



PILOT MEDICAL HANDBOOK

Human Factors for Successful Flying



A compilation of Federal Aviation Administration
and Civil Aviation Medical Institute publications

Pilot Medical Handbook: Human Factors for Successful Flight

Contains articles originally published by the Federal Aviation Administration and the Civil Aviation Medical Institute.

Compiled and published 2009 by Aviation Supplies & Academics, Inc.

Aviation Supplies & Academics, Inc.

7005 132nd Place SE • Newcastle, Washington 98059-3153

Internet: www.asa2fly.com • Email: asa@asa2fly.com

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Printed in the United States of America

2012 2011 2010 2009 9 8 7 6 5 4 3 2 1

ASA-MED-HNDBK

ISBN 1-56027-717-3

978-1-56027-717-0

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1 | Aeronautical Decision Making



Aeronautical decision making (ADM) is a systematic approach to the mental process used by airplane pilots to consistently determine the best course of action in response to a given set of circumstances. The importance of learning effective ADM skills cannot be overemphasized. While progress is continually being made in the advancement of pilot training methods, airplane equipment and systems, and services for pilots, accidents still occur. Despite all the changes in technology to improve flight safety, one factor remains the same—the human factor. It is estimated that approximately 75 percent of all aviation accidents are human factors related.

Historically, the term “pilot error” has been used to describe the causes of these accidents. Pilot error means that an action or decision made by the pilot was the cause, or a contributing factor that led to the accident. This definition also includes the pilot’s failure to make a decision or take action. From a broader perspective, the phrase “human factors related” more aptly describes these accidents since it is usually not a single decision that leads to an accident, but a chain of events triggered by a number of factors.

The poor judgment chain, sometimes referred to as the “error chain,” is a term used to describe this concept of contributing factors in a human factors-related accident. Breaking one link in the chain normally is all that is necessary to change the outcome of the sequence of events. The following is an example illustrating the poor judgment chain.

Human Factors—The study of how people interact with their environments. In the case of general aviation, it is the study of how pilot performance is influenced by such issues as the design of cockpits, the function of the organs of the body, the ef-

fects of emotions, and the interaction and communication with the other participants of the aviation community, such as other crewmembers and air traffic control personnel.

A private pilot with around 350 hours was ferrying an airplane cross-country to a new owner. Due to time constraints, the pilot skipped dinner the night before and had no breakfast on the morning of the flight. The pilot planned to have lunch around noon at a fuel stop.

A descent was begun from 9,500 feet, about 20 miles from the chosen fuel stop, due to haze and unfamiliarity with the area. When the airplane arrived at pattern altitude, the pilot could not find the airport. The pilot then circled north of the town, then back over the town, then flew to the west, then turned back to the east.

The pilot decided to check for airport information in the Airport/Facility Directory, which was on the rear seat and not readily available.

Power had not been increased since the descent to pattern altitude, and the pilot had been holding back pressure on the yoke. While attempting to retrieve the Airport/Facility Directory, a loud “bang” was heard. Looking up, the pilot discovered the airplane was only about 200 feet above ground level. Increasing power, the pilot climbed and located the airport. After landing, it was discovered a fiberglass antenna had been hit, which damaged the leading edge of the left wing.

By discussing the events that led to this accident, it can be understood how a series of judgmental errors contributed to the final outcome of this flight. For example, one of the first elements that affected

the pilot's flight was fatigue. The pilot understood that fatigue and hunger could affect the ability to fly safely, but let the desire to stay on schedule override the concern for a safe flight.

Next, the rush to get airborne led the pilot to skip or postpone necessary aspects of preflight planning. Research before takeoff, with a quick review before descent, could have ensured a clear mental picture of the location of the airport in relation to the town. Copying relevant information from flight guides and other information sources is part of careful preflight planning. Studying the aeronautical charts and checking the Notices to Airmen (NOTAM) beforehand would have alerted the pilot to towers, terrain, and other obstructions in the vicinity of the airport.

Even without proper planning before the flight, good cockpit resource management and organization would have had the flight guide and any other necessary information near at hand, perhaps with the relevant pages flagged. Approaching the airport environment and flying around the area at traffic pattern altitude in hazy conditions could have interfered with other air traffic, and the potential for a midair collision is obvious.

In all circumstances, the pilot's first duty is to fly the airplane. Clearly that would include adjusting the power, setting the trim, and keeping track of altitude. This pilot was extremely fortunate — the outcome could easily have been fatal.

On numerous occasions during the flight, the pilot could have made effective decisions that would have broken the chain of errors and prevented this accident. Making sound decisions is the key to preventing accidents. Traditional pilot training has emphasized flying skills, knowledge of the airplane, and familiarity with regulations. ADM training focuses on the decision-making process and the factors that affect a pilot's ability to make effective choices.

Origins of ADM Training

The airlines developed some of the first training programs that focused on improving aeronautical decision-making. Human factor-related accidents motivated the airline industry to implement crew

resource management (CRM) training for flight crews. The focus of CRM programs is the effective use of all available resources: human resources, hardware, and information. Human resources include all groups routinely working with the cockpit crew (or pilot) who are involved in decisions that are required to operate a flight safely. These groups include, but are not limited to: dispatchers, cabin crewmembers, maintenance personnel, and air traffic controllers. Although the CRM concept originated as airlines developed ways of facilitating crew cooperation to improve decision making in the cockpit, CRM principles, such as workload management, situational awareness, communication, the leadership role of the captain, and crewmember coordination have direct application to the general aviation cockpit. This also includes single pilot operations since pilots of small airplanes, as well as crews of larger airplanes, must make effective use of all available resources — human resources, hardware, and information. AC 60-22, Aeronautical Decision Making, provides background references, definitions, and other pertinent information about ADM training in the general aviation environment. [Figure 1.1]

The Decision-Making Process

An understanding of the decision-making process provides a pilot with a foundation for developing ADM skills. Some situations, such as engine failures, require a pilot to respond immediately using established procedures with little time for detailed analysis. Traditionally, pilots have been well trained to react to emergencies, but are not as well prepared to make decisions requiring a more reflective response. Typically during a flight, there is time to examine any changes that occur, gather information, and assess risk before reaching a decision. The steps leading to this conclusion constitute the decision-making process.

Defining the Problem

Problem definition is the first step in the decision-making process. Defining the problem begins with recognizing that a change has occurred or that an expected change did not occur. A problem is perceived first by the senses, and then is distinguished through insight and experience. These same abilities, as well as an objective analysis of all available

DEFINITIONS

AERONAUTICAL DECISION MAKING (ADM) is a systematic approach to the mental process used by pilots to consistently determine the best course of action in response to a given set of circumstances.

ATTITUDE is a personal motivational predisposition to respond to persons, situations, or events in a given manner that can, nevertheless, be changed or modified through training as sort of a mental shortcut to decision making.

ATTITUDE MANAGEMENT is the ability to recognize hazardous attitudes in oneself and the willingness to modify them as necessary through the application of an appropriate antidote thought.

HEADWORK is required to accomplish a conscious, rational thought process when making decisions. Good decision making involves risk identification and assessment, information processing, and problem solving.

JUDGMENT is the mental process of recognizing and analyzing all pertinent information in a particular situation, a rational evaluation of alternative actions in response to it, and a timely decision on which action to take.

PERSONALITY is the embodiment of personal traits and characteristics of an individual that are set at a very early age and extremely resistant to change.

POOR JUDGMENT CHAIN is a series of mistakes that may lead to an accident or incident. Two basic principles generally associated with the creation of a poor judgment chain are: (1) One bad decision often leads to another; and (2) as a string of bad decisions grows, it reduces the number of subsequent alternatives for continued safe flight. ADM is intended to break the poor judgment chain before it can cause an accident or incident.

RISK ELEMENTS IN ADM take into consideration the four fundamental risk elements: the pilot, the aircraft, the environment, and the type of operation that comprise any given aviation situation.

RISK MANAGEMENT is the part of the decision-making process which relies on situational awareness, problem recognition, and good judgment to reduce risks associated with each flight.

SITUATIONAL AWARENESS is the accurate perception and understanding of all the factors and conditions within the four fundamental risk elements that affect safety before, during, and after the flight.

SKILLS and PROCEDURES are the procedural, psychomotor, and perceptual skills used to control a specific aircraft or its systems. They are the airmanship abilities that are gained through conventional training, are perfected, and become almost automatic through experience.

STRESS MANAGEMENT is the personal analysis of the kinds of stress experienced while flying, the application of appropriate stress assessment tools, and other coping mechanisms.

CREW RESOURCE MANAGEMENT (CRM) is the application of team management concepts in the flight deck environment. It was initially known as cockpit resource management, but as CRM programs evolved to include cabin crews, maintenance personnel, and others, the phrase crew resource management was adopted. This includes single pilots, as in most general aviation aircraft. Pilots of small aircraft, as well as crews of larger aircraft, must make effective use of all available resources; human resources, hardware, and information. A current definition includes all groups routinely working with the cockpit crew who are involved in decisions required to operate a flight safely.

Figure 1.1 These terms are used in AC 60-22 to explain concepts used in ADM training.

information, are used to determine the exact nature and severity of the problem.

One critical error that can be made during the decision-making process is incorrectly defining the problem. For example, a low oil pressure reading could indicate that the engine is about to fail and an emergency landing should be planned, or it could mean that the oil pressure sensor has failed. The actions to be taken in each of these circumstances would be significantly different. Fixating on a problem that does not exist can divert attention from important tasks. The pilot's failure to maintain an awareness of the circumstances regarding the flight now becomes the problem. This is why once an initial assumption is made regarding the problem, other sources must be used to verify that the conclusion is correct.

While on a cross-country flight, a pilot discovered that fuel consumption was significantly higher than predicted during flight planning. By noticing this discrepancy, change has been recognized. Based on insight, cross-country flying experience, and knowledge of airplane systems, the pilot considers the possibility that there might be enough fuel to reach the destination. Factors that may increase the fuel burn rate could include environmental factors, such as higher-than-expected headwinds and lower-than-expected groundspeed. To determine the severity of the problem, recalculate the fuel consumption and reassess fuel requirements.

Choosing a Course of Action

After the problem has been identified, the pilot must evaluate the need to react to it and determine the actions that may be taken to resolve the situation in the time available. The expected outcome of each possible action should be considered and the risks assessed before deciding on a response to the situation.

The pilot determines there is insufficient fuel to reach the destination, and considers other options, such as turning around and landing at a nearby airport that has been passed, diverting off course, or landing prior to the destination at an airport on the route. The expected outcome of each possible action must be considered along with an assessment of the risks involved. After studying the aeronautical chart, the

pilot concludes that there is an airport that has fueling services within the remaining fuel range along the route. The time expended for the extra fuel stop is a worthwhile investment to ensure a safe completion of the flight.

Implementing the Decision and Evaluating the Outcome

Although a decision may be reached and a course of action implemented, the decision-making process is not complete. It is important to think ahead and determine how the decision could affect other phases of the flight. As the flight progresses, the pilot must continue to evaluate the outcome of the decision to ensure that it is producing the desired result.

To implement the decision, the pilot determines the necessary course changes and calculates a new estimated time of arrival, as well as contacts the nearest flight service station to amend the flight plan and check weather conditions at the fuel stop. Proceeding to the airport, continue to monitor the groundspeed, fuel status, and the weather conditions to ensure that no additional steps need to be taken to guarantee the safety of the flight.

The decision-making process normally consists of several steps before choosing a course of action. To help remember the elements of the decision-making process, a six-step model has been developed using the acronym "DECIDE." [Figure 1.2]

DECIDE MODEL
Detect the fact that a change has occurred.
Estimate the need to counter or react to the change.
Choose a desirable outcome for the success of the flight.
Identify actions which could successfully control the change.
Do the necessary action to adapt to the change.
Evaluate the effect of the action.

Figure 1.2 The DECIDE model can provide a framework for effective decision making.