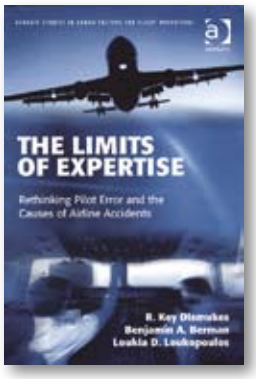
Factors in Vulnerability

A study of pilot error in accidents finds recurrent themes.



BOOKS

The Limits of Expertise: Rethinking Pilot Error and the Causes of Airline Accidents

Dismukes, R. Key; Berman, Benjamin A.; Loukopoulos, Loukia D. Aldershot, England, and Burlington, Vermont, U.S.: Ashgate, 2007. 364 pp. Figures, tables, glossary, bibliography, index.

The great majority of commercial pilots are highly experienced, thoroughly trained and regularly checked, and typically have advanced safety technology at their disposal. They operate according to a flight operations manual and checklists that prescribe carefully planned procedures for almost every conceivable situation, normal or abnormal, they will encounter. How can all this expertise co-exist with the "pilot error" that we are told is a factor in more than half of airline accidents?

The naïve view is that pilots who make an error are somehow less expert than others. That view, the authors of *The Limits of Expertise* say, is wrong. The pilot who makes an error — as seen in hindsight —typically does not lack skill, vigilance or conscientiousness. He or she *is* behaving expertly, in a situation that may involve misinformation, lack of information, ambiguity, rare weather phenomena or a range of other stressors, in a possibly unique combination.

"A particularly problematic misconception about the nature of skilled human performance is that, if experts can normally perform some task without difficulty, then they should always be able to perform that task correctly," the authors say. "But in fact, experts in all domains from time to time make inadvertent errors at tasks they normally perform without difficulty. This is the consequence of the interaction of subtle variations in task demands, incomplete information available to the expert performing the task, and the inherent nature of the cognitive processes that enable skilled performance."

Human cognitive processes are by their nature subject to failures of attention, memory and decision making, the authors say. At the same time, human cognition, despite all its potential vulnerability to error, is essential for safe operations. In theory, a perfectly programmed flight computer could operate the aircraft from takeoff to landing without human intervention, but no one would dream of conducting normal passenger operations that way.

"Computers have extremely limited capability for dealing with unexpected and novel situations, for interpreting ambiguous and sometimes conflicting information, and for making value judgments in the face of competing goals," the authors say. Technology helps make up for the limitations of human brainpower, but by the same token, humans are needed to counteract the limitations of aviation technology.

The authors say, "Airline crews routinely deal with equipment displays imperfectly matched to human information-processing characteristics, respond to system failures and decide how to deal with threats ranging from unexpected weather conditions to passenger medical emergencies. Crews are able to manage the vast majority of these occasions so skillfully that what could have become a disaster is no more than a minor

perturbation in the flow of high-volume operations. But on the rare occasions when crews fail to manage these situations, it is detrimental to the cause of aviation safety to assume that the failure stems from deficiency of the crews. Rather, these failures occur because crews are expected to perform tasks at which perfect reliability is not possible for either humans or machines. If we insist on thinking of accidents in terms of deficiency, that deficiency must be attributed to the overall system in which crews operate."

The authors do not, however, argue that human error is just part of the price of doing business — it must still be reduced, and to be reduced, the factors associated with it must be understood as well as possible, which is the aim of their study. They reviewed 19 major accidents in U.S. air carrier operations from 1991 through 2000 in which flight crew error was found to be an important causal factor by the U.S. National Transportation Safety Board (NTSB).

The methodology was similar to that used in a 1994 NTSB study, on which Berman was the principal investigator, "A Review of Flightcrew-Involved, Major Accidents of U.S. Air Carriers, 1978 through 1990." That publication was reprinted in *Flight Safety Digest*, April 1994.

The book's purpose differs from that of NTSB accident reports. In his foreword, the Hon. Carl W. Vogt, former NTSB chairman and former Flight Safety Foundation Board of Governors chairman, says, "Uncovering the causes of [flight crew] error is one of investigators' greatest challenges because human performance, including that of expert pilots, is driven by the confluence of many factors, not all of which are observable in the aftermath of an accident. Although it is often impossible to determine with certainty why accident crewmembers did what they did, it is possible to understand the types of error to which pilots are vulnerable and to identify the cognitive, task and organizational factors that shape that vulnerability. And it is possible to identify recurrent themes of vulnerability across a large set of accidents."

Common themes in pilot error–induced accidents, according to the authors, include:

- "Inadvertent slips and oversights while performing highly practiced tasks under normal conditions;
- "Inadequate execution of highly practiced normal procedures under challenging conditions;
- "Inadequate execution of non-normal procedures under challenging conditions;
- "Inadequate response to rare situations;
- "Judgment in ambiguous situations that hindsight proves wrong; [and]
- "Deviation from explicit guidance or standard operating procedures."

REPORTS

Unmanned Aircraft Pilot Medical Certification Requirements

Williams, Kevin W. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. DOT/FAA/AM-07/3. Final report. February 2007. 14 pp. Figures, tables, references, appendix. Available via the Internet at <www.faa.gov/library/reports> or from the National Technical Information Service.*

"Although the term 'unmanned aircraft' suggests the absence of human interaction, the human operator/pilot is still a critical element in the success of any unmanned aircraft [UA] operation," the report says. "For many UA systems, a contributing factor to a substantial proportion of accidents is human error."

This research study was undertaken to recommend pilot medical qualifications for UA operations, although not all the questions have been settled yet. "Research may be required to investigate the effects on pilot performance of different types of console display interfaces; how UA flight mission profiles affect pilot workload, vigilance, fatigue and performance; and to determine whether prior flight experience is important in both training and operation of UA," the report says.

To develop recommendations, the researchers proceeded in three steps. First, they conducted a literature review of existing UA pilot requirements. Second, they analyzed current

and potential UA commercial applications and airspace use. The third step was to assemble a team of subject matter specialists to review proposed UA pilot medical certification requirements and recommend how they should be changed or expanded.

The team meeting discussed whether the FAA should create a new medical certification category for UA pilots or use an existing certification. "The rapid consensus [of] the group was that the creation of a new certification would be prohibitive for a number of reasons related to the difficulty, expense and time of initiating any new rule making activity," the report said.

The question then became which existing medical certification or certifications to apply. One suggestion was that an air traffic controller medical certificate would be appropriate, because the activity of a UA pilot was in some ways more like a controller's than a conventional pilot's. Other suggestions included an additional requirement for the UA pilot to have an automobile driver's license as an indication of accountability and professionalism, and identifying the factors associated with the risk of pilot incapacitation for each UA application and basing the level of medical certification on that.

It was noted that the severity of the consequences of UA pilot incapacitation is somewhat less than that of manned aircraft. "First, factors related to changes in air pressure can be ignored, assuming that control stations for non-military operations will always be on the ground," the report said. "Second, it was pointed out by one participant that many of the current UA systems have procedures for lost data link. Lost data link, where the pilot cannot transmit commands to the aircraft, is functionally equivalent to pilot incapacitation. For those systems with an adequate procedure for handling a lost data link, pilot incapacitation does not compromise safety to the same extent as it would in a manned aircraft. Third, the level of automation of a system determines the criticality of pilot incapacitation, since some highly automated systems … will continue flight [and land] whether a pilot is present or not."

The group decided to recommend third-class (private pilot) medical certification. Since that meeting, the FAA Office of Aerospace Medicine has suggested that a second-class (commercial) medical certification would be more appropriate.

The report says, "The main reasons for this recommendation are that some UA pilots are required to maintain visual contact with the aircraft and a third-class medical certification requires only 20/40 vision, with or without correction. On the other hand, second-class medical certification requires 20/20 vision, with or without correction. A second reason for a second-class medical is that there are currently no commercial pilots that have less than a second-class medical."

The report also notes that the waiver process available to pilots can authorize handicapped people to receive medical certification if they demonstrate the necessary ability. "This process gives individuals who might not be able to fly manned aircraft an opportunity to receive medical certification for flying an unmanned aircraft," the report says.

WEB SITES

U.K. Air Accidents Investigation Branch (AAIB), <www.aaib.gov.uk/publications/index.cfm>

As part of the U.K. Department for Transport, AAIB is responsible for investigating civil aircraft accidents and serious incidents that occur within the United Kingdom. In support of the organization's purpose to improve aviation safety, AAIB has created a database of reports and makes it accessible through its Web site.

The Publications section offers quick access to the most recently published reports, selected non-British reports and monthly bulletins

containing lists of accident/incident reports dating back to 1996.

A custom search feature accessible from the Publications opening page permits searching by date from 1980 to the present; by aircraft categories such as "public transport — fixed wing" or "public transport — helicopter"; and by keywords.

Each accident/incident entry or title links to a report that may include basic data, a summary of events, the complete report, contributing factors and recommendations. Reports may be read on line, printed or downloaded at no cost.

National Business Aviation Association (NBAA), <www.nbaa.org>

NBAA supports companies and individuals who fly general aviation aircraft for business. The organization focuses its advocacy efforts on aviation safety, operational efficiency, air traffic control modernization, research and development, U.S. Federal Aviation Administration reform and other issues affecting business aviation.

NBAA's Web site has information for both members and nonmembers. Instead of a separate members-only section, member and nonmember information is mingled so that researchers can navigate freely through the site, as well as read, print and download documents. Only when a reader clicks on a document title that is member-restricted does a pop-up window appear asking for a member log-in number.

Some of the free materials among the more than 3,000 documents available are:

- *NBAA Update* — a weekly e-mail newsletter "providing the latest operational, regulatory and political news for the business aviation community";
- *NBAA Business Aviation Fact Book* — a compilation of business aviation data (the current edition is dated 2004, with a new edition expected later this year);
- *NBAA Automated Flight Deck Training Guidelines* — "the NBAA-recommended minimum training guidelines necessary to satisfy an automated flight deck instructional program";
- *Guidelines for Business Aviation Maintenance Training* — a guidance document giving "manufacturers and training providers a clear understanding of NBAA member company needs and expectations regarding the training of maintenance personnel"; and
- *Training Guidelines for Single Pilot Operations of Very Light Jets and Technically Advanced Aircraft* — "NBAA-recommended training guidelines for the next generation of very light jets." ●

Source

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— Rick Darby and Patricia Setze