HUMAN ERROR: A CONCEPT ANALYSIS

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ABSTRACT

Human error is the subject of research in almost every industry and profession of our times. This term is part of our daily language and intuitively understood by most people however, it would be premature to assume that everyone's understanding of human error is the same. For example, human error is used to describe the outcome or consequence of human action, the causal factor of an accident, deliberate violations, and the actual action taken by a human being. As a result, researchers rarely agree on the either a specific definition or how to prevent human error. The purpose of this article is to explore the specific concept of human error using Concept Analysis as described by Walker and Avant (1995). The concept of human error is examined as currently used in the literature of a variety of industries and professions. Defining attributes and examples of model, borderline, and contrary cases are described. The antecedents and consequences of human error are also discussed and a definition of human error is offered.

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INTRODUCTION

When words and terms are commonly used to describe a particular phenomenon, assumptions may be made by both the authors and their audience. Indeed, it is not unusual to find articles that do not even include a specific definition of the word or term. The assumption that all parties both understand and agree with a specific term may be erroneous. Human error is one term that has become part of the common vernacular in aviation yet it has a wide variety of meanings within the industry. For example, human error is used to describe the outcome or consequence of human action, the causal factor of an accident, and as an action itself.

This lack of a common definition of the term complicates the attempts of researchers to identify meaningful approaches to reducing the effect of human error within our individual professions. Without a working concept of human error, how is it that we can announce that 72% of Navy and Marine Corps flight mishaps between 1995 and 1999 were the result of pilot error (Erwin, 2000); or that human error in road accidents "was the sole cause in 57% of all accidents and was a contributing factor in over 90%" (Green & Senders, n.d., p.1); or that "medical errors are the eighth leading cause of death in the United States" (McFadden, Towell, & Stock, 2004, p.2)? Other industries and researchers declare human error to be the cause of anywhere from 30% to nearly 100% of accidents.

Concepts, like words in our language, evolve over time and may have more than one accepted definition. This paper therefore, does not purport to identify the one true meaning of human error but will offer a definition that includes defining attributes of the concept along with a discussion of the antecedents and consequences of the concept. The use of model, borderline, and contrary cases will illustrate both what human error is and what it is not.

RESEARCH DESIGN

Concept analysis is a research strategy that can be used as an essential element of theory development. The analysis involves a formal, linguistic exercise that enables a researcher to examine the attributes and characteristics of a concept in order to determine which phenomena clarify a concept and which do not. Concept analysis is used to clarify overused and vague concepts that are part of our vernacular so that those using the term in the future start from the same definition. The result of the concept analysis process is an operational definition that has, as a minimum, at least some construct validity.

A concept analysis should not be considered as a final, completed project because concepts change over time, sometimes quite rapidly.

Different researchers may develop slightly different attributes for the same concept or the scientific and general knowledge surrounding the concept has changed. “Concept analysis encourages communication . . . will make if far easier to promote understanding among our colleagues about the phenomena being observed” (Walker & Avant, p. 37-38).

Concept analysis produces additional benefits to future researchers dealing with the concept. First, concept analysis helps the investigator in understanding the underlying attributes of the concept. Second, concept analysis helps to clarify what the concept is, what the concept is similar to, and what the concept is not. Finally, concept analysis identifies the antecedents and consequences of the concept. Antecedents are those events that occur before the concept can occur and consequences are events that happen as a result of the occurrence of the concept (Walker & Avant, 1995).

Wilson (1963) developed an eleven-step process for concept analysis. This was later streamlined and simplified by Walker and Avant (1995) into an eight-step process. The first two steps used by Walker and Avant deal with selecting the concept for analysis and determining the purpose of the analysis. These are both preparatory steps and are not tied to the actual research methodology of concept analysis. The following simplified six-step process will be followed:

1. Identify all uses of the concept that you can discover.
2. Determine the defining attributes.
3. Construct a model case.
4. Develop constructed cases.
5. Identify antecedents and consequences.
6. Define empirical referents.

USES OF THE CONCEPT

Etymology is the study of word origins and is an important element of a concept analysis because it offers clues to the evolution of language. Dictionaries, on the other hand, are the repositories of how words are used well after they have become part of our vernacular. According to the Online Etymology Dictionary (2001), *error* dates to circa 1300 from the Old French word *errur* from the Latin word *errorem,* “wandering, straying, mistake,” and from the Latin *errare* “to wander.” Although error meant to wander or stray in most languages, the Irish word for error, *dearmad,* derived from the Irish word, *dermat,* meaning, “a forgetting.”

The Oxford English Dictionary (OED, 1986) provides the following definitions of the word error:

> 1. The action of roaming or wandering; hence a devious or winding course, a roving, winding. 2. Chagrin, fury, vexation; a wandering of the feelings; extravagance of passion. 3. The action or state of erring. 3a. The condition of erring in opinion; the holding of mistaken notions or beliefs; an instance of this, a mistaken notion or belief; false beliefs collectively. 3b. Something incorrectly done through ignorance or inadvertence; a mistake; a flaw, malformation. (p. 277-278)

According to the American Heritage College Dictionary (1997) *error* is:

> 1: an act, an assertion, or a belief that unintentionally deviates from what is correct, right, or true. 2: the condition of having incorrect or false knowledge 3: the act or an instance of deviating from an accepted code of behavior: 4. a mistake. (p. 466)

The Oxford English Dictionary (OED, 1986) provides the following definitions of the word *human*:

> 1. of, belonging to, or characteristic of man. 2. of the nature of man. 3. belonging or relative to man as distinguished from God or superhuman beings. 4. having or showing the qualities or attributes proper to or distinctive of man. (p. 1,345)

The etymology of human dates back to approximately 1250:

> From Middle French *humain* "of or belonging to man," from Latin *humanus,* probably related to *homo* (genitive, *hominis*) "man," and to *humus* "earth," on notion of "earthly beings," as opposed to the gods (cf. Classical Hebrew, *adam* "man," from *adamah* "ground"). Cognate with Old Lithuaian *zmuo* "man, male person. (Online Etymology Dictionary, 2001)

Combining the meanings of the word "human" with the word "error" leads to an examination of "human error"—characteristics of human beings that involve unintentional deviations from what is correct, right, or true.

It is common for investigators to identify different types of human error in their research (Reason 1990; Strauch 2002; Wiegmann & Shappell 2003; McFadden, Towell, & Stock 2004). Synonyms therefore are useful in developing the attributes of a concept because they provide clues to what is almost the concept but differs in some way from the concept. Webster's New World College Dictionary (2001) provides the following synonyms for error:

> Error implies deviation from truth, accuracy, correctness, right, etc. and is the broadest term in this comparison [an error in judgment, in computation, etc]; mistake suggests an error resulting from carelessness, inattention, misunderstanding, etc. and does not in itself carry a strong implication of criticism [a mistake in reading a blueprint]; blunder implies stupidity, dumbness, inefficiency, etc., and carries a suggestion of more severe criticism [a tactical blunder cost them the war]; a slip is a mistake, usually slight, made inadvertently in speaking or writing; a faux pas is a social blunder or error in etiquette that causes embarrassment. (p. 483)

The use of the concept by authors, politicians, and other historical figures also provides clues to the characteristics of human error. Probably the most familiar quotation, certainly the most cited, is the Latin phrase *errare est humanum*—to err is human. The British philosopher John Locke wrote, "All men are liable to error; and most men are, in many points, by passion or interest, under temptation to it" (Nidditch, 1979, p. 706). President Thomas Jefferson noted "error is to be pitied and pardoned: it is the weakness of human nature" (Jefferson, 1950/1775, p. 283). Physician and educator Lewis Thomas (1979) wrote that errors are part of the human makeup when he noted that humans are coded for error. He considered it an inescapable reality that human beings are built to make mistakes. Stephen Casey (1998) did not specifically define human error but noted that there are incompatibilities between the characteristics of people and the characteristics of the technology we use. The difference between success and failures then lies in how well we minimize those incompatibilities.

It is also appropriate to learn how human error is used in the literature of various professions. The books and articles dealing with human error are obviously too numerous to adequately address all of the diverse opinions about the human error but a sampling across several professions is important. The following sections will focus on the broad fields of transportation, accident investigation, and human factors and then expand into a sampling of other professions that deal with human error.

Transportation

All modes of transportation deal with human error, particularly as it relates to accidents. Human error or pilot error is readily pointed to as the cause factor of most aircraft accidents although maintenance errors and Air Traffic Control errors also receive attention. The role of human error in highway accidents, shipping accidents, train accidents, and pipeline accidents is well researched.

Humans commit driving errors because humans have three fallible mental functions (perception, attention, and memory) that limit the ability to processing information. It is the situation that exceeds the limits of human mental functions that leads to road accidents. (Green & Senders, n.d.).

Jim Hall (1995), Chairman of the National Transportation Safety Board stated that:

> Humans bear the ultimate responsibility for recognizing, interpreting, compensating for, and correcting or mitigating the consequences of deficiencies, failures, and malfunctions in the hardware and software, and ironically in their own performance. Because the human retains responsibility for the system, regardless of its level of automation, human/machine system failures are often reported as human error. (p. 4)

Senders and Moray (1991) wrote, "error is something that has been done which was not intended by the actor, nor desired by a set of rules or an external observer, or that let the task or system outside its acceptable limits" (p. 25).

Ahlstrom & Hartman (2001) in their discussion on human error in airway facilities, noted that human errors are frequently less associated with human characteristics than with error-likely conditions. "People are set up for error by the system design" (p. 2).

Goulielmos and Tzannatos (1997) in a discussion on shipping safety noted human errors have become more critical in the man-machine interface of the bridge. Typical operator errors may be presented as perceptual-motor errors related to skill, procedural errors related to rules, and inadequate monitoring errors.

Accident investigation/prevention

Sidney Dekker (2002) does not specifically define human error but differentiates between an old view of human error as the *cause* of a mishap and a new view of human error as a symptom of externalities acting upon a human being in a specific situation.

Woods, Johannesen, Cook, & Sarter (as cited in Strauch, 2002) define human error as:

> A specific variety of human performance that is so clearly and significantly substandard and flawed when viewed in retrospect that there is no doubt that it should have been viewed by the practitioner as substandard at the time the act was committed or omitted. (p. 20-21)

Strauch (2002) defines human error as "an action or decision that results in one or more unintended negative outcomes" (p. 21). The fundamental attributes of error involve what a human does or intends to do but that leads to outcomes that differ from what was intended.

Petersen (1996) argues that “human errors are caused by the situations in which people find themselves—a particular situation at a particular moment that makes it totally normal and logical to commit an error that may result in an accident and an injury” (p. 4).

Departing from the normal emphasis on human error in accidents, Hollnagel (2004) generally finds the term human error too simplistic. In a pseudo concept analysis, he defines an *accident* as “a short, sudden, and unexpected event or occurrence that results in an unwanted and undesirable outcome. The short, sudden, and unexpected event must directly or indirectly be the result of human activity . . .” (p.5). Hollnagel further comments that “an accident can thus refer to either an event, the outcome of an event, or the possible cause. This unattractive quality is characteristic of other important terms as well, for instance ‘human error’” (pp. 4-5).

Human factors

One of the most cited definitions of human error is “the failure of planned actions to achieve their desired ends—without the intervention of some unforeseeable event” (Reason, 1997, p. 71). Reason noted that the intervention of an unforeseeable event component of his definition is necessary to separate controllable actions from “luck”—either good or bad. Reason further identifies specific modes of human error that include slips, lapses, mistakes and violations—a common taxonomy for human error researchers.

Cacciabue (2004) considers human error, especially in the management of human-machine interactions as “inappropriate performance/behavior, dependent on the context and dynamic contingencies and imbedded in a specific socio-technical environment” (p. 23). Human errors can involve either performance elements (errors of omission or commission) or behavior elements (slips, lapses, mistakes, and violations as discussed by James Reason).

Nursing and medicine

Medicine and aviation have similar problems when it comes to human error. Both deal with time critical decisions, both view human error as a significant problem, both know that errors can result in the deaths of their customers, and both experience significant financial losses directly related to human error. One primary difference between the two is that fatal errors in aviation frequently result in the death of those who commit the error but this is seldom the case for medical practitioners.

In the medical field, medical errors are generally synonymous with human errors. With respect to medical errors, one definition is “the failure of a planned action to be completed as intended (that is, an error of execution) or the use of a wrong plan to achieve an aim (that is, an error of planning)" (Institute of Medicine, 2000. p. 28).

In the patient safety movement within the medical field, the reported death toll of patients under medical care spurred Congress and other federal agencies to take swift and strong action. Unfortunately, much of that effort was focused on the human component of medical error. "High error rates are predictable whenever human beings provide services via complex delivery systems. Human beings routinely make mistakes, even when they exercise due care"." (Hyman & Silver 2005, p. 56).

Attributing problems exclusively to human error may lead investigators into shallow and misleading interpretations of the root causes of accidents. As with aircraft accidents, the medical profession is quick to identify the human error cause associated with adverse events.

> The focus on human error arises from natural laws that capture how people make causal judgments, notably hindsight bias. Knowledge of outcome biases our judgments about the processes that led to that outcome. In looking back, reviewers tend to oversimplify the situation the practitioners faced, blocking their ability to see the deeper story behind the label "human error." (Billings & Woods, 2001)

Minor variations in performing tasks are of little concern in medicine because the outcomes are acceptable, however when some limit of acceptability is exceeded that variation is considered a human error. "Human error is any human action or lack thereof that exceeds the tolerances defined by the system with which the human interacts" (p. 28). While human error may include both intentional and unintentional acts, intentional malevolent behavior is not a human error—it is a deliberate act intended to cause an adverse effect. (Rooney, Vanden Heuvel, Lorenzo, Stoecklein, & Christensen, 2002)

Mhyre and McRuer (2000) define human error as a failure to perform an action within the tolerance limits necessary for adequate and safe performance. Lapses (failures of memory) and mistakes (deficiencies or failures in judgment) are included in this definition.

Based on disciplinary case files from state nursing boards, Woods and Doan-Johnson (2002) identify eight categories of nursing errors. These categories include system, individual and practice errors. The categories identified are:

> 1. lack of attentiveness, 2. lack of agency/fiduciary concern, 3. inappropriate judgment, 4. medication errors, 5. lack of intervention on the patient's behalf, 6. lack of prevention, 7. missed or mistaken

physician or health care provider orders, and 8. documentation errors. (p. 46)

Engineering

Engineers typically view error as the difference between desired and actual performance. Human factors engineering is used during the design phase to reduce human error by making machines and systems error tolerant. Possible human error actions in a man-machine system must be predicted during the design stage to permit appropriate measures to be taken on the machine design, training of operators, or the organizations. (Kohda, Nojiri, & Inoeu, 1997)

In a discussion on the nature of the engineering design process, Sydenham (2004) noted that it is virtually impossible to avoid errors in complex projects because "design is a matter of making many assumptions in often problematic situations" (p. 121). Slips and lapses are identified as the two main sources of error in design.

In the field of reliability engineering, human error is defined as "the failure to perform a task (or the performance of a forbidden action) that could lead to the disruption of scheduled operations or damage to property and equipment" (Dhillon, 2003, p. 530). The specific types of human error identified are design errors, fabrication errors, inspection errors, handling errors, maintenance errors, operator errors, and miscellaneous or contributory errors (p. 531).

Educational testing

Random errors differ from human errors in multiple ways. Most significantly, human errors do not occur randomly and their presence is not known. Human errors tend to be capricious and their consequences are unseen and potentially very serious. The two types of human error are active (derived from individual mistakes) and latent (arising from poor management decisions). While active errors are the most dominant, latent errors are problematic and are connected to active errors (Rhoades and Madaus, 2003).

Computer programming

"At the source of every error which is blamed on the computer you will find at least two human errors, including the error of blaming it on the computer" (Anonymous).

Although computer programming does deal with human error, the classification of computer errors offers an insight into the types of errors that are either produced or that must be corrected. An *error* may involve a piece of incorrectly written program code, or a bug. *Syntax errors* are ungrammatical or nonsensical statements in a computer program. A *logic* *error* is a mistake in an algorithm that causes erroneous results or an undesired operation. An error may also be an *exception*, a condition which arises during program execution due to an unexpected event. For instance, it is an error to attempt to write more files onto a disk that is full. Continuing past an unhandled error can cause error avalanche, a condition in which errors pile up and behavior becomes more erratic.

DEFINING ATTRIBUTES

Defining attributes are those characteristics of the concept that appear repeatedly. In simple terms, defining attributes provide guidance in determining how to identify the concept from other similar or related concepts. "The defining attributes are not immutable" (Walker & Avant, p. 41). Attributes may change over time or they may change when used outside the specific context of the study.

Based upon the literature reviewed and discussed in this paper, the defining attributes of human error are as follows:

1. An action that is performed by a human being.
2. The action occurs at the interface between the human and another system (human, machine, environment).
3. The action is voluntary and deliberate.
4. The action exceeds tolerance limits.

The action is performed by a human being

While some people will argue that faulty reasoning is also a human error, it is actually a precursor of error. Humans do not have the capacity to know all things nor are they capable of processing every piece of information available in order to arrive at perfect decisions. The evaluation of human error must begin with the action or series of actions performed. Although some medical literature refers to a failure to perform an action as part of human error, the deliberate decision to do nothing is an action that is frequently appropriate under certain circumstances.

The action occurs at an interface between a human and another system

A critical attribute of human error is the interaction between a human and some other system (whether another human being, a machine, or the environment). The SHELL model identifies typical interfaces between one human and software, hardware, the environment, and other human beings. Human error occurs at one or more of these interaction points.

The action is voluntary and deliberate

Actions that are performed involuntarily (e.g., because of force or coercion) are not human errors. An action that is not made intentionally is not a human error. Actions that are performed after the mental, physical, or physiological capabilities of the human are exceeded are also not human errors. This is important because it separates *human error* from *human limitations*. Aviation is filled with examples in which a pilot was unable to process all of the audio, visual, sensory, and other inputs of a given situation and crashed the airplane. Although these accidents are normally classified as pilot error accidents, they deal more specifically with internal limitations of all human beings.

The action exceeds tolerance limits

Tolerances are defined by the system with which the human is interacting. A pilot who lands an aircraft with a 20-knot crosswind has not committed an error if the aircraft has a defined crosswind landing tolerance of 30 knots. Human error may also be defined within social, legal, or professional tolerances. Acceptable tolerances will vary widely depending on the system and the circumstances. Tolerances in the nuclear power industry differ from those of commercial aviation, which also differ from those of highway driving.

CASES

Cases are used in a concept analysis to provide examples of what the concept is, what it is not, and what it is similar to. The model case provides a real example that is absolutely an instance of the concept. All components of the defining attributes will be present in the model case.

Borderline cases provide additional insight into the concept by presenting examples that contain some of the defining attributes but not all of them. Borderline cases help us to understand the difference between the defined concept and something close, but not quite the concept.

Contrary cases are used to delineate boundaries of the concept. A contrary case is an example of what is clearly not the concept. Contrary cases are helpful because "we often find it easier to say what something is not than what it is" (Walker & Avant, p. 44).

MODEL CASE

A model case of human error is the Jessica Dubroff aircraft accident in April 1996. Jessica was a seven year-old uncertificated student pilot attempting to set a new record as the youngest pilot to fly an airplane across the United States. Accompanying Jessica were her father (a non-pilot) and her flight instructor. Jessica was an instant celebrity with media coverage from ABC, CNN and others. Shortly after takeoff from Cheyenne, Wyoming, the aircraft crashed approximately 4000 feet north of the runway, killing all three people. The aircraft investigation revealed that the aircraft was 96 pounds over the allowable gross weight and the density altitude at Cheyenne was higher than the instructor pilot was accustomed to. The weather at the time of the takeoff was deteriorating with heavy rain, gusty winds, and air turbulence.

The National Transportation Safety Board (NTSB) determined that the probable cause of the accident was:

> The pilot in command's improper decision to takeoff into deteriorating weather conditions (including turbulence, gusty winds, and an advancing thunderstorm and associated precipitation) when the airplane was overweight and when the density altitude was higher than he was accustomed to, resulting in an a stall caused by failure to maintain airspeed. (NTSB, p. 53)

Analysis

This accident meets all of the defining characteristics of human error. The pilot took an action (attempting to take off) that was both voluntary and deliberate. Although there were pressures to keep to a rigid schedule, the pilot had the option to delay the flight. The pilot also had a duty to compute the weight and balance on the aircraft and the performance characteristics of the aircraft for the conditions present at the airport. The action occurred at the interface between a human and a system (the aircraft) and the action was outside of established tolerances. In this case, the aircraft was overweight and the combination of high-density altitude, gusty winds, turbulence, and heavy rain left no margin for safety. This accident provides a pure example of human error in transportation.

CONSTRUCTED CASES

Borderline case

The worst aircraft accident in the history of commercial aviation occurred March 27, 1977, at Tenerife in the Canary Islands when two Boeing 747 aircraft collided on a fog-enshrouded runway (Bruggink, 2000). The KLM aircraft was cleared to taxi down the runway and perform a 180-degree turn in preparation for takeoff. The Pan Am aircraft was cleared to follow the KLM aircraft down the same runway but was told to taxi clear of the active runway at the third taxiway. The Pan Am aircraft did not clear the runway at the assigned taxiway and was still on the runway when the KLM captain commenced takeoff without clearance. The ensuing collision on the runway killed 583 people. Because of the fog at the airport, the two aircraft did not see each other until it was too late to avoid the accident.

Analysis

While it might be assumed the pilot of the Pan Am aircraft committed a human error that led to this accident, the circumstances do not match all of the criteria identified in the critical attributes. The pilot did taxi down the active runway but he did so under the direction of the tower controller. The pilot obviously was taking action at the interface of himself and his aircraft. There is no evidence from the pilot of the Pan Am (who survived the accident) or from cockpit and tower voice recordings that the Pan Am crew ever saw the third taxiway. Many factors could explain why the crew might have missed the taxiway including unfamiliarity with the airport, the fog, and the height of the cockpit. The circumstances involving the Pan Am aircraft and its crew do not support a conclusion that they deliberately and voluntarily violated their taxi instructions.

The action of the Pan Am pilot might be considered a *mistake* because the action was inadvertent but not a *human error*. Both mistakes and human error involve actions committed by humans and occur at the boundary between a human and another system. The two terms differ significantly because mistakes do not imply voluntary and deliberate action even if the action actually exceeds acceptable tolerance levels of a system.

CONTRARY CASE

Before setting off on a cross-country flight, the pilot obtains a detailed weather briefing for the proposed route of flight. Based on this information, the pilot decides to delay the flight until the weather improves.

Analysis

A contrary case is a clear example of an instance that is not the concept. The pilot in this scenario demonstrated sound judgment and a concern for safety. The defining attributes of human error are not present in this case.

ANTECEDENTS AND CONSEQUENCES

According to Walker and Avant (1995), "antecedents are those events or incidents that must occur prior to the occurrence of the concept" (p. 45). The antecedent for human error is a cognitive ability to distinguish between courses of action based upon external inputs. If a person is unable to process available inputs and make some sort of decision on what action is or is not needed, it cannot be human error.

Another antecedent for human error is experience and prior knowledge. Transportation professionals (pilots, ship captains, truck drivers, etc.) develop their skills through education, practice, and experience. Drawing upon this knowledge and experience permits the human interacting with a system to reduce those situations that could exceed the tolerance limits of the system.

Consequences are, “those events or incidents that occur as a result of the occurrence of the concept” (Walker & Avant, 1995, p. 45). The consequences of human error include events or outcomes that are unintended and undesired. Unintended but desirable outcomes are not uncommon for humans and form the basis of those "unexpected pleasures in life" that we enjoy. An action that produces an intended but undesired consequence likewise should not be considered a human error. These actions may be noble, malicious, desperate, or criminal but not human errors. The soldier who throws himself on an enemy hand grenade to save his comrades commits a deliberate act with an intended but undesired consequence did not commit an error.

Another consequence of human error could be harm or loss. Although death, injury, or some other form of loss is not a consequence of all human errors, they are frequently used as a metric to determine that a human error has occurred. A consequence of human error can also include *no* harm or loss. A pilot who nearly lands his aircraft with the landing gear retracted but is warned by the tower at the last moment and executes a successful go-around commits a human error but does not suffer a loss.

EMPIRICAL REFERENTS

The final step in a concept analysis is to define the empirical referents of the concept. Empirical referents are “classes or categories of actual phenomena that by their existence or presence demonstrate the occurrence of the concept itself” (Walker & Avant, 1995, p. 46). In many cases, the empirical referents are the same as the defining attributes of the concept. No unique empirical referents for human error have been identified in this paper. Human error is identified retrospectively through a largely subjective process conducted by other humans familiar with the specific system with which the human interacted. The subjective nature of this identification has made human error research difficult at best.

CONCLUSION

As a result of analyzing the concept of human error, a new definition is offered. *Human error is a voluntary and deliberate action by a human interacting with another system that exceeds established tolerances defined by that system.* The consequences of human error encompass a continuum that runs from no injury or loss to major damage and casualties. The action taken by the human involves the cognitive ability to decide between alternate courses of action based upon experience, knowledge, and the combined external and internal inputs available to the human. The ability of humans to decide which of the numerous inputs are significant in choosing the correct action to take is important in understanding *why* we have human error. Bounded rationality and satisficing describe the problem of decision-making but do not help to reduce human error.

Human error is a term that is overused and over-emphasized. The inclusion of slips, lapses, violations, and blunders into previous definitions of human error provide interesting glimpses into the dynamics of human involvement in accidents but also unnecessarily overstate the true dimension of human error. Human error and human limitations both play a role in aviation accidents but should not be treated as the same phenomenon. Developing a narrower definition of human error may allow future researchers to develop specific strategies to reduce the impact of true human error in accidents.

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