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Improved Aeronautical Decision Making Can Reduce Accidents

Poor pilot decision making plays a leading role in causing aircraft accidents. But proper training can reduce pilot judgment errors significantly.

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Why do qualified, experienced, professional and mature helicopter pilots continue to have accidents related to poor judgment and bad decision making? "Decision making" refers to the mental process we all use in determining a particular course of action. When used by pilots in conjunction with their flying activities, this process is know as aeronautical decision making (ADM).[1]

The relationship of accidents to pilot ADM and judgment can be summarized as follows:

- Pilot error continues to be a leading cause of aircraft accidents;
- Three U.S. National Transportation Safety Board (NTSB) studies found pilot error the probable cause in as many as 68 percent of rotorcraft accidents;
- Studies of both fixed- and rotary-wing accidents indicate that poor or improper pilot decision making is a leading contributor to pilot-error accidents;
- Six U.S. government-sponsored evaluations of ADM training programs demonstrated that training can reduce pilot judgment errors by as much as 46 percent; and,
- Three operational evaluations of crew resource management (CRM) and ADM training programs specifically for helicopter pilots demonstrated a reduction in human-error accident rates by as much as 54 percent.

Decisional Errors Play a Major Role in Accidents Caused by Pilot Error

A pilot's judgment and decision-making abilities were thought to be largely a by-product of the quality and quantity of flying experience. Nevertheless, beginning in the 1970s, cockpit voice and data recorders and improved accident investigation techniques began to reveal the role played by CRM and ADM in accidents. As a result, in that same decade the U.S. Federal Aviation Administration (FAA) initiated a methodology study of teaching judgment to general aviation pilots.

In an FAA-sponsored study by Jensen and Benel,[2] U.S. general aviation accidents occurring from 1970 to 1974 were analyzed using the NTSB's computerized data base. Air crew errors were divided into three major categories: procedural, perceptualmotor and decisional. Examples of procedural errors included failure to lower the landing gear or overlooking checklist items. Perceptualmotor errors included overshooting a glideslope or stalling an airplane. Decisional errors included failing to delegate tasks in an emergency situation or continuing flight into adverse

weather. Jensen and Benel's analysis of fatal accidents involving pilot error indicated that 264 were procedural, 2,496 were perceptualmotor and 2,940 were decisional. In a paper presented in 1991, Alan Diehl analyzed U.S. airline and scheduled air taxi accidents occurring during 1987, 1988 and 1989, using the Jensen and Benel taxonomy. The data indicated that 24 of 28 major accidents involved air crew error.[3] In the 24 accidents involving air crew error, there were 16 procedural, 21 perceptualmotor and 48 decisional errors made. The relative percentages of these errors and the errors in Jensen and Benel's study are depicted in Figure 1.

Although these studies did not address helicopters in particular, an engineering study in 1985 and 1986 of worldwide accidents of Bell civil helicopter models found that poor judgment was the common factor in all human-error accidents.[4]

In two NTSB studies covering the period 1976 to 1981, the pilot was cited as a cause or factor in more than 64 percent of rotorcraft accidents.[5] The FAA conducted an in-depth analysis of one of these studies (the NTSB's *Special Study – Review of Rotorcraft Accidents 1977-1979)*, which cited 890 rotorcraft accidents. It found that decision/judgment errors accounted for 41 percent of the pilot-error accidents (Figure 2, page 3).

The NTSB, in its 1987 study on emergency medical service (EMS) helicopter operations, found that in the 59 EMS helicopter accidents studied, 68 percent involved pilot factors or poor judgment as a part of the probable cause.[6] As a result, the NTSB in that same study recommended that the FAA require ADM training to be incorporated into EMS initial and recurrent training for pilots. In 1991, in an accident summary report issued as a result of a midair collision involving a Piper PA-60 twin-engine fixed-wing aircraft and a Bell 412 helicopter, the NTSB recommended that ADM training be implemented among all categories of pilots in the civil aviation community.[7]

Another definition of ADM is "the ability to search for and establish the relevance of all available information, evaluate alternative courses of action, and the motivation to choose and execute the course of action which assures safety within the timeframe permitted by the situation."[8]

There have been six U.S. government-sponsored independent evaluations of the effectiveness of ADM training programs as they apply to low-time general aviation pilots. Alan Diehl described how these evaluations were performed, after subjects received various types of ADM training:

> The basic criteria were errors made during short, seemingly routine, cross-country 'observation flights.' On these flights, specially trained observers surreptitiously placed subjects in a series of specific decision-making situations (e.g., rushing preflight inspections or suggesting steep maneuvers at low altitudes). Observers then unobtrusively recorded the errors on these judgment items. In these rigorous 'double-blind' experiments, the observers were not informed which subjects had received ADM training, while subjects were unaware of the real purpose of the flights beforehand (e.g., subjects might be led to believe they would be evaluating new map designs.) [9]

The evaluations showed that the effectiveness of ADM training varied depending on the type of training received. In the six studies, improvement in the subjects' aeronautical decision making ranged from 8 percent in a voluntary,

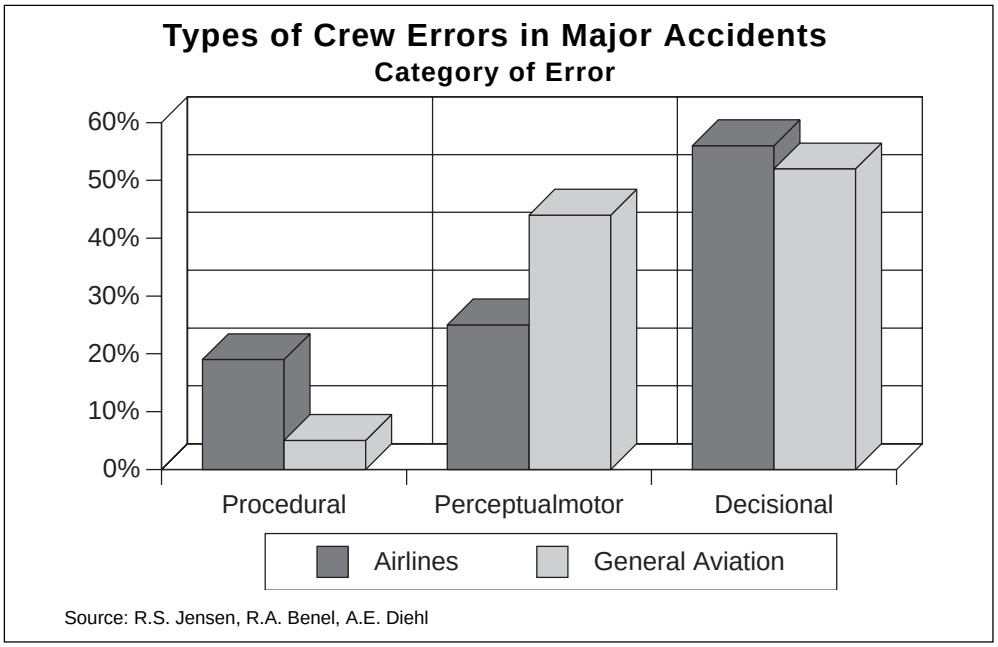

Figure 1

minimally structured training program to 46 percent in a well-structured, comprehensive, ground school environment that included simulator training.

These six studies provided strong statistical evidence that ADM training can improve pilot decision making and judgment in low-time pilots. The real test of the effectiveness of ADM training is in its contribution to the reduction of accidents.

Helicopter Accidents Reduced by ADM Training

Categorical distinctions between CRM and ADM are disappearing because comprehensive versions of these programs have common functional components. Comprehensive CRM training programs almost always include elements of decision making.

The U.S. Navy began comprehensive, formal CRM training at all Navy and Marine Corps helicopter training units in 1987. The air crew error rate for mishaps was 7.01 when the training program began. By 1990, the rate had been reduced to 5.05, a 28 percent improvement.[9]

Based on the findings of the engineering study that found poor judgment to be the common factor in Bell helicopter human-error accidents, Bell launched an aggressive judgment-training program for helicopter pilots in 1987.[10] By 1990, the human-error accident rates for the Bell Model 206 had fallen from 3.9 per 100,000 flight hours to 2.49 per 100,000 flight hours, a reduction of 36.2 percent. Petroleum Helicopter Inc. (PHI), the largest commercial helicopter operator in the United States, began ADM training in mid-1986. Chief Pilot Vernon Albert reported in *Rotor & Wing* magazine that:

> From 1980 through 1986, we had an accident rate of about 2.3 accidents per 100,000 flight hours. In mid-1986, we started ADM training, and the rate in 1987 was 1.86 and then dropped to 1.05 in 1988. The only thing we changed in our training syllabus was adding ADM and cockpit resources management.[11]

These figures represented a reduction in overall accidents of 54 percent after PHI began ADM training for its helicopter pilots.

Vernon Albert said in a recent interview that PHI continues to successfully incorporate CRM and ADM training in its pilot training courses.

"PHI is flying over 200,000 rotorcraft hours annually and the accident rate has continued to diminish and is now less than 1.0 per 100,000 flight hours," Albert said.[12]

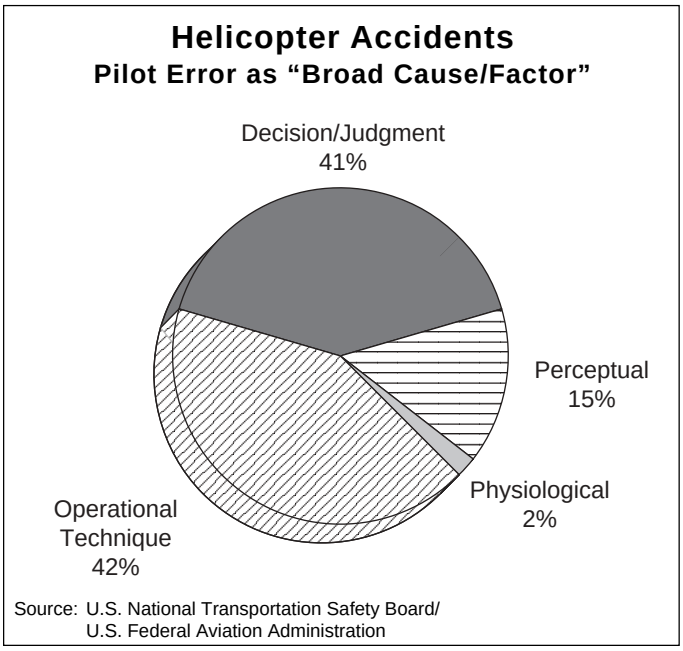

Figure 2

A comparison of the reduction in helicopter accidents after implementation of ADM and CRM training in these three instances is shown in Figure 3 (page 4).

The FAA and Transport Canada have developed versions of ADM training manuals for helicopter pilots. These manuals are widely used by major rotorcraft organizations. The FAA also produced a published series that includes four ADM training publications:

- *Aeronautical Decision Making for Helicopter Pilots;*
- *Aeronautical Decision Making for EMS Helicopter Pilots — Learning from Past Mistakes;*
- *Aeronautical Decision Making for EMS Helicopter Pilots — Situational Awareness Exercises; and,*
- *Risk Management for Air Ambulance Operators.*

FlightSafety International (FSI) introduced ADM into its curriculum in 1989. Initially, decision making was taught by a classroom presentation supplemented by the use of an interactive computer. In 1992, the company's helicopter instructor staff at the West Palm Beach Sikorsky Learning Center was trained in development and implementation of decision-making scenarios for use in the simulator. Each scenario is called a "SPOT" (Special Purpose Operational Training) and consists of a short operational simulator flight that is designed to provide pilots with opportunities to practice decision-making skills in a real-time environment. One of the interesting sides to the training is that pilots are not graded or critiqued on the decisions they reach but only on the process by which

they reach them. The pilots determine if the decisions that they made were the best possible given all of the facts. During the post-flight debriefing, which may be augmented by reviewing videotaped segments of the flight, the decision-making process is carefully examined. Did the pilot follow the fundamental steps required in reaching a good decision? Some experienced instructors feel that aggressive decision making may be part of the pilot personality profile. FSI CRM training specialist Ken Westerlund said:

> Helicopter pilots, and perhaps all pilots, have a tendency to make decisions quickly, sometimes without gathering all available information. This type of decision making may be a result of a number of factors including self-confidence, faith in one's ability and training. Most of our customers are former military pilots.[13] Military pilot training historically has heavily stressed immediate action by memory in emergencies. In modern twin-turbine helicopters, few emergencies actually require the pilot to take immediate action, and when they do an accelerated memory response is appropriate. In most cases, however, time is available for the pilot to make use of the full decision-making model.

When available time is assessed and used properly, there is evidence that success rates increase. In an FSI study of flight crews using a Bell 222 visual/motion simulator, pilots were given a catastrophic tail-rotor failure shortly after takeoff. Those instructed to land immediately upon encountering the failure crashed in more than 80 percent of the cases. However, pilots instructed to climb to a safe altitude and stabilize there until they felt more prepared to land crashed less than 20 percent of the time.[14]

An established aeronautical decision-making process such as the one described below helps organize thoughts and addresses the situation or problem in an objective manner.

The decision-making process begins after a need is recognized. An example might be a the illumination of a caution light or an engine gauge out of limits.

After the need is recognized, the first step in the decision-making process is to clearly identify the problem. This is a step that flight crews often overlook. After a caution light illuminates, for example, crew members may "jump to conclusions" concerning the nature of the problem, instead of taking the time to get the "big picture." Is the caution light the only indication of a malfunction, or is it a symptom of a larger problem? Can the light be confirmed by other indications? If operating in a multi-crew cockpit, verbal agreement as to the identity of the problem and the conditions that need to change should be reached. Identifying the problem also allows the crew to assess the approximate time available to complete the decision-making process. If the problem requires an immediate or a very rapid response, an "accelerated response" may be necessary.

It is important to access all available sources of information. Time may or may not be a limiting factor. Some malfunctions, for example, pose no immediate threat to the crew, such as a landing gear stuck in the retracted position. In such cases, the crew should recognize that time to complete the decision-making process may only be limited by the aircraft fuel supply.

Some of the resources available to the crew for fact collection may include other crew members, aircraft gauges and sensations, air traffic control (ATC), other aircraft, flight manuals, checklists, other documentation and ground-based support. Ultimately, the final decision will be no better than the information collected during this crucial phase of the process.

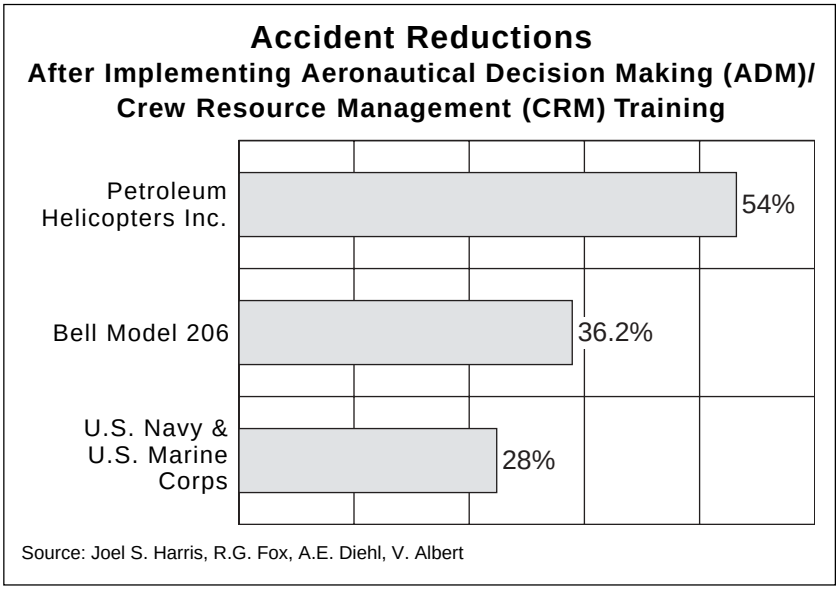

Figure 3

Another often overlooked area in the decision-making process is identifying as many alternative courses of action as possible. When identifying alternatives, crews need to consider beyond the obvious choices. Careful identification of all alternative courses of action greatly enhances the decision-making process and helps assure the best possible outcome.

Careful and accurate assessment of the influence of each alternative must now be made. The pros and cons of each alternative are weighed and evaluated.

Make a decision as a result of the process. If the pilot has collected as many facts and identified as many alternatives

as time allows, and thoughtfully weighed the influence of each alternative, choosing a good response should not be difficult.

Take timely action to implement the chosen response. Or, if at this point additional time is available, the crew may decide to consider a deliberate delay in implementing the response, choosing instead to collect more facts or to identify additional alternatives or to reassess the influence of various alternative responses.

Monitor the effect of the response chosen. Keep an open mind. There is often a tendency to stick with a decision even though there is new information that suggests the need to reevaluate. Do not take the position, "It's my decision and I'm going to stick with it, no matter what." As new information becomes available, renew the decision-making process and repeat it until the problem has been successfully resolved.

Good judgment is the capacity to make responsible choices. Judgment affects decision making. Some of the factors that affect judgment are experience, training, workload, time pressure, stress, fatigue, situational awareness and attitude. Some constructive attitudes that enhance a pilot judgment include:

- A positive "can-do" spirit;
- Open-mindedness;
- Willingness to listen;
- Optimism;
- Cooperation; and,
- Teamwork.

Disruptive attitudes interfere with effective crew performance. The FAA has identified the following hazardous attitudes:[1]

- Anti-authority: "Don't tell me!"
- Impulsivity: "Do something — quickly!"
- Invulnerability: "It won't happen to me."
- Machismo: "I can do it."
- Resignation: "What's the use?"

In certain situations, time is a severe limitation to the decision-making process. When time is short, an accelerated response may be necessary. Standardization of procedures and training prepares pilots for accelerated responses. The advantage of standardized procedures such as checklists, flight manuals and standard operating procedures (SOPs) is that many of the critical decision functions will have been accomplished previously under ideal conditions. Some SOPs recognize that time is critical. In such a case, facts will have already been collected, alternatives identified, influence of alternatives weighed and the best response selected. In critical or emergency situations, these predetermined procedures reduce time and workload, allowing the crews to safely get from need recognition to response selection.

Decision making is the process of recognizing the need to make a decision, identifying the problem, collecting facts, identifying alternatives, weighing their influence and selecting and implementing a response.

Judgment and decision making are related, and many factors can and do affect judgment. Pilots must guard against hazardous attitudes that degrade judgment and decision-making skills.

Using the decision-making process gives the pilot an organized method of solving problems and implementing decisions. ♦

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