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THE CASE FOR COCKPIT VIDEO RECORDERS

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"I rely on God."[1]

Five seconds before impact, the flight engineer said, “No, but, go by this, Captain.” Two seconds before impact, the Captain told the first officer, “Just check the instrument.” Immediately prior to impact, the first officer said, “Check what?” Although the flight data recorder captured the aircraft’s flight parameters as it slowly rolled to the left before impacting the ground less than two minutes after take-off, there was no indication of any mechanical or electrical failure.[2]

When investigators attempted to determine the cause of the crash of EgyptAir flight 990, the information gleaned from the flight data recorder (FDR) revealed the aircraft parameters as it departed controlled flight, but it did not identify any malfunctions. Egyptian authorities disagree with the United States National Transportation Safety Board (NTSB) interpretation that the first officer’s repeated Arabic phrase, “Tawakilt ala Allah,” signified he committed suicide by intentionally crashing the aircraft.[3] The case of the Air India Boeing 747 accident was similar – the FDR recorded the aircraft parameters and the cockpit voice recorder (CVR) captured the flight deck communications, but neither revealed what caused the aircraft to crash.

Because flight data and cockpit voice recorders cannot provide enough data to fully reconstruct the events preceding a crash, NTSB Chairman Jim Hall recommended to

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[1] Translation of the Egyptian phrase offered by the first officer eleven times in response to the captain’s question of what was happening to EgyptAir Flight 990, a Boeing 767-366ER, that crashed into the Atlantic Ocean about 60 miles south of Nantucket, Massachusetts in the early hours of October 31, 1999 killing all 217 people on board and destroying the aircraft. National Transportation Safety Board, “Air Accident Brief,” http://www.ntsb.gov/publictn/2002/AAB0201.pdf; Internet; accessed 14 March 2005.

[2] Analysis of the flight data and cockpit voice recordings from the January 1, 1978, crash of an Air India Boeing 747 departing Bombay. David O’Hare and Stanley Roscoe, *Flightdeck Performance: The Human Factor* (Ames, Iowa: Iowa State University Press, 1990), 187.

[3] Guardian Unlimited, “U.S. and Egypt Split on Fatal Plane Crash,” http://www.guardian.co.uk/egyptair/article/0,2763,330000,00.html; Internet; accessed 15 March 2005.

the Federal Aviation Administration (FAA) in April 2000, that cockpit video recorders be installed in all new commercial aircraft commencing in 2003, and that existing commercial aircraft be retrofitted by 2005.[4] The Airline Pilot Association and the unions it represents oppose the introduction of flight deck image recording, fearing that it will impinge upon pilots' right of privacy in the workplace without adding significant information to accident investigations.[5]

To facilitate accident investigations, flight safety experts and aviation mishap investigators advocate placing video recorders in aircraft cockpits to capture instrument presentation, switch positioning, aircrew actions, and non-verbal communication such as hand gestures or body language. However, pilots and the organizations representing them are fighting the proposal, arguing that video recorders will violate their privacy while providing little or no information that is not available from other sources. This paper posits that the overall benefits of introducing cockpit video recording systems into aircraft will outweigh any negative effects.

To this end, this paper will begin with an introduction to flight mishap investigation and the development of crash survivable devices designed to record information to aid investigators in their efforts to reconstruct aviation accidents and recommend actions to avoid or mitigate future, similar mishaps. The paper will then examine the arguments for and against the introduction of video recording systems and

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[4] CNN.com, "US News: Safety Board Proposes Cockpit Video Cameras in Planes by 2003," http://archives.cnn.com/2000/US/04/11/video.in.cockpits/; Internet: accessed; 23 January 2005.

[5] Jamie Zolla, "Cockpit Image Recorders: Is it a Necessary Safety Measure or an Unjust Invasion of Privacy?" *University Aviation Association Aviation Policy Seminar* (January 2005) [report online]; available from http://faculty.dwc.edu/fairbairn/DCSem05/topic_files/7%20Cockpit%20Image%20Recorders.doc. Internet: accessed; 15 March 2005.

illustrate why the benefits outweigh the disadvantages. To avoid the confusion caused by the same acronym being used for both cockpit voice recorder and cockpit video recorder, the latter system will henceforth be referred to as a cockpit image recorder (CIR).

On 18 January 2005, European company Airbus unveiled the A 380, which, with a capacity of up to 840 passengei8 T7iaolter-uny

insurance premiums, consumer trust, litigation expenses, etc. According to the USAF Chief of Safety, "safety is a force multiplier."[8] Using the example of the B-2 bomber, there are no spare aircraft; the type is no longer in production, and it takes years to generate a fully qualified replacement pilot. Not only do aircraft operators, be they civilian or military, want to know why an aircraft crashed, they want the information in time to prevent recurrences. USAF accident investigation regulations specify how investigators will handle information that might have an immediate impact upon operations:

> If safety personnel or investigators discover information that seriously impacts the operations of a weapons system, the continuation of an exercise, or other operations; immediately notify the convening authority by telephone and follow up with a confirming message, regardless of whether or not such information is associated with a mishap currently under investigation.[9]

Returning to the question of why aircraft crash, one must look at the factors considered by investigators. According to the USAF, "the purpose of every safety investigation is to determine all factors (human, materiel, and environmental) that directly or indirectly contributed to the mishap."[10] The NTSB lists three broad reasons for aircraft accidents: aircraft, environment and personnel. Statistically, personnel-related cause/factors are cited in 70 to 80 percent of all accidents involving United States

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[8] Kenneth W Hess, "Message From the Chief of Safety," *United States Air Force Flying Safety Magazine*, January/February 2004, 3.

[9] Air Force Publishing, "Air Force Instruction 91-204: Safety Investigations and Reports: 1.4 Acting on Critical Safety Information," http://afpubs.hq.af.mil; Internet; accessed 27 December 2004.

[10] Air Force Publishing, "Air Force Pamphlet 91-211: Safety USAF Guide to Aviation Safety Investigation, 1.2. Why Investigate Mishaps?" http://afpubs.hq.af.mil; Internet; accessed 27 December 2004.

licensed carriers; aircraft related cause/factors are named in 20 to 30 percent, and 30 to 40 percent involve environmental issues.[11]

Both the USAF and the NTSB use accident cause determinations that equate to design/mechanical, weather and human related factors. In reality, many of the mishaps attributed to environmental or aircraft reasons are in fact personnel related.[12] The fundamental reasons for aircraft crashes are few and none of them is new. Except for those rare instances of aircraft flying into un-forecast and unobserved weather, aircraft crash because somebody made a mistake. These can be errors linked to lack of knowledge. Design, for example, is linked to the technology and knowledge available at the time the aircraft was in the conceptual and development stage. After 40 years of operation, if an aircraft develops a crack that leads to a crash, design might be identified as the cause even though there was no way that the designer could have foreseen the problem. An accident that resulted from an error or poor workmanship during maintenance would also fall into the category of human error. If a pilot chooses to fly into inclement weather and has an accident, it is not the meteorological conditions but the pilot's judgment that leads to the accident.[13] Although there are many human elements that can lead to an aircraft accident, ". . . it is frequently the case that the full blame is assigned to the pilot in command – the captain – even though the performance of other

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[11] The numbers do not total 100% because more than one type of cause/factor can be named for an accident. National Transportation Safety Board, "U.S. Air Carrier Operations Calendar Year 2000: Annual Review of Aircraft Accident Data," 20. http://www.ntsb.gov/publictn/2004/ARC0401.pdf; Internet; accessed 14 March 2005.

[12] Alexander T. Wells, *Commercial Aviation Safety*. Edited by Shelly Chevalier. 2nd ed. (Highstown, New Jersey: McGraw-Hill, 1997), 81.

[13] Air Force Publishing, "Air Force Instruction 91-204: Safety Investigations and Reports: 5.10.6. Determining and Documenting Findings," http://afpubs.hq.af.mil; Internet; accessed 27 December 2004.

crew members may have been questionable."[14] Therefore, crash investigators are interested not only in system mechanical malfunctions at the time of an incident, but also all aircrew activity.

In 1957, the U.S. Civil Aviation Authority (forerunner to the FAA) introduced regulation for all air carrier airplanes weighing over 12,500 pounds and operating above 25,000 feet to be fitted with a Crash Survivable Flight Data Recorder (CSFDR) by July 1, 1958. The devices were to record altitude, airspeed, heading, and vertical accelerations as a function of time. Today, all new airliners must be capable of monitoring and recording a minimum of eighty-eight aircraft parameters including time, altitude, airspeed, heading, attitude, and control inputs. Advances in data storage and the introduction of fully digital flight control systems and avionics, which transfer electronic data on digital data buses, made vast amounts of critical flight and aircraft system information available for capture by FDR.[15] As such, new aircraft that exploit "fly-by-wire" technology are constructed with extremely advanced data collection devices.

However, recorded data is limited in its utility because it only provides information relevant to what happened and does not address why it happened. Furthermore, flight data recorders do not always work,[16] the data is not always useable[17] and, despite their name, CSFDRs do not always survive a crash. Additionally, national

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[14] David O'Hare and Stanley Roscoe, *Flightdeck Performance: The Human Factor* . . ., 187.

[15] Dennis R. Grossi, "International Symposium on Transportation Recorders Aviation Recorder Overview," National Transportation Safety Board Seminar. Arlington, Virginia, (3 - 5 May 1999): http://www.ntsb.gov/events/symp_rec/proceedings/authors/grossi.htm; Internet; accessed 14 March 2005.

[16] Australian Transport Safety Bureau, "Air Safety Investigation Report 200105715," http://www.atsb.gov.au/aviation/pdf/vh-xdz.pdf; Internet; accessed 16 March 2005.

[17] National Transportation Safety Board, "Press Release: Korean Air Flight 6316 MD-11, Shanghai, China 15 April 1999," http://www.ntsb.gov/pressrel/1999/990427.htm; Internet; accessed 16 March 2005.

air regulations may permit the operation of an aircraft with an unserviceable FDR for a given amount of time. Canada, for instance, permits an operator to fly an aircraft with an unserviceable FDR for up to 90 days providing the CVR is serviceable or vice-versa.[18] The requirement to ascertain aircrew activity at the time of an air incident and the desire to gain some form of back up for FDRs led to the introduction of the CVR. In 1964, when the FAA legislated the requirement for CVRs, it explained: "[CVRs] would be a valuable tool in the investigation of accidents by providing firsthand information of the flight crews' observation and analysis of conditions aboard the airplane and the procedures employed by them to cope with an emergency."[19]

CVRs have proved themselves a useful tool in accident investigation by filling in many of the unknowns in FDR-provided data. However, because CVRs rely upon cockpit voice communications and any other audible signals such as alarms from emergency warning systems, they are limited to recording what is said or heard in the cockpit. If the flightdeck crew is uncommunicative, or a situation does not trigger an emergency alarm, the CVR is of little utility. CVRs are also susceptible to the same failures as FDRs. The requirement to both fill in the blanks left by FDR and CVR recordings and provide an additional backup source of information has led the NTSB to call for cockpit imagery. Furthermore, advances in aviation technology have also created the requirement for CIRs:

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[18] Transport Canada, "Canadian Aviation Regulations, Part VI, General Operating and Flight Rules, Subpart 5: Aircraft Requirements, Use of Flight Data Recorders and Cockpit Voice Recorders, 605.34," http://www.tc.gc.ca/CivilAviation/Regserv/Affairs/cars/Part6/605.htm; Internet; accessed 16 March 2005.

[19] Christopher Julius, "Statement at NTSB Aviation Image Recording Public Hearing Legal and Privacy Issues Panel," (28 July 2004), http://www.ntsb.gov/events/2004/av_img_rec/julius_statement.pdf; Internet; accessed 15 March 2005.

> The advent of data links and text messages, developed in part to reduce the volume of voice message traffic, meant that the traditional CVR would not capture key elements of air-ground communications. Moreover, the displays in modern glass cockpits are graphical interpretations of the instruments they have replaced, and any anomalies in the translation of electronic data to the visual presentation might present misleading information.[20]

The Airline Pilot Association (ALPA) is, however, strongly opposed to the installation of CIRs and argues that:

> (1) the benefits of video imaging are vastly overrated, (2) far more effective and efficient tools exist to obtain the data necessary to accurately investigate an accident and help prevent future accidents, and (3) legal protections to prevent abuse of recorded information, especially in foreign countries, are inadequate to protect pilots' privacy.[21]

It should be noted that the introduction of CVRs met with the same type of resistance facing CIRs. When the Australian Aeronautical Research Laboratories attempted to introduce the first CVR in 1958, the Royal Australian Air Force stated:

> "such a device is not required ... the recorder would yield more expletives than explanations" . . . And the Federation of Air Pilots declared that it would be like "a spy flying alongside ... no plane would take off in Australia with Big Brother listening."[22]

ALPA does not believe that CIRs provide additional information sufficient for investigators to determine accident causes more efficiently or definitively. The organization opines that new digital FDRs, with their ability to capture over a thousand aircraft parameters, system and performance information and aircrew inputs will provide

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[20] Aviation Today, "Avionics Magazine: Safety: On Camera: Inside and Out," http://www.aviationtoday.com/sia/20030801.htm; Internet; accessed 17 March 2005.

[21] Airline Pilots Association Committee Corner, "Cockpit Image Recorders Not Needed or Wanted," http://www.alpa.org/alpa/DesktopModules/ViewAnnDocument.aspx?DocumentID=5517; Internet; accessed 23 January 2005.

[22] Australian Government Department of Defence, Defence Science and Technology Organization, "The Black Box: An Australian Contribution to Air Safety," http://www.dsto.defence.gov.au/corporate/history/jubilee/blackbox.html; Internet; accessed 15 March 2005.

sufficient data to satisfy crash investigators requirements. As ALPA's Executive Air Safety Chairman offered, "This is objective data—the type the investigators need, not information that is subject to conjecture or speculation."[23]

The need for objective data must be underscored, for crash investigators are frequently faced with the requirement to base many of their assumptions on the subjective interpretation of available evidence despite the availability of fight data and cockpit voice recordings. This is particularly true of safety investigations. Since the mid-1990s the USAF has lost more than 25 aircraft per year due to airborne accidents.[24] USAF safety investigations determine findings, which are statements of each significant event or condition sustaining the sequence of events leading to the mishap, based "on the weight of evidence, professional knowledge, and good judgment."[25] FDR data is not blindly accepted. As discussed, FDRs do not always work and the data does not always survive an accident intact; even when the data capture is good it must be verified to ensure its accuracy and correlated to time.[26] If gaps or inconsistencies exist, analysts manipulate the data to compensate.[27] This manipulation in itself negates the argument that FDRs provide purely objective information. While objective data from FDRs might

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[23] Airline Pilots Association Committee Corner, "Cockpit Image Recorders Not Needed Or Wanted" . . .; Internet; accessed 23 January 2005.

[24] United States Air Force Safety Center, "Aircraft Statistics," http://afsafety.af.mil/AFSC/RDBMS/Flight/stats/aircraft_stats.html; Internet; accessed 16 March 2005.

[25] Air Force Publishing, "Air Force Instruction 91-204: Safety Investigations and Reports: 5.9. Determining and Documenting Findings," http://afpubs.hq.af.mil; Internet; accessed 27 December 2004.

[26] Civil Aviation Authority, "CAP 731 Approval, Operational Serviceability and Readout of Flight Data Recorder Systems, Ch 7. FDR Serviceability and Readout," http://www.caa.co.uk/docs/33/CAP731.PDF; Internet; accessed 17 March 2005.

[27] Aviation Safety Council Taipei, Taiwan, "GE791 Accident Investigation Factual Data Collection Group Report, Recorders Group," http://www.asc.gov.tw/acd_files/791eng/Recorders_Group.pdf; Internet; accessed 17 March 2005.

provide aircraft parameters and aircrew control inputs leading up to a crash to depict what happened, without interpreting additional information such as witness testimony, expert analysis of wreckage, pathologist reports, and results of re-enactments conducted in a simulator or in the same type of aircraft,[28] investigators cannot attempt to determine why it happened. Answering the question of why an accident occurred is little different from any other form of problem solving; hypotheses are formulated and discussed, evidence is examined and experiments are conducted. In other words, conjecture and speculation are as integral to crash investigators' analyses as is the consideration of properly analyzed "objective" data.

Arguing against the assertion that CIRs might help accident investigators find the probable causes of unsolved accidents, ALPA claims that after searching aviation databases, its Engineering and Air Safety Department could find no air carrier accidents in the United States in the past 20 years that remain unsolved.[29] Because the NTSB conducts safety and not criminal investigations, it assigns probable cause[30] based upon the weight of the evidence and the opinions of its investigators and expert analysts. There is no such classification as an unsolved accident – the NTSB database lists only three categories of report status: preliminary, factual and probable cause.[31] Thus, it is no

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[28] Air Force Publishing, "Air Force Pamphlet 91-211: Safety USAF Guide To Aviation Safety Investigation, 5.11. Specific Considerations for Detailed Analyses," http://afpubs.hq.af.mil; Internet; accessed 27 December 2004.

[29] Airline Pilots Association Committee Corner, "Cockpit Image Recorders Not Needed Or Wanted," . . . ; accessed 23 January 2005.

[30] National Transportation Safety Board, "Chapter VIII, Title 49 of the Code of Federal Regulations, 831.4 Nature of Investigation," http://a257.g.akamaitech.net/7/257/2422/04nov20031500/edocket.access.gpo.gov/cfr_2003/octqtr/pdf/49cfr831.4.pdf; Internet; accessed 17 March 2005.

[31] National Transportation Safety Board, "Aviation Accident Database and Synopses," http://www.ntsb.gov/ntsb/query.asp#query_start; accessed 17 March 2005.

wonder ALPA was unable to find any unsolved accidents. Had cockpit imagery been available, the probable causes listed for many accidents might very well be different than that captured on the NTSB database.

ALPA points out that cockpit voice recordings can be used in legal proceedings and, based upon collective agreements between individual unions and their employers, might be used for disciplinary action against pilots.[32] Therefore, the organization's fear that cockpit imagery might be similarly used is valid. However, ALPA seems to assume that cockpit imagery would only be used to demonstrate pilot culpability. If recorded actions were appropriate to the circumstances, the CIR could just as easily be used as a tool to eliminate the pilot as a link in the causal chain that led to an accident. This is the tact being taken by a U.S. company that insures ophthalmic surgeons, "Considering . . . that about 70% of medical misadventures for all specialties occur in the operating room, a videotape can act as a shield and help diminish the chance of a paid claim . . ."[33] Additional evidence that imagery can be used to protect the operator is demonstrated by the widespread use of video cameras in police cruisers. Recorded video from the vast majority of incidents indicate that law enforcement officers acted properly, however, those rare cases where police exceeded their powers or acted inappropriately were also captured.

ALPA has also expressed concern that images of pilots facing death might be distributed because of lax security, which could see tapes passing into public hands.

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[32] Airline Pilots Association Committee Corner, "Cockpit Image Recorders Not Needed Or Wanted," . . .; Internet; accessed 23 January 2005.

[33] Ophthalmic Mutual Insurance Company, "Risk Management: Eyes, Lies and Videotape," http://www.omic.com/resources/risk_man/deskref/medicaloffice/general/17.cfm; Internet; accessed 23 January 2005.

Existing U.S. regulations, which prohibit the release of flight deck recordings to the public, are not adequately enforced. Furthermore, not all nations have laws that restrict the distribution of cockpit recordings. While this concern is valid, it could however, be addressed by adopting extra security measures, stricter enforcement of current regulations, meting out harsher penalties for violators, and through agreements with other nations to evolve international legislation. When operating within the aerospace boundaries of countries that do not possess regulations to restrict the distribution of cockpit recordings, the recorders could be turned off for the portion of the flight within the nation of concern. This would strengthen legal arguments to prevent the release of recordings from accident investigations in foreign countries. While it is true that installing a system that can be disabled by the pilots could potentially lead to abuse, as pointed out by ALPA, "when a cockpit occupant has devious or criminal intent, no amount of recording capability will affect the outcome."[34]

Other claims made by organizations representing airline pilots seem to be mired in emotional rhetoric, and attack the concept of CIRs irrationally. The Allied Pilots' Association (APA) distributed a "talking points" paper to its members to ensure that they provide approved comments if asked about CIR systems. The paper reflects ALPA's opposition stance, but it also adds claims from experts that imagery from CIRs would not be detailed enough for accident investigation and that CIRs could lead investigators to make hasty or incorrect conclusions without looking at all available evidence. The APA paper also stressed that cockpit video recording would not be worth the expense since

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[34] Airline Pilots Association Committee Corner, "Cockpit Image Recorders Not Needed Or Wanted," . . .; Internet; accessed 23 January 2005.

prevention is more effective than investigation. Hence the money spent for any CIR program would be better invested in safety programs aimed at accident prevention.[35]

The claim that CIR imagery lacks the definition or fidelity required for accident investigation is false. By 2000, many of the problems associated with resolution and rapid changes in lighting had already been resolved.[36] In the intervening years, camera technology has made major advances increasing resolution in all lighting conditions while reducing cost and the physical size of both optics and memory.[37] The APA's fear that investigators would leap to conclusions when presented with CIR data and not consider all available evidence raises the question of why investigators would not do the same thing when presented with FDR and/or CVR data. Investigators do not take any evidence at face value; as discussed, FDR and CVR data is often incomplete and always requires verification. Additionally, wreckage is always examined to provide correlative data.[38]

Perhaps the most confounding claim made by the APA is that CIRs are not worth the expense. Humans are not perfect; they make mistakes and whether these errors occur during design, construction, maintenance or operation, any of them individually or

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[35] Allied Pilots' Association, "APA States Position on Cockpit Video: Talking Points - What you should know, in case you are asked," http://www.alliedpilots.org/Public/Publications/Perspective/pp_v7.pdf+cockpit+ video+recorder&hl=en; Internet; accessed 23 January 2005.

[36] U.S. House of Representatives, "Statement of Robert H. Frenzel Senior Vice President for Aviation Safety and Operations Air Transport Association of America Before the Aviation Subcommittee, Committee on Transportation and Infrastructure House of Representatives Hearing on Egypt Air," http://www.house.gov/trans portation/aviation/hearing/04-11-00/frenzel.html; Internet; accessed 25 January 2005.

[37] FindArticles.com, "Safety Board Urges Deployment of Cockpit Image Recorders from Air Safety Week, 2 August 2004," http://www.findarticles.com/p/articles/mi_m0UBT/is_30_18/ai_n6281128; Internet; accessed 17 March 2005.

[38] Kurt Saladana, "Anatomy of an Aircraft Accident Investigation," *United States Air Force Flying Safety Magazine*, January/February 2001, 40-45.

combined might lead to an aircraft accident. Additionally, contracts for the provision of aircraft components and maintenance are usually awarded to the lowest bidder, not the company with the best safety record or the best reputation for quality work. As astronaut Alan Shepherd observed, "It's a very sobering feeling to be up in space and realize that one's safety factor was determined by the lowest bidder on a government contract."[39] While it might be theoretically possible to eliminate aircraft crashes, it would require a large commitment of resources and the financial costs would be extremely high. How much extra would the public be willing to spend on air travel or to fund the acquisition of even more expensive military aircraft? According to aviation safety expert Kenneth Cubbin, "At some point the public will have to accept that a zero accident rate in the airline industry is unattainable and the risk factor involved with air travel is about as good as it is going to get."[40] In the event that an A-380 crashes, the financial liability of operating companies would not permit grounding all A-380s until the accident investigation is complete. Likewise, if a B-2 crashes, military operational requirements would not permit the B-2 fleet to sit idle waiting for the safety investigation to determine cause. This was borne out by the events that surrounded a grounding of the USAF's F-117 fleet:

> During the Safety Investigation Board for the 1997 Class A F-117 mishap at the Chesapeake Bay Airshow, when the F-117 fleet was temporarily grounded, one of the world's many dictators [Saddam Hussein] started rattling his sabre. Tacticians tied his actions directly to his belief that the 117 was out of business.[41]

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[39] Great Aviation Quotes, http://www.skygod.com/cgi/search.pl; Internet; accessed 13 Mar 05.

[40] AVweb, **"**ETOPS Mania by Kenneth Cubbin," http://www.avweb.com/news/safety/183011-1.html; Internet; accessed 27 December 2004.

[41] Kurt Saladana, "F-117," *United States Air Force Flying Safety Magazine*, January/February 2001, 18.

The CIR thus offers the opportunity to more definitively and more expeditiously determine why an accident happened. This capability minimizes the risk of the occurrence of a subsequent accident for the same reasons. If they could be used to prevent the loss of a single B-2 or A-380 and the associated loss of life, CIRs will have justified their cost.

A concern not raised by opponents of CIRs is the possible effect video monitoring has on crew performance, i.e. will CIRs change the way flight deck crews operate to the extent that they will interfere with the safe operation of the aircraft? Part of this question is answered by the current use of flight deck video in simulators, where training sessions are recorded to provide feedback to pilots as part of Crew Resource Management (CRM) programmes.[42] Military and commercial aircrew are already pre-conditioned to operating while their actions are being recorded on video. In the case of fighter pilots, training missions are taped from start to finish on the aircraft Head-Up Display (HUD) video recorder, which captures all pertinent flight instrument information, the view through the HUD, and all communications. Additionally, all missions are debriefed using part or all of the HUD tape. Finally, the acceptance of being videotaped may be a function of a person's age and his or her exposure to modern western culture. In its direction on conducting witness interviews, the USAF Safety Center dispels the notion that videotaping is commonly viewed as overly intrusive: "There used to be a fear that a

[42] Flight Safety International, "Crew Resource Management Training," http://www.flightsafety.com/brochures/pdfs/CRMbro.pdf; Internet; accessed 18 March 2005.

camera would make the witness nervous, but most of the people that you are interviewing will be used to video cameras."[43]

Perhaps the best reason to incorporate CIRs is validated by ALPA's and the APA's arguments that more resources should be directed toward accident prevention than crash investigation. Most aircraft accidents are caused by human error and the vast majority of these errors are attributed to the pilot(s).[44] Investigators have always been challenged to determine mishap aircrew habit patterns to see if they played a role in causing or sustaining the sequence of events that lead up to an accident:

> Although many accidents involve several errors, sometimes made by more than one individual, characteristic patterns of factors associated with particular error types are discernible . . . investigations have traditionally concentrated on the crew's behaviour, and it takes a long time to collect sufficient data to identify common patterns.[45]

If cockpit image recordings of individual pilots and crews were available for analysis, investigators may be able to better understand why an error was made, vice just being able to identify what the error was. Better still; if trainers could incorporate cockpit imagery into crew continuation training, it might be possible to identify error patterns and to introduce corrective measures early enough in the training process to prevent an accident. This type of post-flight analysis is currently being conducted in many countries by using FDR data to determine deviations from normal flight parameters with the aim of

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[43] United States Air Force Safety Center, "Witness Interviews," http://afsafety.af.mil/AFSC/RDBMS/Flight/SIB-Support/Interview%20Files/Witness_Interview_ROE.doc; Internet; accessed 20 December 2004.

[44] Robert L. Helmreich and Clayton H. Foushee, "Why Crew Resource Management? Empirical and Theoretical Bases of Human Factors Training in Aviation," in *Cockpit Resource Management*, edited by Earl L. Weiner, Barbara G. Kanki and Robert L. Helmreich, 3-45 (San Diego, California: Academic Press Inc., 1993), 5.

[45] John W Chappelow, "Error and Accidents," in *Aviation Medicine*, edited by Air Vice-Marshal (RAF) John Ernsting, Air Commodore (RAF) A.N. Nicholson and Air Commodore (RAF) D.J. Rainford, 3rd ed. (Oxford, England: Butterworth-Heinemann, 2000), 600.

identifying potential hazards.[46] Using cockpit imagery would complement and improve this type of analysis. Similarly, the use of operating theatre videotape to train surgical staff has become commonplace, even though the existence of the recordings creates some exposure to legal and liability issues.[47] If medical professionals have been able to benefit from the use of video recordings of their operations to improve safety and performance, there seems to be no reason that aviation professionals could not do the same. Using cockpit image recordings as a flight safety tool would satisfy ALPA's and the APA's demand for more emphasis on prevention than on investigation.

Because the majority of aircraft accidents are historically attributed to the aircrew, and studies identify breakdown of coordination between crewmembers as the reason a mishap crew took incorrect action, CRM training is now standard for all multi-place aircraft.[48] Although simulator-based CRM training is the norm, no matter how realistic the simulator, it is still limited because it is artificial – all stresses placed upon trainees are artificial; a fact not lost on the trainees. Additionally, everybody is on their best behaviour for a scheduled simulator mission, participants knowing that they are being assessed. Crew interactions captured by CIRs during routine flights would offer valid insight into how crews comport themselves and interact under normal working conditions. Rather than limit cockpit video recording as only an investigative tool for crash analysis, it could also be used to help prevent future accidents by helping to identify

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[46] Alexander T. Wells, *Commercial Aviation Safety*. . ., 70.

[47] Quality and Safety in Healthcare Online, "Video Techniques and Data Compared with Observation in Emergency Trauma Care," http://qhc.bmjjournals.com/cgi/content/full/12/suppl_2/ii51; Internet; accessed 20 March 2005.

[48] David O'Hare and Stanley Roscoe, *Flightdeck Performance: The Human Factor* . . ., 214.

and eliminate dangerous habit patterns and by providing feedback on crew coordination in real operations.

The NTSB, the primary agency responsible for aircraft crash investigation in the United States, wants CIRs to be installed in commercial aircraft. The Board argues that the devices are needed to provide information not captured by flight data or cockpit voice recorders. This information would include avionics presentations (information as it was displayed to the pilots), determine who made control inputs, and capture body language and gestures – none of which are provided by any other means. The addition of an image recording system would also provide redundancy to back up existing recorders, which do not always function as designed.

Groups representing pilots, such as ALPA, oppose the introduction of cockpit imagery because it will invade privacy and expose pilots to liability. They also argue that imagery is not required because it will provide investigators with no information they cannot obtain by other means.

This paper has shown that by providing information that is unavailable from any other source, CIRs will permit aviation accident investigators to more accurately and expeditiously determine not only what happened during an aircraft crash, but also why it happened. This will in turn permit investigators to recommend methods to prevent a recurrence of the same type of accident. If used to their full capabilities, CIRs could also be used to study crew habit patterns and crew cooperation as a pro-active means of accident prevention. Other professional groups have started to use video as part of training programs to improve safety and increase effectiveness; there is no reason that

aviation industry could not do the same. It is true that the introduction of CIRs might expose pilots to litigation if their recorded actions were interpreted as displays of incompetence, however, video would also vindicate those who acted professionally.

Weighing the benefits claimed by the NTSB against the disadvantages presented by groups representing pilots, it is reasonable to conclude that the introduction of cockpit image recording will advance the overall cause of flight safety rather than adversely affect aircrew performance or expose them to unfair litigation.

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