Both Sides Now

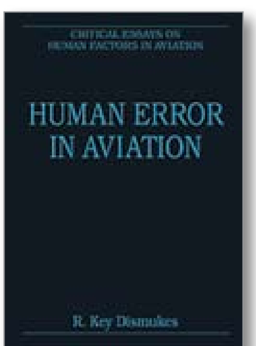
Studying skilled performance is one way of understanding human error.

BOOKS

Ambiguity and the Need for Human Decisions

Human Error in Aviation

Dismukes, R. Key (editor). Farnham, Surrey, England and Burlington, Vermont, U.S. Ashgate, 2009. 604 pp. Figures, tables, references, index.



"Skilled human performance is the product of the most complicated and sophisticated information-processing system known in the universe: the human brain," says Dismukes in his introduction to this anthology of articles from scientific and academic sources. "The essays reprinted in this book provide a cross-section of operational challenges, research accomplishments and issues that remain to be addressed. …

"Both correct performance and errors must be understood in the context of the experience, training and goals of the individual; characteristics of the tasks performed; human-machine interfaces; events — routine and unanticipated; interactions with other humans in the system; and organizational aspects. Those aspects include the organization's explicit and implicit goals, reward structures, policies and procedures. Explicit and implicit aspects sometimes diverge; for example, the norms for how tasks are actually performed on the line may not be consistent with formal guidance."

Although pilots make errors from time to time, he says, it is often a mistake to design the pilot further out of the system by adding another layer of automation. "Some of the most crucial tasks pilots perform cannot be handled by computers," he says. "Most of the time, humans — but not computers — are able to make reasonable decisions in novel situations; when available information is incomplete, ambiguous or conflicting; and when value judgments are required."

As an example of the latter situation, Dismukes presents a scenario in which a passenger is having a heart attack while the aircraft is on approach to an airport with deteriorating weather. Can a computer balance the need to get medical help for the passenger as quickly as possible with trying to land where the weather conditions might pose a high risk?

He believes that studying the skilled performance and errors of aviation personnel other than pilots has not received enough attention, compared with studies of pilots' performance, possibly because there is a bias in accident investigations to focus on the person who performed the final actions before the accident. "Equipment failures leading to accidents can often be traced to inadequate maintenance, so we should be equally concerned with mechanics' errors, which, like pilot errors, should be considered manifestations of weaknesses and flaws in the overall system," he says. "Similarly, we should be concerned with the skilled performance and errors of air traffic controllers, dispatchers, instructors, managers, equipment designers and all others in the aviation system whose work affects safety and production."

Although Dismukes was able to find worthwhile essays on particular dimensions of performance and on factors that affect the quality of performance in those dimensions, he was disappointed at how few essays he reviewed for possible inclusion in the book were published in peer-reviewed journals and provided a "thoughtful, critical overview of a domain of skilled performance in aviation."

He suggests two reasons why more research is not being conducted on skilled performance and human error. The first is that it is hard to design controlled, laboratory experiments in this field. Cognitive processing and behavior are relatively easy to study, he says, but it is a different story when scientists try to design replicable experiments concerned with flying aircraft. These involve "multiple, dynamically shifting tasks, incomplete and ambiguous information and competing goals."

The second reason, he believes, is lack of funding. "A handful of full-mission flight simulator facilities dedicated to research on aircrew performance exist around the world," he says. "However, the cost of such facilities runs into the tens of millions of dollars, and running enough experimental subjects (pilots) through a simulation to answer a given research question requires a very long and expensive study. … Fortunately, some research questions can be answered using lower fidelity simulators that are much cheaper."

The book is divided into four sections, each beginning with a brief introduction to set the stage for its essays. The first section is devoted to conceptual frameworks for thinking about skilled performance and error; the next offers selections that address specific aspects of performance such as workload, automation management, situation awareness, risk assessment and crew resource management (CRM).

The next section comprises essays about factors affecting performance, such as fatigue, stress, age, experience and organizational influences. The fourth section broadens the scope to include maintenance and air traffic control.

"Crews as Groups: Their Formation and Their Leadership," by Robert Ginnett, is one example of the type of material in the book. In CRM, he says, a group — not individuals — is the basic unit, which does not come naturally in an individualistic culture where personal achievement is stressed. He examines how a group most effectively becomes a coherent team.

"Groups are something more than merely a collection of the individuals comprising them," he says. "Some groups do remarkably well with no particularly outstanding individuals. Other groups, made up almost exclusively of high-performing individuals, do not do at all well as a team."

The optimal crew, he says, is not an "all-star team" but people who can integrate their experiences and strengths, particularly when the unexpected arises. "In many accidents in today's complex systems and environment, it is common to find that some aspect of the environment or situation created ambiguity which, by definition, eliminates a structured solution," he says. "After all, if you do not know what the problem is, it is unlikely that you know what the solution is! But if you can get two or three independent critical thinkers involved, you will have a better chance of ruling out individual biases and will be on the road to a more effective solution."

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One key to a well-functioning crew is the quality of the leader. In the cockpit, that is the captain. Ginnett quotes from an earlier study of his when he interviewed subordinate pilots and asked, "Are all the captains you fly with pretty much the same?"

One response was, "Oh, no. Some guys are just the greatest in the world to fly with. … When you fly with them, you feel like you want to do everything you can to work together to get the job done. Some other guys are just the opposite. You just can't stand to work with them.

That doesn't mean you'll do anything that's unsafe, but you won't go out of your way to keep him out of trouble either."

Ginnett discusses some of the characteristics of captains who, prior to observation in a study, were assessed by check pilots as being especially skilled at creating highly effective teams. He calls them HI-E captains.

"Contrary to expectations, the HI-E captains hardly discussed tasks at all," Ginnett says. "Even when tasks were mentioned — closing the cabin door, retracting the aft air stairs or keeping the cockpit door open prior to pushback — they were more about boundary issues than about the tasks themselves."

Boundary issues are essentially a question of who is included in the group. "The HI-E captains … worked to create a larger vision of the relevant work group — one that exceeded the bounds of the aircraft," Ginnett says. "They took pains to include, at least psychologically, gate personnel, maintenance and air traffic controllers as part of the group trying to help them — not as an outside hostile group trying to thwart their objectives."

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The Zeus-like authoritarian captain is supposed to be a thing of the past. Instead, the HI-E captain can communicate standards and expectations both through formal briefings and by modeling the desired norms. "For example, a captain may quite subtly transmit the importance of exchanging information as the group goes about its work by merely taking the time to exchange information (two-way communication) in the time allotted for the crew briefing. The norm that 'communication is important' is expressed in the series of exchanges including (1) I need to talk to you; (2) I listen to you; (3) I need you to talk to me; or even (4) I expect you to talk to me."

The captain's expression of authority can be visualized as a continuum, with "laissez-faire" at one end and "autocratic" at the other. Ginnett found that the HI-E captains did not settle somewhere around the mid-point; they shifted one way or another as circumstances or their intentions changed. At no time, however, did they move all the way to the laissez-faire pole.

Ginnett says that the HI-E captains used three methods to build an effective leader-team relationship.

The first was establishing their competence. They demonstrated the legitimacy of their authority by means such as logical organization of their briefing, using the language of aviation precisely and showing comfort in the group setting.

Second was disavowing perfection. The HI-E captains made it clear that the other crewmembers were expected to take responsibility for the work of the group. One said, "I just want you guys to understand that they assign the [cockpit] seats in this airplane based on seniority. So anything you can see or do that will help out, I'd sure appreciate it."

The third behavior was engaging the crew. Instead of giving a completely standardized briefing that might as well have been a recording, they were interactive. "By dealing in real time with the people who were filling the roles, they conveyed important normative information about themselves and the value of the individuals who made up this particular group," Ginnett says.

— Rick Darby

WEB SITES

Boeing Firefighting Aid

Boeing Commercial Airplanes, Airport Technology, <www.boeing.com/commercial/airports/rescue_fire.htm>

To benefit airports, airlines, and fire and rescue departments, Boeing has made airport rescue and firefighting (ARFF) information about its Boeing, McDonnell Douglas and Douglas aircraft models available via the Internet. Boeing's instruction sheets and diagrams for each aircraft type highlight precise locations of flammable materials and equipment, techniques to gain emergency rescue access, locations of batteries and flight deck control switches, and interior and exterior aircraft sections made of composite materials.

Instruction sheets include detailed information on fuel tank capacity and hydraulic reservoirs, operation of switches and controls, floor height from ground, methods for dealing with hot brakes and wheel fires, ways to determine aircraft surface integrity, and other critical information.

The 2009 edition of "Aircraft Rescue and Fire Fighting Information" is available in English only as a single manual or as individual instruction sheets by aircraft type. A 1999 edition of the manual is available in Russian. All materials may be read online, printed or downloaded at no cost. Instruction sheets in large formats for training purposes may be requested from an address provided on the site.

Boeing's responses to inquiries from airport operators and airport and community fire departments about airport emergency planning have been compiled into additional instructional documents. Examples of information covered include "Aircraft Recovery Planning at Airports" with lists of recommended equipment and "Tire Safety" diagrams showing hot-brake and damaged-tire safety areas. "Firefighting Practices for New Gen Composite Structures" describes fire behavior of composite materials. Use of foam on runways for aircraft experiencing unsafe landing gear issues is discussed in "Runway Foaming Requirements." Some materials cite compliance, regulations and guidelines from the U.S. Federal Aviation Administration and the International Civil Aviation Organization.

For commercial airports that might encounter transient military flights or host military air shows, Boeing identifies contact information within the U.S. Department of Defense.

— Patricia Setze

Law Group Offers Safety News

Nolan Law Group, <www.nolan-law.com>

Nolan Law Group's core practice area is representing clients in legal cases involving aviation accidents. Blogs, white papers, accident alerts, news and case reports are some of the aviation resources available on the company's Web site.

Researchers will find two blogs by aviation writer David Evans and others. The first, "Aviation Safety Journal," contains articles on accident events and related regulations and news. The blog maintains a chronological list of general and commercial aircraft accidents and incidents. Entries contain essential information; some include photos.

The second blog, "Helicopter Accident Digest," is similar in design. Like "Aviation Safety Journal," there is a chronological list of accidents and incidents. Recent discussions cover news, operational and safety issues, regulatory oversight, the investigation process, and litigation procedures.

There is also a list of Internet links to support organizations and government and consumer agencies.

Three videos from *NASA Pilots Guide to In-Flight Icing* — "How Icing Occurs," "How Icing Affects Flying Performance" and "How Icing Forms on Unprotected Areas" — may be viewed free online.

— Patricia Setze