12

Human Error*

1. INTRODUCTION

A. ACCIDENTS VERSUS WILL – An accident does not occur because the participants willfully attempt to kill themselves or others, or destroy property. These events are the province of forensic specialists skilled in criminal behavior or psychiatrists and psychologists who study suicidal behavior. Too often in the past when an accident investigation determined that a pilot was involved in the causation, the ongoing process of reviewing the facts bogged down as the term Pilot Error was used. That put an end to the investigation and ways to punish the culprits were applied. The "Whys?" of such behavior were not explored. An accident is too costly an event to waste in this manner. If we can't learn from such events we are doomed to repeat them.

The notion that the guilty must be punished or made to pay stems from the tradition of tort law which attempts to affix blame on the causally involved parties so the courts can decide who pays. In order to prevent mishaps from recurring, we must put aside the idea of an "eye for an eye" as practiced in some countries and concentrate on the nature of human error and what must be done to correct the behaviors involved in a non-punitive manner. Legal experts are not always familiar with the nuances of piloting an aircraft and tend to expect miracles from aircrews. Frequently a pilot who is considered to be a hero to his peers for his actions in a mishap is treated as a criminal by the courts in some countries.

B. THE NATURE OF ERROR – An essential fact of human nature is that people make mistakes. This tendency to commit errors is so widespread that we simply assume that errors will occur. From a human factors perspective, there is no such thing as error-free operations. Researchers have been fascinated by the nature of human errors. Names have been given to different types of errors, *e.g.*, a slip is different from a mistake.

C. THEORIES OF ERROR CAUSATION – Various theories have been advanced to explain the causes of different types of errors. Certain types of errors are caused by simple physical incompatibilities. For example, printed characters are confused when they are too small. Other types of errors are caused by complex psychological factors. Still other errors are caused by types of stress such as fatigue or severe time limits.

D. LOW ERROR SYSTEMS – Fortunately, we know a lot about what causes errors and how to design systems that minimize the likelihood of certain types of errors. The important point is that regardless of the precautions we take, errors will occur. If we depend on error-free human performance, our system eventually will fail. For errors we cannot avoid, we must design system elements so as to minimize their effects.

E. CAUSES AND OUTCOMES OF ERROR – There are three basic factors to consider in studying human error. The first is that the causes of the same type of error can be fundamentally different. The second is that anyone can and will make errors, no matter the experience level, proficiency, maturity or motivation. The third is that the outcomes of similar errors can be different. An error that leads to a disaster might be a near miss in other circumstances.

* Including excerpts from FAA's Human Factors Guide to Aviation Maintenance.

F. STUDYING PILOT ERROR – There are three basic techniques by which pilot error may be studied. These are observation of the pilot in flight; observation in a simulator or studying mishaps. Of course, when a pilot is being observed in flight his/her behavior will not be the same as under normal circumstances. Similarly, in a simulator, the individual being observed does not perform in a normal manner. Additionally, simulators do not provide a realistic environment to study error. It has long been a problem with aviation psychologists studying pilot error that there are not enough airline crashes to establish trends. Unfortunately, this is not a problem in military aviation. However, for the researcher of civilian pilot mishaps there is never enough data. We know that the reportable accident is the tip of an iceberg that consists of numerous near-miss incidents. If we could study those near-misses, we might be able to predict and prevent accidents. This is why incident reporting is so important in aviation safety. But pilots are hesitant to “put themselves on report” or to even admit that their performance is not perfect. In the 1970s NASA instituted a program of non-punitive reporting of in-flight near misses called the Aviation Safety Reporting System (ASRS). This successful program resulted in the institution of such preventative program as CRM.

2. ACCIDENT PRONENESS

A. DEFINITION – Accident proneness is defined as a chronic personality trait. This trait is rare in aviation because of the rigid selection process and extensive training. There are other reasons for having multiple mishaps.

B. CHANCE – If we examined 1,000 mishaps involving 1,000 people, three people could be expected to have as many as five mishaps due to chance alone.

C. RISK EXPOSURE – In order to compare individuals with the same experience level in aviation (for example flight hours in type) we must examine their exposure to hazards during their flying careers. If a pilot with 1,000 hours in a particular aircraft type has had two or three mishaps and a second pilot with the same experience in type has had none, we must ask about their comparative exposure levels. Did the first pilot fly predominantly in poor weather?, mountainous terrain?, at night?, in foreign countries with which the individual was unfamiliar? or in combat? Perhaps the second pilot did most of his/her flying during daytime VFR conditions in training situations or ferrying aircraft within the Continental United States. To compare these people on their accident histories would be like comparing apples to oranges.

3. SOURCES OF ERROR

A. SHEL MODEL INTERFACES – When looking for sources of error in the aviation environment we can turn to Edward’s SHEL model (see Chapter 1). The interface between the human operator and the machine known as the L-H interface encompasses the field of ergonomics, including the design of displays, controls, tools, etc. The interface between humans and software (the L-S interface) includes looking at poorly written manuals, checklists, etc. Examining personal protective equipment, etc. involves the L-E interface. The domain of interpersonal relationships may be scrutinized through observing the L-L interface which includes supervision, communications, Trans-Cockpit Authority Gradient, CRM, etc.

B. INFORMATION PROCESSING – We have seen in Chapter 8 that the experienced aviator may base decisions on a false hypothesis due to a mistaken assumption. Other errors in judgment have been discussed elsewhere in this handbook.

C. THE CLASSIFICATION OF ERRORS – Errors may be classified as design-induced or operator-induced (pure pilot error). Errors may be random, systematic or sporadic. Random errors may be corrected through training. Systematic errors can be eliminated through practice. On the other hand, sporadic errors (such as SLOJ discussed in Chapter 11) are the most difficult to predict and prevent. Errors of omission occur where an individual forgot to do something (a lapse). Commission errors occur where a person did something they shouldn't have (a mistake). Substitution errors are errors of intention, that is the person intended to do something, but did the wrong thing (as in a slip). Reversible errors should be designed into aerospace systems. Irreversible errors occur where there is no correcting device built into a system.

4. A MODEL OF HUMAN ERROR

A. PREDICTING ERROR – The investigator needs not only to discover the underlying "whys" of error behavior, but also needs to be able to predict when and under what circumstances such behavior will occur. In order to predict behavior we must understand the events leading up to the error. We need to construct a model for describing human error. Unfortunately most aviation mishap reporting concentrates upon the outcome or actions taken by the participants. Accident reports frequently contain a listing of behaviors or factors that influence behavior. These taxonomies do not allow us to predict when such behaviors will occur. They also do not allow us to tie in to the already existing body of human factors research literature on perception, decision making and performance. A model for human error that allows prediction and provides a frame of reference for research is Reason's model of human error (see paragraph 5 below).

Human nature is to distance oneself from mishap behavior in a process of denial that we could ever become involved in such events. In this manner one is protected from considering the consequences of being engaged in such a highly dangerous profession as aviation. However, in order to increase our understanding of the events leading up to a mishap, we need to put ourselves in the role of the participants.

B. DATA INPUT – The first step in putting oneself into the cockpit or on the workbench with an operator or maintainer is to try to determine what kinds of information the individual was receiving from the environment. This data input is what the individual has had to rely upon in order to form a mental picture of the situation. The information obtained is heavily influenced by the nature of the stimulus, the physical condition of the receptor and the ambient conditions (background noise). Coloring the way the perception is interpreted is a function of prior experience and learning, individual biases and prejudices and our personal attitudes and motivation. The input of data from other people gives us additional information to form our mental model. The human interaction is an important source of cues to our environment.

When any energy impinges on our senses we mayor may not notice it depending upon the question of whether it is an adequate stimulus and whether it is an appropriate stimulus for that sense. If the energy from a light source is too weak for our eyes to see, we say it is not an adequate stimulus. If the energy is below the visible light spectrum (infrared) or above it (ultraviolet) we do not see it because it is an inappropriate stimulus for our eyes although it may be appropriate for our other senses (our skin feels warm under infrared radiation).

C. COGNITIVE PROCESSES – The next step for the investigator is to try to get inside the skull of the participants in a mishap in order to recreate the thought processes that led to a wrong decision or action. Training and supervision usually play a role here.

D. ACTIONS – Finally, we need to examine the actions of the individual to determine what kind of error behavior occurred. This can lead to a determination of whether the error was design induced; due to a lack of training; experience or proficiency; or due to the individual's lack of discipline.

An analysis of this kind can help us understand where, when and under what circumstances human error can occur. Thus the ability to predict error will aid in identifying hazards and in preventing mishaps. Ultimately, the goal of any safety program is to identify and eliminate hazards in order to prevent mishaps. An example of how such a model might be useful in predicting human error is demonstrated in Figure 12-1 which was taken from a U.S. Navy study of aircraft accidents (Weigmann and Shappell, 1995).

E. THE TAXONOMY OF UNSAFE OPERATIONS – Figure 12-1 was based on Reason's Model of Human Error. It illustrates that the Navy would need to put more effort into training pilots to avoid making rule-based and knowledge-based mistakes. Thus the reporting of human error can be

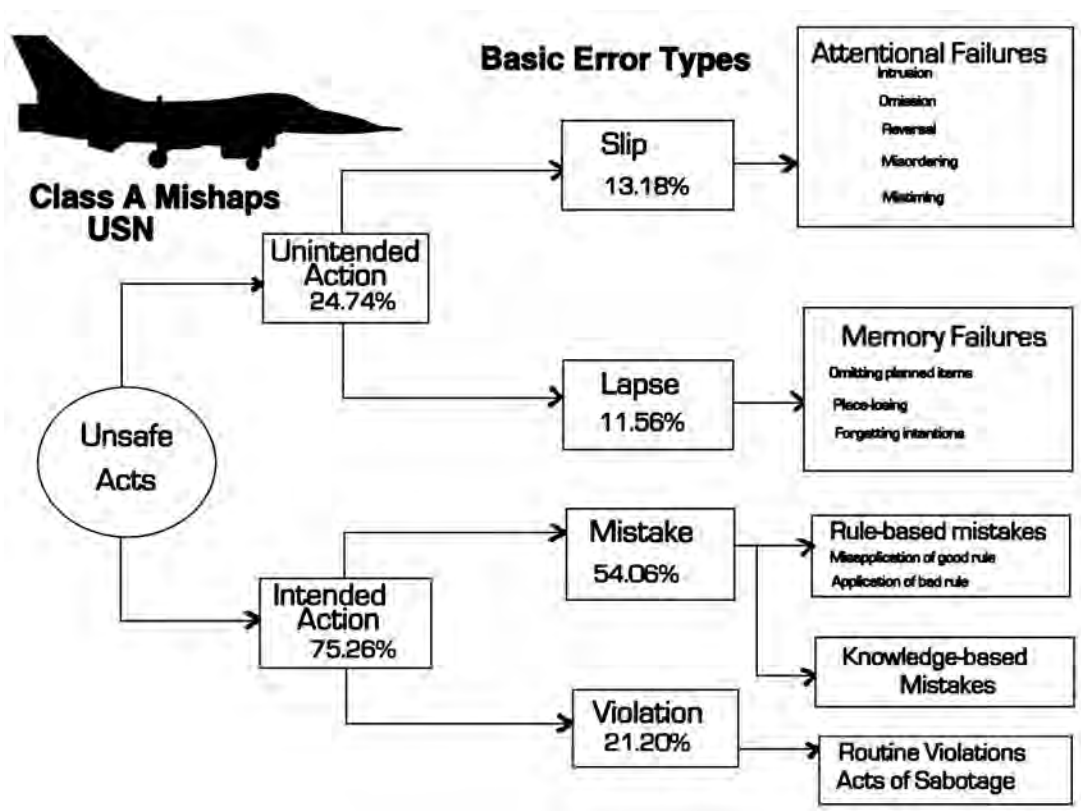

Figure 12-1. U.S. Navy Aircraft Accidents by Error Types

12

Human Error*

1. INTRODUCTION

A. ACCIDENTS VERSUS WILL – An accident does not occur because the participants willfully attempt to kill themselves or others, or destroy property. These events are the province of forensic specialists skilled in criminal behavior or psychiatrists and psychologists who study suicidal behavior. Too often in the past when an accident investigation determined that a pilot was involved in the causation, the ongoing process of reviewing the facts bogged down as the term Pilot Error was used. That put an end to the investigation and ways to punish the culprits were applied. The "Whys?" of such behavior were not explored. An accident is too costly an event to waste in this manner. If we can't learn from such events we are doomed to repeat them.

The notion that the guilty must be punished or made to pay stems from the tradition of tort law which attempts to affix blame on the causally involved parties so the courts can decide who pays. In order to prevent mishaps from recurring, we must put aside the idea of an "eye for an eye" as practiced in some countries and concentrate on the nature of human error and what must be done to correct the behaviors involved in a non-punitive manner. Legal experts are not always familiar with the nuances of piloting an aircraft and tend to expect miracles from aircrews. Frequently a pilot who is considered to be a hero to his peers for his actions in a mishap is treated as a criminal by the courts in some countries.

B. THE NATURE OF ERROR – An essential fact of human nature is that people make mistakes. This tendency to commit errors is so widespread that we simply assume that errors will occur. From a human factors perspective, there is no such thing as error-free operations. Researchers have been fascinated by the nature of human errors. Names have been given to different types of errors, *e.g.*, a slip is different from a mistake.

C. THEORIES OF ERROR CAUSATION – Various theories have been advanced to explain the causes of different types of errors. Certain types of errors are caused by simple physical incompatibilities. For example, printed characters are confused when they are too small. Other types of errors are caused by complex psychological factors. Still other errors are caused by types of stress such as fatigue or severe time limits.

D. LOW ERROR SYSTEMS – Fortunately, we know a lot about what causes errors and how to design systems that minimize the likelihood of certain types of errors. The important point is that regardless of the precautions we take, errors will occur. If we depend on error-free human performance, our system eventually will fail. For errors we cannot avoid, we must design system elements so as to minimize their effects.

E. CAUSES AND OUTCOMES OF ERROR – There are three basic factors to consider in studying human error. The first is that the causes of the same type of error can be fundamentally different. The second is that anyone can and will make errors, no matter the experience level, proficiency, maturity or motivation. The third is that the outcomes of similar errors can be different. An error that leads to a disaster might be a near miss in other circumstances.

---

* Including excerpts from FAA's Human Factors Guide to Aviation Maintenance.