2020 was postponed until 2021 due to COVID-19 restrictions. The full technical paper can be found on the ISASI website at www.isasi.org in the Library tab under Technical Presentations.—Editor)*

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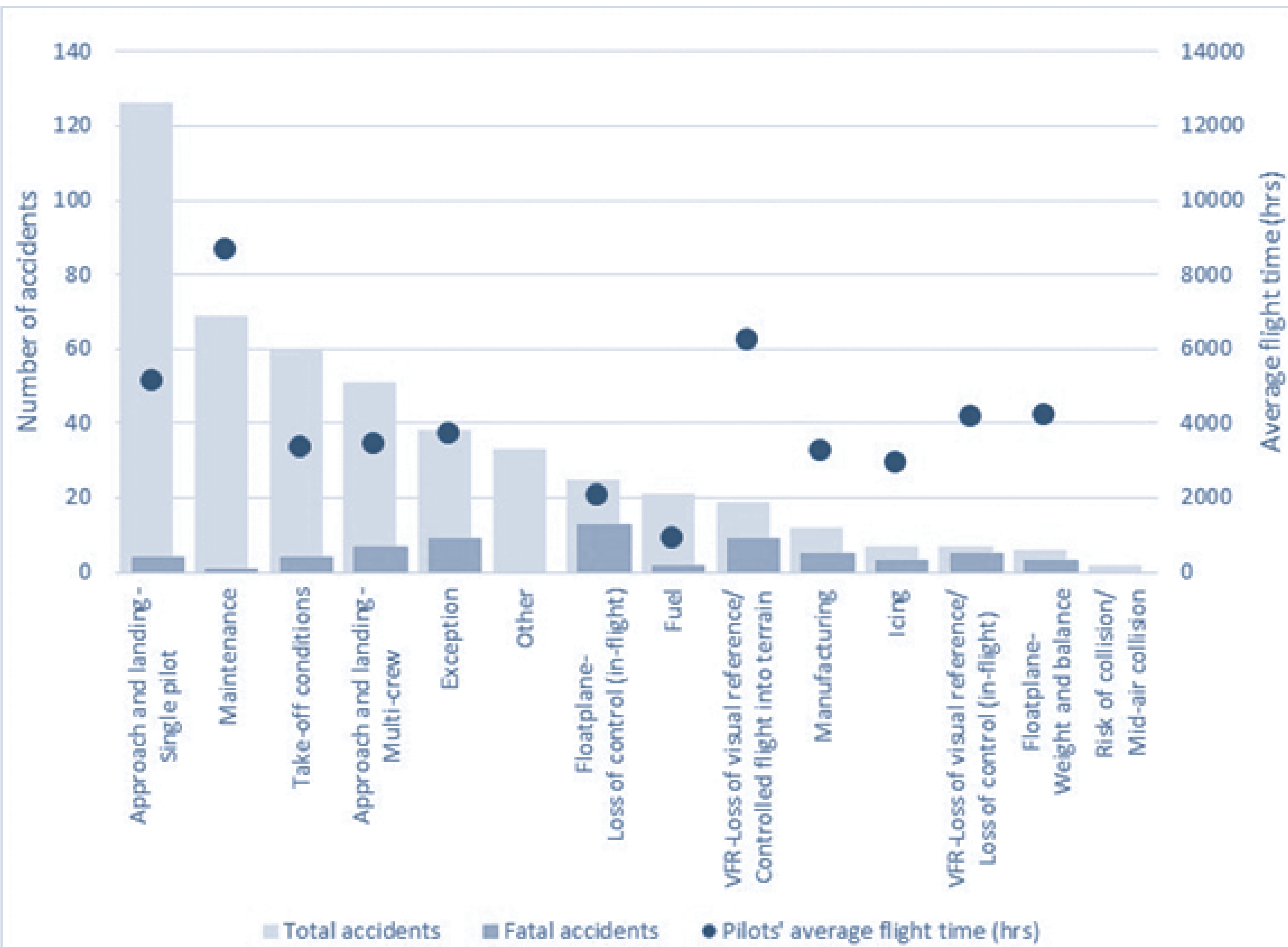


Figure 2. Average flight time for pilots involved in airplane air-taxi accidents compared to the total number of airplane accidents and fatal accidents during the study period 2000–2014.

rules); and

(c) any aircraft that is authorized by the minister to be operated under this subpart.

Other commercial operations regulated under the CARs and discussed in this report include

- airline operations (Subpart 705) involving aircraft built to carry 20 or more passengers, generally used for commercial passenger flights;
- commuter operations (Subpart 704) involving aircraft built to carry 10 to 19 passengers, generally used for commercial passenger flights; and
- on-demand charter flights and aerial work (Subpart 702) involving aircraft used to perform jobs such as fighting forest fires or spraying pesticides on crops.

Air-taxi services operate in a very different context from other sectors of aviation. They often have no set schedule and fly into remote areas in uncontrolled airspace with few airports or navigation aids. What airports there are may be small, with fewer services and less infrastructure. Access to current and forecast weather information or the latest technology may be limited. Operators tend to be smaller. Flight crews have a more direct role in managing many of the operational hazards, and pilots often have direct contact with clients.

Compared to those who fly for other commercial purposes, air-taxi pilots may not have operational support from dispatch and other personnel. Flights tend to be shorter, resulting in more takeoffs and landings. Aircraft are exposed to

Table 1. Safety themes identified from interviews with air-taxi industry and corresponding conclusions

Safety theme	Conclusion
1. Airports and infrastructure	Remote and northern communities of Canada require appropriate airport facilities and infrastructure to ensure that air-taxi operators can provide safe air services for those communities.
2. Availability of qualified personnel	The availability of qualified personnel is critical to safety; competent personnel is a key component in managing risk.
3Airborne collision avoidance	Traffic avoidance services and procedures are critical elements to mitigate the risk of collision.
4. Interruptions and distractions	Well-developed company policies and standard operating procedures are critical to reducing the likelihood and effects of personnel being interrupted and/or distracted.
5. MEDEVAC operations	The unique nature of conducting MEDEVAC operations can place a great deal of stress on pilots and may have a negative influence on their decision-making.
6. Night operations	Adequate visual references during night operations are critical to ensuring the safety of the flight.
7. Onboard technology	Improved technology, if incorporated into an operation, has significant potential to enhance safety in air-taxi operations.
8. Survivability	Aircraft crashworthiness, safety information, and safety equipment are key components to improve occupant survival in the event of an accident.
9. Weather information	Accurate weather information is a critical component of flight planning and allows pilots to make effective weather-related decisions.
10. Acceptance of unsafe practices	If unsafe practices are not recognized and mitigated, or if they are accepted over time as the "normal" way to conduct business, there is an increased risk of an accident.
11. Fatigue	Fatigue-related impairment has a detrimental effect on aviation safety so it is important to manage it in the air-taxi sector.
12. Maintaining air-taxi aircraft	Maintaining aircraft in a serviceable condition is fundamental to ensuring the safety of flight.
13. Operational pressure	Internal and external pressures, including pressure to get the job done, can negatively impact safety.
14. Pilot decision-making (PDM) and crew resource management (CRM)	PDM and CRM are critical competencies that help air-taxi flight crews manage the risks associated with aircraft operations.
15. Training of pilots and other flight operations personnel	Providing training for pilots and other flight operations personnel is essential for them to develop the skills and knowledge they need to effectively manage the diverse risks associated with air-taxi operations.
16. Training of aircraft maintenance engineers	Aircraft maintenance engineers working in air-taxi operations require extensive technical knowledge to ensure that the wide variety of aircraft types and models used in this sector are maintained in airworthy condition.
17. Safety management	Effective safety management is important for air-taxi operators to be able to proactively identify hazards and mitigate risks to a level as low as reasonably practicable.
18. Regulatory framework	Regulations must keep pace with advances in the aviation industry to help achieve an acceptable level of safety.
19. Regulatory oversight	A robust system of regulatory oversight that includes safety promotion, monitoring, and enforcement is critical to ensuring that air-taxi operators are provided with the support they need to effectively manage the risks associated with their operation and that they are complying with the regulations.

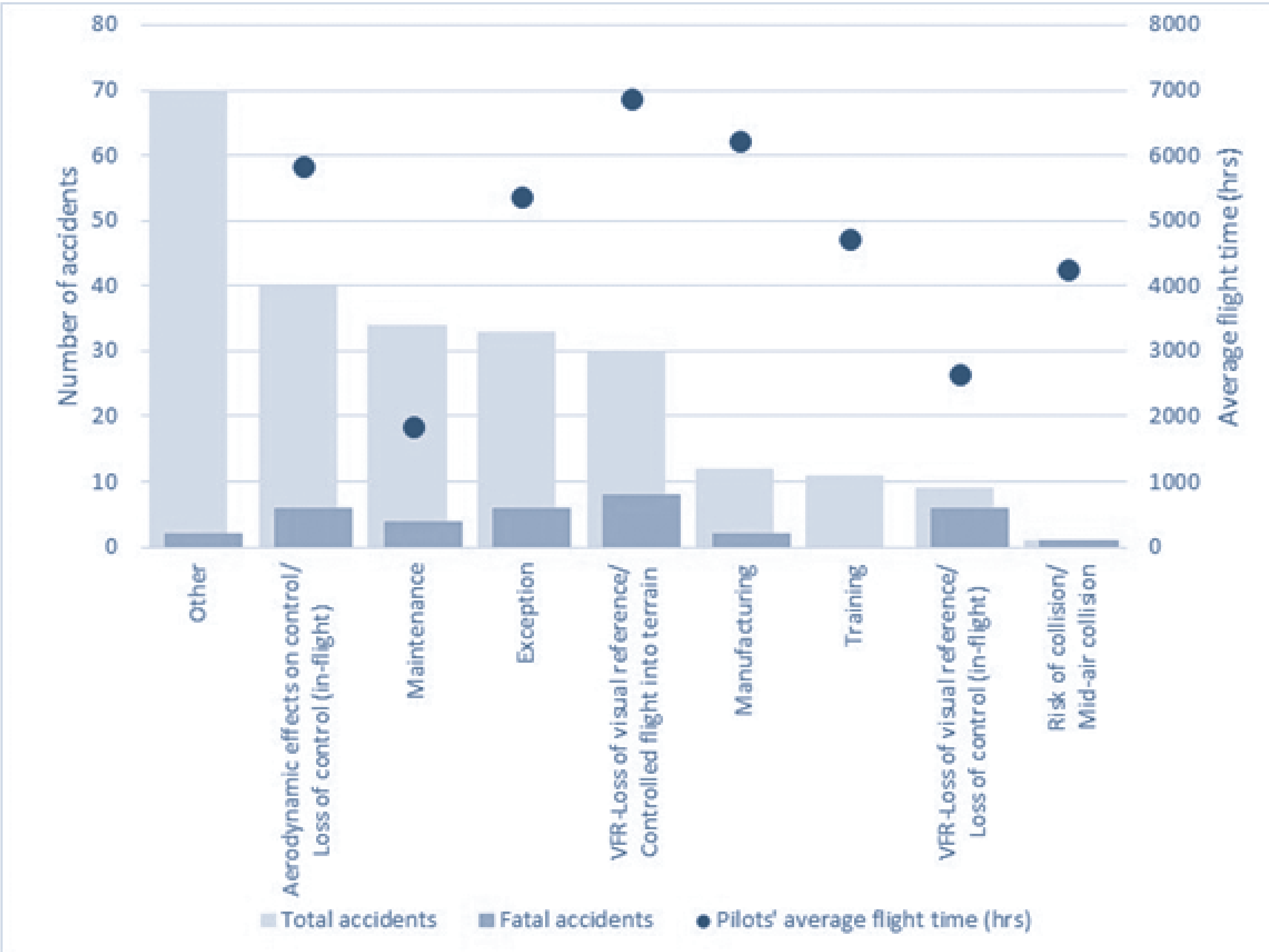


Figure 3. Average flight time for pilots involved in helicopter air-taxi accidents compared to the total number of helicopter accidents (240) and fatal accidents during the study period 2000–2014.

more severe weather because they are flown at lower altitudes and over rugged, coastal, or northern topography. The aircraft can be small (carrying fewer than 10 passengers, by regulation) and in many cases old (some more than 70 years old) and with less-sophisticated technology. Pilots often fly by visual reference to the ground, rather than navigating using instruments alone. Flight crews may have to land on gravel airstrips, lakes, or frozen surfaces—especially helicopter crews that often have to land at unprepared sites.

The air-taxi sector has had more accidents and more fatalities than all other sectors of commercial aviation in Canada. The numbers speak for themselves. In the 18-year period from Jan. 1, 2000, to Dec. 31, 2017, there were 789 accidents in the air-taxi sector, resulting in 240 fatalities—representing 55% of all accidents in commercial air services in Canada and 62% of the fatalities in this period (see Figure 1).

By contrast, during the same period, airline operations in Canada experienced 93 accidents (6% of the total) and 15 fatalities (4% of the total).

The safety issues underlying air-taxi accidents are known, and they are persistent. The hazards and risks have been identified, and mitigation measures have been recommended in numerous studies and reviews, some of which go back nearly three decades. And yet the air-taxi sector continues to experience a high number of accidents and fatalities. Why these accidents keep happening and how safety in the sector can be improved is what the TSB's Safety Issue Investigation (SII) into the safety of the air-taxi sector sought to explain. This paper presents a condensed summary of the results of the larger SII.

Method and Results

In the first phase of the SII, the investigation team reviewed TSB occurrence data, previous investigation reports, and reports on safety in the air-taxi sector by other organizations. The investigation team analyzed 716 occurrences in air-taxi operations that were reported to the TSB from 2000 to 2014 (the study period) to determine whether there were any patterns or trends.

Statistical analysis showed a downward trend in the total number of air-taxi accidents during the study period. However, there was no similar downward trend in the number of fatal accidents or fatalities over this period. Because activity data in Canada is reported only for commercial aviation as a whole, it is not possible to calculate an accident rate specific to the air-taxi sector.

More insightful was reviewing the TSB investigation reports for 167 of the occurrences from the study period. Using the grounded theory qualitative method, investigators categorized accident types based on the circumstances described in the reports. The analysis provided a more precise understanding of how these accidents were happening and revealed that the highest number of fatalities in both airplane and helicopter air-taxi accidents resulted from flights that started in visual meteorological conditions and continued to a point where the pilot lost visual reference with the ground. The main difference was how the flight ended: in a loss of control or a controlled flight into terrain (CFIT).

Figure 2 shows summary statistics for accident types and pilot experience (hours flown) for air-taxi airplane occurrences. Of the 476 airplane accidents, the most common types were

- single-pilot approach-and-landing (26%),
- maintenance-related (14%),
- takeoff-condition–related (13%),
- multicrew approach-and-landing (11%), and
- floatplane loss-of-control (5%).

The highest number of fatalities occurred as a result of floatplane accidents involving loss of control (34 deaths), followed by VFR + loss of visual reference + CFIT accidents (26 deaths) for airplanes other than floatplanes.

A pilot's level of experience can affect the risk of being involved in an accident. Pilots who were involved in maintenance-related accidents had an average total flight time of 8,657 hours, the highest flight-time average of all accident types. The lowest flight-time average, 912 hours, was held by pilots who had been involved in fuel-related accidents.

Figure 3 shows summary statistics for accident type and pilot experience (hours flown) for air-taxi helicopter occurrences. Of the 240 helicopter accidents, the most common accident types were

- aerodynamic effects on control with loss of control (17%),
- maintenance-related issues (14%),
- VFR + loss of visual reference + CFIT (12%),
- manufacturing-related issues (5%), and
- training (5%).

The highest number of fatalities occurred as a result of helicopter accidents involving VFR + loss of visual reference + CFIT (14 deaths), followed by VFR + loss of visual reference + loss of control (13 deaths).

Pilots involved in VFR + loss of visual reference + CFIT accidents had the highest average total flight time, 6,837 hours, of all helicopter accident types. Pilots involved in maintenance-related accidents had the lowest average total flight time, 1,800 hours.

Figure 3. Average flight time for pilots involved in helicopter air-taxi accidents compared to the total number of helicopter accidents (240) and fatal accidents during the study period 2000–2014.

Finally, analysis of the all of the accident data, airplanes and helicopters combined, revealed that the factors contributing to air-taxi accidents fell into two key categories:

- Acceptance of unsafe practices (e.g., flying overweight, flying into forecast icing, not recording defects in the aircraft log, flying with unserviceable equipment, "pushing the weather," and flying with inadequate fuel reserves).
- Inadequate management of operational hazards (e.g., inadequate response to aircraft emergencies, inadequate crew coordination contributing to unstable approach, VFR flight at night, loss of visual reference in marginal weather conditions, scales not available for weight and balance calculations).

The pilots involved in these accidents had a combined overall average of 5,000 hours of experience. Therefore, it would appear that pilot experience is not necessarily mitigating against these types of accidents. In the air-taxi sector in the past, it was generally believed that the greatest risk of an accident came from inexperienced pilots pushing the limits; however, what emerged from the SII was that accidents involved both inexperienced and highly experienced pilots alike.

The SII could not draw conclusions on the accident rate in the air-taxi sector in Canada by hours flown or by number of movements (takeoffs or landings). The data is currently collected or reported only for commercial aviation as a whole. Furthermore, movement data is not captured for locations where air-taxi operators are more likely, such as uncontrolled airports, remote locations with unprepared landing sites, or lakes.

To get a better understanding of the pressures on the industry and the issues faced in daily work, in the second phase of the SII TSB investigators interviewed 119 people from 32 air-taxi operators, as well as six civil aviation inspectors from Transport Canada, the regulator. Approximately 300 hours of audio interview recordings provided a rich source of insight into the air-taxi sector.

Using the grounded theory qualitative method, the information from these interviews was analyzed and organized into 19 safety themes. Further analysis within each theme (using accident data, previous studies, and TSB safety recommendations) yielded the conclusions presented in Table1.

Discussion

To understand how these 19 safety themes interact with each other as well as how they connect to the underlying factors of the accident analysis, namely the acceptance of unsafe practices in air-taxi operations and the inadequate management of operational hazards, the investigation team analyzed the safety themes within a model called the safe operating envelope. The resultant visual representation (see Figure 4) can be used to help explain the persistence and complexity of the factors contributing to

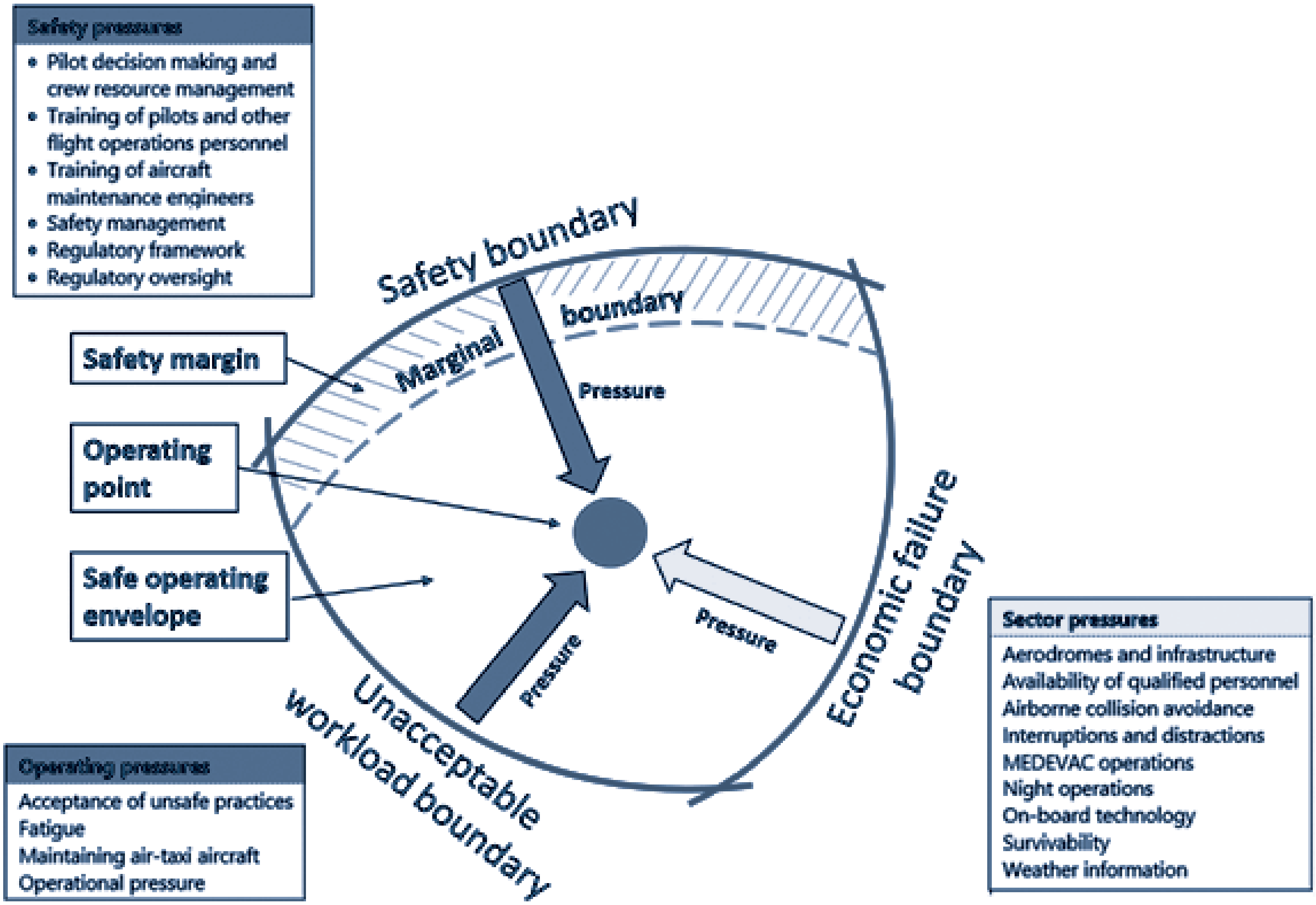


Figure 4. The safe operating envelope model adapted for this SII. (Source: TSB)

air-taxi accidents.

In this model, the air-taxi sector (or an individual operator) is represented by the operating point (the blue circle in Figure 4), and its position is determined by how hazards and risks are managed. As a result, the operating point is constantly moving. If it crosses any of the boundaries of the safe operating envelope (dark blue lines in Figure 4), the system breaks down. The boundaries are

- economic factors (the financial costs become unsustainable),
- workload factors (there is not enough time or resources available), and
- safety factors (there may be harm to workers, passengers, or the public).

The marginal boundary (light blue hatched area in Figure 4) depicts the depth of the safety margin: the fewer or weaker the defenses in place, the narrower the safety margin. As the operating point crosses over the marginal boundary, the safety of the operation diminishes until the operating point crosses the safety boundary, where a failure (an accident or incident) occurs.

These multiple pressures affect the dynamics of the model and are influenced by many stakeholders in the air-taxi sector (see Figure 5). In addition to the stakeholders close to the "sharp" end of the operation, namely the operator and individuals, the regulator and the manufacturers, two other key stakeholders, have very important roles in the safety of air-taxi operations, clients, and passengers. Clients, those who pay for air-taxi services or need them for their communities or cities, can influence how air-taxi services are delivered and overseen. As well, passengers on air-taxi flights are much more involved in frontline safety than those on other commercial flights. Safety knowledge imparted to air-taxi passengers can have an important influence in the safe operation of a flight.

The model in Figure 4 shows the interaction among three kinds of pressures observed in the data and provides direction for their management on an ongoing basis.

- *Sector pressures* are operational hazards that increase the level of risk and are part of the context of air-taxi operations. They can and should be planned for and managed before a flight takes off.
- *Operating pressures* increase the risks within the air-taxi sector and are tied to the day-to-day demands of efficiency in a financial and a workload sense.
- *Safety pressures* counteract the sector and operating pressures, mainly based on actions carried out before a flight.

In order to raise the bar on safety in

air-taxi operations, all stakeholders need to change to a culture in which unsafe practices are not accepted. Operating safely has to become the norm.

Increasing the safety pressures has the potential to influence safety in a meaningful way in this sector in Canada. Working with safety as a balancing pressure, rather than merely a cost, can elevate safety in day-to-day operational decisions and risk management.

Recommendations

Practically speaking, the SII concluded that the 22 active TSB recommendations that apply to the air-taxi sector need to be addressed. In addition, stakeholders must work together to

- change the safety culture by using modern safety management to support PDM and CRM, including single-pilot CRM;
- invest in measures to increase the safety pressures within air-taxi operations: PDM/CRM; training of pilots, other flight operations personnel and aircraft maintenance engineers; safety management; and regulatory framework and oversight;
- invest in measures to decrease the sector pressures (e.g., provide better weather information) and operating pressures (e.g., manage fatigue); and
- improve how activity (rate) data is obtained to better evaluate how well safety measures are working.

The TSB issued four new recommendations as a result of the SII. These are described next.

An important step in raising the bar on safety in air-taxi operations is getting clients, passengers, crews, and operators to not accept unsafe practices even when there seems to be a sufficient safety margin and to speak up to prevent unsafe practices from happening. This requires strategies, promotion, and education tailored to the air-taxi sector to change values, attitudes, and behaviors and to create a culture in which unsafe practices are considered unacceptable.

Therefore, the board recommends that the Department of Transport collaborate with industry associations to develop strategies, education products, and tools to help air-taxi operators and their clients eliminate the acceptance of unsafe practices.
TSB Recommendation A19-02

Many operators belong to a variety of associations, such as the Air Transport Association of Canada (ATAC), the Helicopter Association of Canada (HAC), the Association Québécoise du Transport Aérien (AQTA), the Floatplane Operators Association (FOA), and the Northern Air Transport Association (NATA). Such associations are well positioned to influence safety within the sector and can provide a venue for sharing best practices, tools, and safety data specific to air-taxi operations. They can also provide assistance and training in implementing proactive safety management that incorporates a positive safety culture.

Therefore, the board recommends that industry associations (e.g., ATAC, HAC, AQTA, FOA, and NATA) promote proactive safety management processes and safety culture with air-taxi operators to address the safety deficiencies identified in this safety issue investigation through training and sharing of best practices, tools, and safety data specific to air-taxi operations.
TSB Recommendation A19-03

Some operators interviewed for the SII identified gaps in the existing regulations and standards. Others recommended practices that go beyond the current regulatory requirements or that include concepts that are not yet addressed by regulations. For example, some operators carry out all flights under IFR, use two pilots for all operations, or establish their own minimum requirements for pilot flight experience.

However, in the face of competing pressures, operators may choose to simply comply with the existing regulations even though going beyond the regulations would increase safety pressure. For example, they may limit training expenses by providing only the training required by regulation, even when specialized mountain or survivability training would mitigate risks specific to the operation. As long as gaps, such as the ones identified in the SII, exist in the regulatory framework, there will be an uneven level of safety in the air-taxi sector.

Figure 5. Stakeholders that have a role to play in the air-taxi sector. (Source: TSB)

Therefore, the board recommends that the Department of Transport review the gaps identified in this safety issue investigation regarding Subpart 703 of the Canadian aviation regulations and associated standards and update the relevant regulations and standards.
TSB Recommendation A19-04

Activity data (e.g., the number of hours flown or the number of takeoffs and landings) is used to calculate accident rates in Canada. However, activity data is collected or reported for commercial aviation as a whole, but not for particular sectors (such as air taxi) or aircraft types (such as floatplanes or helicopters). Without hours-flown and movement data that is categorized by CARs subpart and aircraft type, it will be more difficult for stakeholders in the air-taxi sector to assess risks and determine if mitigation strategies being carried out to improve safety are actually working.

Therefore, the board recommends that the Department of Transport require all commercial operators to collect and report hours-flown and movement data for their aircraft by Canadian aviation regulations subpart and aircraft type and that the Department of Transport publish that data.
TSB Recommendation A19-05

Conclusion

To improve safety in the air-taxi sector, the two main underlying factors contributing to air-taxi accidents (acceptance of unsafe practices and inadequate management of operational hazards) must be addressed differently than in the past. Supportive influences from all stakeholders can help operators plan safer flights and support pilots' use of PDM/CRM practices that prioritize safety. This will lead to a culture in which unsafe practices are considered unacceptable.

In practice, this culture looks like weighing baggage or estimating conservatively, respecting visibility and wind limitations, routinely briefing passengers as if they will have to exit the aircraft in an emergency in water or remote terrain, considering hazards and associated risks during route planning, and asking advice of others. At another level it involves convincing clients, operators, and passengers to not accept unsafe practices and to speak up if any are observed. This ability requires knowledge and a change of attitude and actions, which will contribute to the needed change in culture.

Another step is making it routine for effective PDM/CRM practices by line pilots to be supported by managers, supervisors, and peers, as well as by a positive safety pressure from clients and passengers. The cultural shift created would spread to other operational personnel, including fellow pilots, maintenance, dispatch, and ground operations. This is a longer-term process that could provide numerous additional defenses. Peers have the potential to drive this positive pressure, asking the question "Who is the pilot you want to send your family to fly with?" This type of culture is not new: many operators have already developed this culture of operating safely in the knowledge that it was necessary for their success.

How does a small air-taxi operator practice effective and efficient safety management? Cost, time, and pressures for air-taxi flights like MEDEVAC, food supply, transportation of workers, including firefighters, are always present. A safety management system (SMS) provides a framework for this systematic, proactive search for hazards and management of risk that "becomes part of that organization's culture and of the way people go about their work." It is not necessary for an air-taxi operation to have all of the components of an airline SMS; in fact, this would not be appropriate for the air-taxi context. An SMS, if it is appropriately scaled and designed to support risk management in air-taxi operations, while retaining its core components, can be a proactive means to identify and mitigate hazards on a continuous basis.

Introducing measures of safety performance that can help operators recognize where they are within the safe operating envelope is another important aspect of safety management. Some industry initiatives have established higher standards to distinguish operators that exceed the regulatory requirements. Additionally, there are many new light-weight recording devices becoming available to air-taxi aircraft that would permit basic flight data monitoring.

The in-depth SII honed the understanding that the complexity of the air-taxi sector and its associated operations means that change must happen from the inside, and from all stakeholders. The ultimate goal is to attain an operational environment in which operational hazards are effectively and proactively managed and unsafe practices are considered unacceptable. ◆

A New Safety Investigator Profile

By Daniel Barafani, Latin American Society of Air Safety Investigators (LASASI) President, ICAO AIG Panel Expert, Former Air Force Pilot, Safety and Accident Advisor, Junta de Sequridad del Transporte (JST-Transportation Safety Board), Argentina; and Enriqueta Zambonini, LASASI Vice President, Pilot, Air Accident Investigator, JST

(Adapted with permission from the authors' technical paper The New Safety Investigator Profile 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)*

Introduction

Aviation accident investigation arises from the need to seek a response to events and to be able to establish the immediate causes. Since the beginning of human attempts to sustain flight, aviation has increased in volume, and with each war new challenges of primacy and improvement emerged. From the development of commercial passenger aircraft to jet fighters and unmanned drone systems, flight has become more complex in technology, operation, and context. The theories that explain the processes involved in accidents and incidents are becoming more complex as well.

This paper features a brief examination of the evolving air safety investigation process and paradigms with a focus on the investigator´s profile as part of that historical process.

We will then list and describe the fundamental concepts and skills needed for the future investigator profile. Lastly, we suggest why considering this concept as the conducive solution to redesign the profile of safety investigator is so important.

The Most Relevant Paradigms

(1931) Heinrich Domino Model

1. According to the model, an unsafe action has the potential to become an incident/accident and has to be prevented/interrupted in order to avoid the domino effect that ends in an occurrence.
2. The observation that a succession of causes that precipitate each other gives rise to accidents. A failure in some of the elements of the prevention system triggers a system crash or loss: accident or incident.

(1997) Reason: The Theory of Multiple Causes/Swiss Cheese Model

According to this theory, there are latent conditions in organizations that act on defense vulnerabilities and, when aligned and associated with an active failure, cause an accident.

(Present Time) Systemic Approach

In this approach, it is no longer a matter of attributing guilt, but rather implementing the investigation as a mechanism for identifying factors that lead to issue recommendations that remedy errors and improve aviation safety.

The entire aeronautical system can learn from those errors and is back fueled for continuous improvement.

Operational Safety Evolution

The history of air safety investigation can be divided into three eras and current challenges.

Technical Age: From the 1900s to the Late 1960s

Aviation emerged as a revolutionary massive transport mode in which accident and incident investigation identified that deficiencies were initially referred to as technical factors and technological failures. The results of the investigations were aimed at improving the technical aspects.

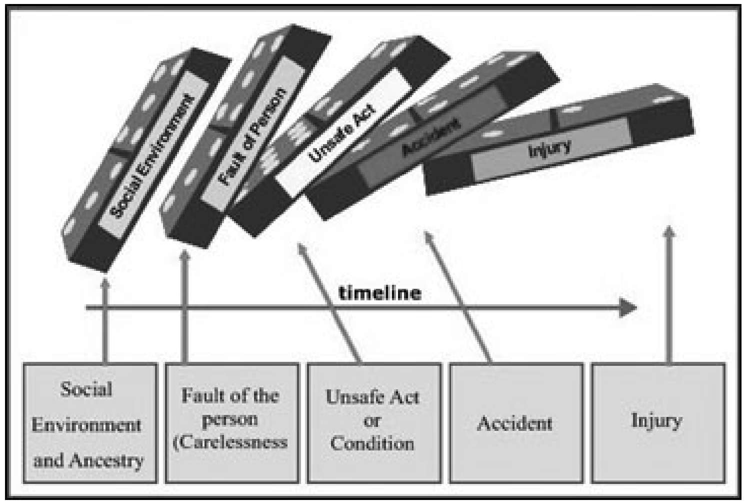


Figure 1. Herbert Heinrich's Domino Model.

In the 1950s, technological improvements led to a gradual reduction in the frequency of accidents, and safety processes were expanded to cover regulatory compliance and surveillance.

In the early commercial aviation era, 70% of accidents were related to technical aspects (focused on those aspects); therefore, accident investigators with a clearly technical profile were needed to accurately determine the failure of a component to the smallest detail.

For example, in the de Havilland Comet accident, the results of an air safety investigation determined that structural problems were the result of a concentration of stress at the vertices of the square-

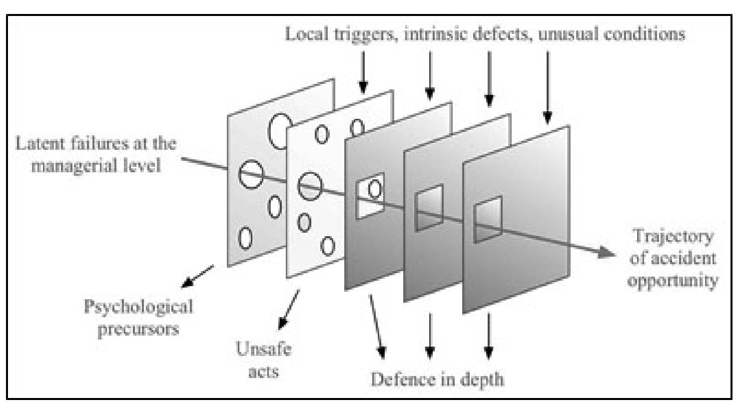


Figure 2. James Reason's Swiss Cheese Model.

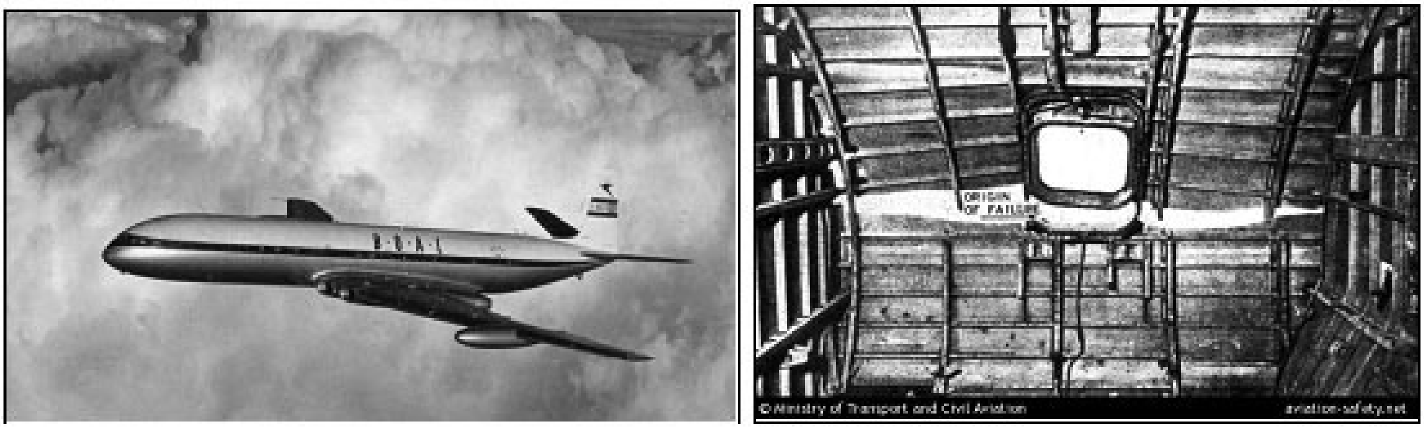


Figure 3. de Havilland Comet window failure.

shaped windows. This gave rise to the oval shape of the current windows in aircraft.

Human Factors Era: From the Early 1970s to the Mid-1990s

In the early 1970s, the frequency of aviation accidents was significantly reduced by technological advances and improvements in operational safety regulations. Aviation became the safest mode of transport, and the safety approach was expanded and aimed at including the "human factor" as the human-machine interface.

This required a redesign of the accident investigator's profile to be more closely related to the human factors aspect.

A new search for information beyond the usual investigation processes became necessary. Despite the investment of resources for "error mitigation," human performance continued to be cited as a recurring factor in accidents.

The application of human factors science tended to focus on the person, without fully considering the operational and institutional context.

It was not until the early 1990s that it was first recognized that humans operate in a complex environment, which includes multiple factors that have the potential to affect the human demeanor and performance.

The Institutional Era: From the Mid-1990s to the Present

During the institutional era, research began to be seen through a systemic approach, which addressed institutional factors in addition to human and technical factors. As a result, the notion of the "institutional accident" was introduced. It considered the impact of culture and institutional policies on the effectiveness of safety risk controls. In addition, traditional data collection and analysis efforts, which were limited to the use of data collected through the investigation of accidents and serious incidents, were complemented by a new proactive approach to safety.

This new approach was based on routine data collection and analysis using proactive and reactive methodologies to control known safety risks and detect emerging safety issues. These improvements made it logical to move toward to a safety management approach.

This new evolution in the complexity of accident investigations required continuous support in updating and training investigators to acquire the necessary and appropriate knowledge and skills in order to effectively contribute to improving safety.

New Challenges

According to global reports, the accident rate remains at low levels even though aviation is constantly growing. There are more than 200,000 flights daily, and 19,000 aircraft are flying at approximately the same time. Current technology and innovations such as ADS-B that transmit in-out information of aircraft positions, weather, flights details, engines, and other information can be sent in real time to the operator's base of operations. In addition, aircraft can be equipped with different storage systems that record all kinds of data and images. These are tools that provide information to facilitate the process of investigating an accident or incident.

During the investigation of accidents and incidents, in addition to the source of reactive information related to the occurrence of the event, there is further data that must be considered and analyzed, whether or not it is related to the event.

An accident or incident is a source of information with a high potential to be explored and exploited. It requires additional skills and competencies to identify, record, analyze, and interpret the information to transform it into intelligent data, the foundation for improvement and management of safety.

This new scenario is faced with the investigation of accidents and incidents. In addition to the state and qualified research authorities performing their task as set out in Annex 13, new requirements in Annex 19 are added. This obliges AIA, ICAO, and other qualified agencies to redesign the role of investigation agencies and to deepen the profile of the accident investigator.

Daniel Barafani

Enriqueta Zambonini

Figure 4. Los Rodeos Airport, Canary Islands, accident.

New Scope of AIA Agencies

Annex 19 in Chapter 5: Collection, Analysis, Protection, Sharing, and Exchange of Data and Information on Safety

(Authors' note: This chapter is intended to ensure the continued availability of operational safety data and information to serve as the basis for safety management activities.)

Chapter 5:

5.1 Operational safety data collection and processing systems.

5.1.1 States shall establish safety data collection and processing systems (SDCPS) to capture, store, aggregate, and enable safety data and information analysis.

Note 1—SDCPS refers to processing and reporting systems, safety databases, information exchange schemes, and recorded information and includes, but is not limited to,

(a) data and information relating to accident and incident investigations, and

(b) data and information relating to safety investigations carried out by state authorities or aviation service providers.

Current Regulatory Framework-ICAO Circular 295

Since the outcome of an accident investigation is largely dependent upon the aviation knowledge, skills, and experience of assigned aircraft accident investigators, they should have

- an understanding of the depth of investigation that is necessary so that the investigation conforms with the legislation, regulations, and other requirements of the state for which they are conducting the investigation;
- a knowledge of aircraft accident investigation techniques;
- an understanding of aircraft operations and the relevant technical areas of aviation;
- the ability to obtain and manage the relevant technical assistance and resources required to support the investigation;
- the ability to collect, document, and preserve evidence;
- the ability to identify and analyze pertinent evidence to determine the causes and, if appropriate, make safety recommendations; and
- the ability to write a final report that meets the requirements of the accident investigation authority of the state conducting the investigation.

In addition to technical skills and experience, accident investigators require certain personal attributes. These attributes include integrity and impartiality in the recording of facts; the ability to analyze facts in a logical manner; perseverance in pursuing inquiries, often under difficult or trying conditions; and tact in dealing with a wide range of people who have been involved in the traumatic experience of an aircraft accident.

Skills and Competencies

A safety investigator's profile, in addition to the skills of being an accident investigator, should deepen other skills and competencies, namely

Leadership

Given the complexity of the current aeronautical system, characteristics of accidents/incidents, and the consequent interaction among different states (manufacturers, operators, technicians, accredited representatives, advisors, etc.), research teams become multidisciplinary and cosmopolitan. In order to work assertively and optimize time, resources, and human capital, safety investigators must be well trained and develop skills to exercise effective leadership management to work efficiently as a team.

Leadership is defined as the ability to influence a group to achieve its goals or the process of influencing others and supporting them to work to achieve common goals. But leadership is difficult to execute without training, self-knowledge, and application tools.

It is as much an inherent personal quality as a set of skills learned. To achieve successful leadership, the elements of effective leadership must be understood as well as

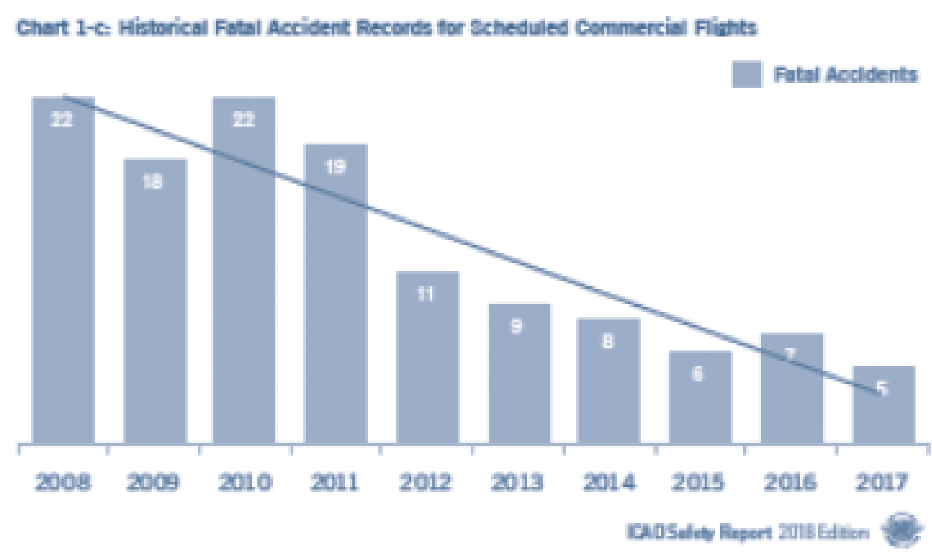


Figure 5. Worldwide fatal accidents 2008–2017.

the consequences of poor leadership.

Leadership Levels

If we consider leadership as a qualification, we could mention three levels:

1. Decision-making, in coordination with one's superior and autonomously.
2. Organization and coordination of one's own work and the work of the team.
3. Development and evaluation of performance in relation to collaborators.

The success of the work is measured in the scope of objectives, as well as in the way they are achieved. Thus, leadership during teamwork is key.

In our field, we have the opportunity to change the reality surrounding us, beginning with what happens, what we see, and what we can identify that needs to be changed. It is imperative to consider leadership as a key factor in the profile of safety investigators for the future of research and for the success of improving aviation safety.

SMS (Safety Management System)

When an accident or serious incident occurs, the accident investigation process is initiated to find any possible failure within the aeronautical system and its motives and generate the necessary countermeasures to avoid recurrence. Therefore, in an operational safety management environment, the accident investigation process plays a distinct role, as it is a fundamental process regarding operational safety defenses, barriers, revisions, and compensations in the system.

As an important reactive component of the elements included in the SMS framework, accident investigations contribute to the continuous improvement of an aviation system's operational safety by providing the initial causes of accidents/incidents and lessons learned from these events.

This can support decisions regarding the development of corrective measures and can also identify the necessary improvements to the aviation system, such as SMS, as well as the state's accident investigation process.

In addition to establishing the findings and causes of origin of accidents/incidents, most investigations identify hazards and threats. An effective and comprehensive research process includes the identification and differentiation between a final consequence, an insecure event, and hazards/threats that contribute to occurrences.

This can include systemic, latent, or institutional factors within the entire aviation system framework. In today's proactive operational safety management environment, there is an important and necessary integration between an accident/incident investigation process and an organization's hazard identification/reporting process.

The final report format of the investigation should clearly state the hazards/threats encountered during the investigation process, which may require a separate follow-up measure through the hazard identification and mitigation process of the organization's risks.

This is why safety investigators will need to acquire knowledge regarding

- The concept of safety,
- Integration of management systems,
- Notification and investigation of safety,
- Collection and analysis of operational safety data,
- Operational safety indicators and performance control,
- Operational safety risks, and
- Operational safety risk management.

In addition to achieving the SMS analyses of operators and service providers relating to the hazard/threat identification processes, safety investigators also need to know the risk analysis matrix and understand the mitigation measures developed from identified hazards and safety and performance indicators.

SSP (State Safety Program)

With Annex 19, the investigating body assumes a new role within the state's aeronautical system. The investigative body is not only limited to the investigation of accidents/incidents but is also called upon to be part of the state safety program operation, providing all safety information obtained from the extrapolation of reactive data from an investigation of an occurrence or from safety studies. In addition, the investigative body should be independent from the implementing authority.

To meet this new challenge, investigators have a broader role than just the technical research of an event. They must develop new expertise to fully participate in the state safety program. For this independent accident investigation (AIG) body to succeed, investigators must clearly understand the relationships of the AIG body within the SSP and its interrelationship with other aeronautical authorities, operators, and service providers, along with the contribution of the AIG to this new modality of safety management at the state level. To do so, investigators must acquire new knowledge regarding

- The SSP framework,
- State operational safety policies and objectives,
- State safety responsibilities,
- The contribution of accident and incident investigation to the SSP,
- Sharing operational safety information,
- State safety risk management, and
  - Collection, analysis, and exchange of operational safety data
  - Operational safety data and information analysis
- State safety assurance,
  - Data protection and operational safety information.

Operational Safety Indicators

Data Analysis

The systemic approach in an accident and incident investigation allows us a broad and deep view of the aeronautical system. We are able to identify real safety hazards and deficiencies that can potentially affect the safety of the system during the investigation process. This hard data is placed into a Safety Data Collection Processing System (SDCPS) for data mining that must be extrapolated and transformed into data intelligence. To do so, investigators will need to acquire basic knowledge regarding

- Descriptive and inference statistics.
- Central trend and dispersion measures, and
- Probabilistic analysis.

Knowledge of the Aeronautical System

Air safety investigators also require

A full knowledge of the aeronautical system to generate, coordinate, and participate in working groups with those involved in the aeronautical system, taking into account what expertise each participant brings to the system.

The ability to work in conjunction with those involved in the search for mitigation measures against each identified safety deficiency. It is not enough to develop the recommendations in an isolated area of the AIA environment. For the recom-

Continued on page 30

NEWS ROUNDUP

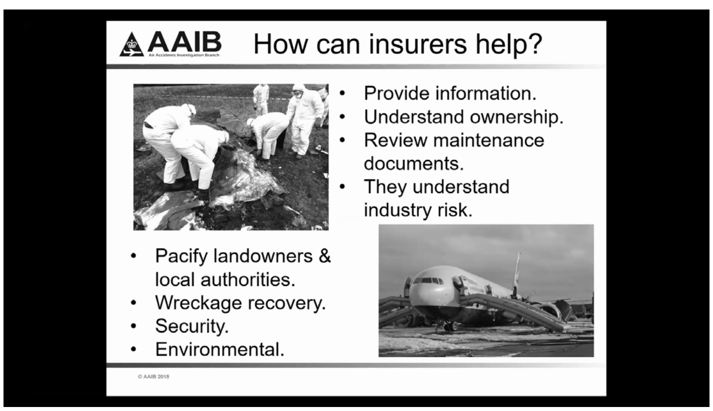
ESASI Uses Virtual Communications

The European Society of Air Safety Investigators (ESASI) used a virtual meeting format in late March to communicate with members on topics of interest not covered during ESASI's annual seminar. On March 23, the Society introduced the FocusOn… program with the topic being aviation insurance. ESASI officials Steve Hull, Brian McDermid, and Olivier Ferrante provided the following report.

Genesis of ESASI FocusOn…

During the last year, ESASI's legal (and tax) status was formalized as it became a "Charitable Incorporated Organization" with the objective of "enhancing the safety of aviation." This raised the question among ESASI officials as to whether ESASI was doing enough, particularly during this difficult period for aviation. Our seminars are popular, and the proceedings of our first workshop, Safety Investigation Throughout the Aircraft Life Cycle (Design for Safety), was well received by the international community. While we have a strong membership base, we still only hold one seminar per year, which gives us limited opportunity to reach out to all areas of our industry. And so, the concept of FocusOn… was born.

Each FocusOn… is a virtual event lasting between one and two hours and focuses on one specific topic relating to safety investigation. The aim is to educate new investigators and to inform our members, and the intention is to run two sessions per year in addition to our annual seminar or workshop. FocusOn… is free to attend, and a recording of each session will be available on the ESASI website and may be freely used for the enhancement of aviation safety. So the committee then decided on the topic for our first FocusOn….



FocusOn…Insurance

ESASI's secretary had long wanted to expand our discussion topics and to explore areas of aviation safety and investigation that are not widely known to airlines, safety departments, crews, engineers, and safety investigation authorities (SIA). He suggested that the inaugural FocusOn… look at aviation insurance, particularly the claims process and the role of loss adjustors that runs in parallel to a safety investigation.

On Jan. 17, 2008, a Boeing 777-200ER, flying from Beijing, China, to London, England, crashed just short of the runway while landing at Heathrow Airport. There were no fatalities. This was the first time in the aircraft type's history that a Boeing 777 was declared an insurance hull loss and subsequently written off.

To cover these areas, ESASI was delighted that both Theresa

Gallagher (claims manager for Global Aerospace, London) and John Bayley (regional director, Europe and Russia, McLarens Aviation) accepted our invitation.

Brian McDermid, principal inspector at the AAIB, and Steve Hull, ESASI secretary and former British Airways safety officer, set the scene from the SIA and airline perspectives. And then the first FocusOn… was off and running on Zoom, kindly hosted by the Icelandic SIA (RNSA).

Summary

The event was a success, with more 120 attendees from Europe and the wider international community. While the majority were from SIAs, a significant number were from other areas related to the aviation industry.

In his session describing the role of the loss adjustor, Bayley provided an excellent analysis of the repair costs associated with the introduction of new technologies, such as composite materials, larger engine components, and 3-D printed parts. This was especially instructive for those participants who do not routinely deal with financial aspects. Indeed, the increase of the repair costs has influenced the decision to declare a wreckage a hull loss, when in different circumstances the aircraft may have remained operative. This point, related to the cost of repairs versus declaring a hull loss following an accident involving substantial damage, is crucial when considering accident statistics and the attrition rates of different aircraft types.

For instance, when dealing with insurance claims, Gallagher underlined the question of "subrogation" in an open manner to help attendees better understand the stakes, the related issues, and sometimes the very lengthy (and expensive!) legal processes that can follow.

In the domains of search and rescue, particularly at sea, FocusOn… addressed the importance of being prepared to face a major accident, leading to the expensive location and recovery of key aircraft parts, such as flight recorders. The obligations of the state of registry to institute and investigate when an accident to an aircraft on its register occurs on the high seas were reiterated during the session. But FocusOn… also discussed ways to be prepared through specific insurance contracts.

During the question-and-answer session, participants from airline flight safety wanted to explore ways to develop business cases within their companies for investing in additional safety equipment. They received clear answers regarding the current situation in the underwriting business, but in the mid-to-long term it is hoped that improved mutual knowledge could deliver both safety and financial gains.

These examples are just snapshots of the topics that were presented during this very interesting and instructive session. More information can be retrieved as the video proceedings will be available on ESASI's website (www.esasi.eu) for educational purposes to promote aviation safety.

Next FocusOn…'?
At the end of the session, participants were asked to send their feedback to the ESASI committee as well as suggestions for the next FocusOn… theme. So look out for FocusOn… Number 2 later this year! ◆

ICAO Working Group to Attend Sessions

Ron Schleede, ICAO Working Group chair, reports that ISASI representatives participated in the 6th Accident Investigation Panel meeting (AIGP/6) in May. The meeting was virtual, taking place over six days. Past AIGP meetings have led to significant updates and amendments to ICAO standards and recommended practices and ICAO documentation on a worldwide basis. ISASI's participation is welcomed because of the considerable expertise of its membership and panel members.

ISASI also has plans to participate in the third High-Level Safety Conference (HLSC) 2021, originally planned for June. It will now take place in October as part of the High Level COVID Conference—either as a virtual or a hybrid event. The theme of HLSC 2021 is "Embracing Evolution."

ISASI's first participation at ICAO, after being accepted as an approved International Observer Organization, was in February 2015 at HLSC 2015. Tentative plans include participation in both events by ISASI members Ron Schleede, Bob MacIntosh, and Mark Clitsome. ◆

ASASI Notes Industry Changes

John Guselli, president of the Australian Society of Air Safety Investigators, says the story from Down Under is one of improvement and cautious optimism. COVID vaccines are being distributed, providing an increasing hope for the future.

Domestic aviation is well on course to achieve stability with our domestic airlines currently touting passenger load figures of 70% and upward, albeit on reduced schedules compared to this time last year. Our international travel market remains flat with traffic not expected to rebound until late in 2021. The Australian government is supporting aviation through extended wage supplementation and a part subsidization of airline airfares to key tourist ports. More good news in that the Australia-New Zealand travel bubble is now in place, allowing unrestricted travel without the need for quarantine requirements.

New Memberships
We continue to increase in membership despite the pandemic. To support our ongoing encouragement for women in aviation, we have welcomed Ellena Papadopoulos and Sarah Storier to the ASASI membership ranks and will provide further details on their diverse backgrounds in the next ASASI newsletter.

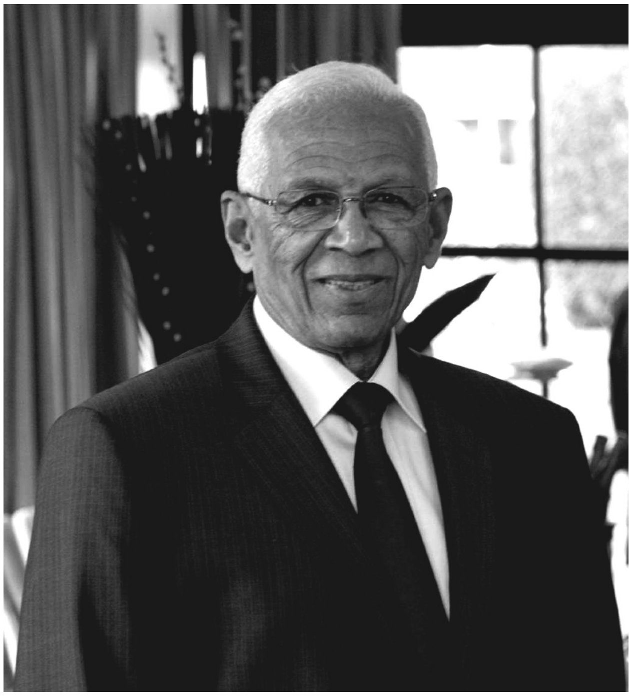
The Paul Choquenot-CASA Scholarship
We were delighted to announce the provision of another scholarship for Australian aviation students enrolled in recognized courses of study. The Australian Civil Aviation Safety Authority

In Memoriam

The Saint-Germain family was saddened to report the death of Max Saint-Germain on April 12. He was 90 years old. A funeral was held on April 26 in Tournefeuille, France. Max was a strong supporter of ISASI and actively participated in the Society's efforts and programs. He was passionate about air safety.

As director of the Airbus Flight Safety Office, Max became the ISASI corporate representative for Airbus in 1985 and joined ISASI as an Associate Member in 1986. After retiring from Airbus in 1989, he upgraded to Full ISASI membership in 1992, Life Member in 2001, and Life Fellow Member in 2006. He continued to submit a voluntary contribution to ISASI every year. Max served on the European Society of Air Safety Investigators Council from 1990–2006 and participated in several ISASI Seminar Organizing Committees. He made three technical presentations to ISASI's annual seminar in 1987 and 1988 and three to the Flight Safety Foundation's annual meeting. He was a member of the Flight Safety Foundation's Advisor Committee.

ISASI President Frank Del Gandio said, "Max Saint-Germain was one of ISASI's true assets. He always kept me appraised of European issues and assisted ISASI to adjudicate those issues. I especially remember his invaluable assistance for the Barcelona (1998) and Shannon (2000) seminars. His untiring energy and dedication to ISASI were always evident. My wife and I always enjoyed our conversations with him and his wife, Yanni, at the seminars. Max was truly one of a kind, and I will miss our good friend." ◆



(CASA) has funded an annual award to honor the legacy of Paul Choquenot, the founding director of the (then) Bureau of Air Safety Investigation. It will encourage our younger aviation professionals to take an active part in the industry at the formative stages of their careers through research into innovative safety management practices. This scholarship will enable the funding of successful students to attend Australian and New Zealand (ANZSASI) Societies of Air Safety Investigators seminars in either Australia or New Zealand. Further details will be provided in the next ASASI newsletter.

ANZSASI: Postponed Until November 2021
With an abundance of caution, the ANZSASI seminar has been postponed to November 12–14. It will still take place at the Novotel Gold Coast in Queensland. ◆

Canadian Society Elects New Leaders

CSASI members selected a new set of officers. The new slate includes: President Barry Wiszniowski; Vice President Bryon Mask; and Secretary-Treasurer Steve Roberts. All three new officials were chosen by acclimation. Wiszniowski noted, "the new team is looking forward to our new role withing the Society." ◆

Continued on page 30

mendation to be acceptable, feasible, and applicable, it is necessary to collaborate and exchange ideas, concepts, and approaches with all those involved in the recommendation—from the aeronautical authority, the service provider, the operator, etc., and led by the investigator in charge of safety.

Conclusion

Today we cannot imagine an investigation without analyzing regulations, technology, and operations—and considering context, culture, and institutional policies and standard operating procedures. In addition, we must take into account SMS, risk management, and operational safety culture. We cannot even think about the analysis of a commercial aviation accident without having thoroughly reviewed the flight data recorder and the cockpit voice recorder data.

We seem to have a well-established influence of this in our professional practice, with our own context, region, and cultural identity. But even if the investigation protocols, methods, and systems have reached a level of global standardization where we all speak the same language and can visualize the fruits of our work and the number of accidents and incidents continues to drop, continuous safety improvement remains our daily responsibility.

Looking ahead, a new challenge arises—we clearly see the evolution of aviation and the research along with it. We need to think about ourselves and redesign our investigation profile based on the modern scenario and adapt to it in a functional and effective way. ◆

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Aug. 31–Sept. 2, 2021—A Virtual Experience

ISASI is please to announce that registration is now open for ISASI 2021 and can be accessed through the ISASI website or by visiting https://cvent.me/348zY9.

Delegate fees are US$89 US for ISASI members and US$99 for nonmembers If you work for a company that is a corporate member of ISASI, please choose the member price when registering.

The full seminar agenda will be posted on the ISASI website, www.isasi.org, and should be available by the last week of May. Please note that we will not be offering tutorials this year. Every effort will be made to stagger the presentations each day to facilitate attendance from different time zones.

Sponsorship and exhibitor opportunities are available, and detailed information can be obtained by contacting Ron Schleede at RonSchleede@aol.com or Barb Dunn at avsafe@shaw.ca

We look forward to your support and participation.

ISASI 2021 Seminar Committee