People or Systems?

To blame is human. The fix is to engineer.

By Richard J. Holden

DURING A LECTURE IN A SAFETY and human performance course, students were told about the distinction between the person-centered and systems-centered approaches to managing safety (Reason, 2000; Woods & Cook, 1999). This was to be a simple, if mindset-changing, lesson on eschewing the person-focused approach of blame, punishment and empty intonations to be safe. Instead, students were encouraged to view safety as the emergent product of a complex sociotechnical system. The implication is that changes in safety can only come about through changes that address not only people, but also the many system components with which people interact.

To illustrate the point, the students are told about a Food and Drug Administration (FDA) recall of a medication infusion device whose mechanical components were contributing to medication overdoses (sidebar, p. 35). FDA recalled only those devices not yet installed. For those devices that remained, the solution was to train nurses to essentially "be safer" and to place warning labels on the devices.

The lecturer expected this would be a convincing lesson on the absurdity of fixing a human-device interface problem by focusing on anything except that interface. But a student raised an unexpected objection: "Yes, I see how the manufacturer could make its product fool-proof, but it's the user's responsibility to not be a fool in the first place." Another student agreed.

This recalls common assertions that accidents are largely the fault of humans. In fact, in the first half of the 20th century, some estimated that 88% of accidents were caused by the unsafe acts of workers (Heinrich, Petersen & Roos, 1980). [*Author's note:* A systems-centered approach need not suspend individual responsibility (in this case trained and licensed professionals), but it is unlikely that the overdoses were due to foolishness or a lack of responsibility, as the student implied. The student erred in presuming that mistakes were being caused primarily and deliberately by humans.]

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These person-centered views are not limited to student protestations. These views may even be a psychological tendency and an industry norm, despite teachings to the contrary. Psychological evidence about typical human behavior and a critical assessment of how accidents are handled in the modern world suggest that there is something fundamental, perhaps universal, about the assignment of accident causality (and sometimes blame) to the actions and dispositions of humans.

This article first makes a case about the tendency to attribute causality and blame to person factors. This tendency has been well described by psychologists who study causal attribution theory (Harvey & Martinko, 2009; Malle, Knobe & Nelson, 2007). The tendency may also apply to managers, industry practitioners, official investigators and legislators who deal with safety on a daily basis, and some evidence is presented to support that contention. Further, the trend of focusing on intentional safety protocol violations and how it may be a pitfall if it simply reinforces the person-centered approach is discussed. Finally, the numerous implications of focusing on person factors are discussed. The main implication is that person-centered tendencies engender ineffective person-centered solutions:

> [A]ssociated countermeasures are directed mainly at reducing unwanted variability in human behavior. These methods include poster campaigns that appeal to people's sense of fear, writing another procedure (or adding to existing ones), disciplinary measures, threat of litigation, retraining, naming, blaming and shaming (Reason, 2000, p. 768).

How Fundamental?

Ross (1977) found the person-centered approach to be so ubiquitous in society that he called it the fundamental attribution error. Researchers of the phenomena have found that when people observe an action or outcome, they tend to attribute its cause to the actor's internal or dispositional traits, even in the face of overwhelming evidence that the action was caused by the situational context.

For example, a worker who slips on a wet work surface may be said by observers to have fallen due to clumsiness, carelessness or inattention. Other findings from research on causal attributions (Fiske & Taylor, 1991) suggest that individuals 1) attribute the cause of action to external factors if they were the ones who performed the action, but to internal factors if they witnessed others performing it (the actor-observer bias); 2) attribute others' failures to internal factors but their own failures to external factors, and the reverse for successes (the self-serving bias); and 3) make inferences about a person's character (e.g., dumb, motivated, risky) based on the actor's observed actions, even when those actions are constrained by external factors (the correspondence bias).

Person-Centered or System-Centered?

Infusion pumps are devices that control the flow of medication or other product into a patient through an intravenous (IV) line. An infusion pump manufactured by Alaris Products and used in many hospitals had a key bounce problem such that pressing a button once would sometimes register that key press twice. For example, pressing 4.8 might result in 44.8 being entered, which represents a 10-time overdose.

In August 2006, the manufacturer was ordered by the Food and Drug Administration to send a letter to every hospital still using the device. The letter alerted hospitals to the problem and offered these "solutions": 1) instructions for nurses to use a proper stance, listen to the number of key press beeps, verify the screen display, obtain an independent double check and look at the IV tubing to verify the correct flow rate; and 2) a warning label to be placed on each device.

A simpler and more effective solution might have been to fix the mechanical key bounce problem.

Abstract: *Person-centered safety theories have been largely dismissed in favor of systems-centered theories. Students and practitioners are taught that incidents occur due to the complex interactions of numerous work system elements, human and nonhuman. Nevertheless, person-centered approaches to safety management prevail. This article explores the notion that attributing causality and blame to people persists because it is both a fundamental psychological tendency as well as a norm in many industries. Consequences of that tendency are discussed and a case is made for continuing to invest in whole-system design and engineering solutions.*

Despite much early research on causal attributions—more than 900 studies were published in the 1970s alone—the link between attribution theory and safety was not made explicit until the mid-1990s (Glendon, Clarke & McKenna, 2006). However, the importance of attribution in safety management cannot be understated:

> [A]ttributional processes are at the very heart of workplace safety management. Workers, supervisors, managers and safety specialists are all involved in making inferences of causality or attributions. . . . These causal inferences, in turn, broadly determine the actions that are taken or not taken to correct hazards and prevent injuries. In a very real sense, actions to manage safety derive more from attributions than from actual causes (DeJoy, 1994, p. 3).

For technical precision, it is worth noting that causal attributions and blame are not identical concepts. In attribution theory, blame implies that the behavior was inappropriate, unjustifiable or intentional (Shaver & Drown, 1986). Thus, blame is a special case of causal explanations. However, a person-centered causal attribution of workplace accidents need not involve blame. Worker behavior can be seen as the cause of accidents even when the behavior itself is not attributed to impropriety or intentions of harm.

The causes of these attribution tendencies are still debated. They include the proposal that some cultural and educational systems promote individual agency and a focus on the individual (i.e., Western individualism); the high salience of human action (e.g., the noticeable nature of a human falling); the low salience of situational conditions especially if those conditions are chronic or latent (e.g., the less-observable daily stress, prior upstream managerial decisions or a slippery floor's coefficient of friction); the cognitive difficulty of adjusting initial judgments or searching for multiple, interactive causes; and differences in experience with the action being attributed (e.g., supervisors who have more experience with a subordinate's job are less likely to attribute accidents to subordinates).

The cause of attribution tendencies is important (DeJoy, 1994). Causes aside, much evidence points to a general psychological tendency toward person-centered attributions. If this is the case, an SH&E professional might ask to what extent this tendency prevails in the world of contemporary safety management. In other words, is the person-centered approach an industry norm? Dekker (2002) addresses this question when he writes of the bad apple theory of safety management. According to this theory, one "identifies bad apples (unreliable human components) somewhere in an organization, and gets rid of them or somehow constrains their activities" (p. 3). This theory belongs to the old view of human error, which states that:

> Human error is the cause of many accidents. The system in which people work is basically safe; success is intrinsic. The chief threat to safety comes from the inherent unreliability of people. Progress on safety can be made by protecting the system from unreliable humans through selection, proceduralization, automation, training and discipline (Dekker, 2002, p. 3).

According to Dekker, the new view first succeeded the old view around the time when human factors pioneers Fitts and Jones were askedto advise the U.S. military on how to select less error-prone fighter pilots. They instead discovered that it was not the pilots but the planes' design that needed to change in order to improve the compatibility between the plane and the pilot. This systems-centered view is credited with having saved many lives and dollars during World War II and the Korean War (Helander, 2006). According to the new view:

> Human error is a symptom of trouble deeper inside the system. Safety is not inherent in systems. The systems themselves are contradictions between multiple goals that people must pursue simultaneously. People have to create safety. Human error is systematically connected to features of people's tools, tasks and operating environment. Progress on safety comes from understanding and influencing these connections (Dekker, 2002, p. 3; Hollnagel & Woods, 2005).

Dekker is critical of the notion that the old view is a thing of the past, left behind in a pre-World War II era. He refers to "the reinvention of human error" as a modern-day resurgence of blame, a "retread of the old view" (p. 14). He argues that even in the 21st century safety management approach, the focus is too much on human failure and too little on flawed systems, too much on judgments and too little on explanations. Even when the worker or operator is not blamed, his/her boss is. He alleges that overly simplistic error classification and other modern safety management methods reinforce the old view, albeit unintentionally. Attributing causality and blame to the person remains the industry norm (Woods & Cook, 1999).

An Empirical Test of Dekker's Critique

To test Dekker's critique that modern safety management has not abandoned the person-centered approach, National Transportation Safety Board's (NTSB) investigations of major aviation accidents (www.ntsb.gov/ntsb/major.asp) were examined.

Table 1

Analysis of Aviation Accidents Investigated by NTSB

#	Date, location of accident	Probable cause(s) and contributing factors as determined by NTSB investigation
1	10/11/2006 New York	“pilots’ inadequate planning, judgment and airmanship”
2	08/27/2006 Lexington, KY	“the flight crewmembers’s [sic] failure to use available cues and aids to identify the airplane’s location . . . and their failure to cross-check and verify that the airplane was on the correct runway” *Contributing factors: flight crew conversation, inadequate regulatory procedures*
3	12/19/2005 Miami, FL	“failure and separation of the right wing during normal flight, which resulted from 1) the failure of the Chalk’s Ocean Airways maintenance program to identify and properly repair fatigue cracks in the right wing and 2) the failure of the Federal Aviation Administration to detect and correct deficiencies in the company’s maintenance program”
4	12/8/2005 Chicago	“pilots’ failure to use available reverse thrust in a timely manner. . . . This failure occurred because the pilots’ first experience and lack of familiarity with the airplane’s autobrake system distracted them” *Contributing factors: inappropriate pilot guidance and training, onboard computer performance, new procedure poorly implemented, lack of safety margin, pilots’ failure to divert landing to other airport*
5	06/07/2005 Washington, DC	“inexperience of the driver (fleet service agent)”
6	02/16/2005 Pueblo, CO	“flight crew’s failure to effectively monitor and maintain airspeed and comply with procedures” *Contributing factors: inadequate certification requirements for flight in icy conditions*
7	11/22/2004 Houston, TX	“flight crew’s failure to adequately monitor and cross check the flight instruments” *Contributing factors: flight crew failure to carry out procedures in a timely manner, and flight crew noncompliance with procedures*
8	10/19/2004 Kirksville, MO	“pilots’ failure to follow established procedures and properly conduct a nonprecision instrument approach at night . . . and their failure to adhere to the established division of duties” *Contributing factors: pilot failure to make standard callouts, inappropriate regulations, pilots’ unprofessional behavior, fatigue*
9	10/14/2004 Jefferson City, MO	“pilots’ unprofessional behavior, deviation from standard operating procedures and poor airmanship . . . pilots’ failure to prepare for an emergency landing in a timely manner . . . pilots’ improper management of the double engine failure checklist” *Contributing factors: engine conditions that prevented engine from restarting, inadequate airplane flight manuals*
10	08/13/2004 Florence, KY	“fuel starvation resulting from the captain’s decision not to follow approved fuel crossfeed procedures” *Contributing factors: captain’s inadequate flight plan, pilot distraction, pilot delay in using checklist, flight crew failure to monitor fuel and diagnose fuel-related problems*
11	03/23/2004 Gulf of Mexico	“flight crew’s failure to identify and arrest the helicopter’s descent for undetermined reasons”
12	01/08/2003 Charlotte, NC	“airplane’s loss of pitch control during take-off . . . [that] resulted from the incorrect rigging of the elevator system compounded by the airplane’s aft center of gravity” *Contributing factors: lack of oversight of maintenance work, inappropriate maintenance procedures and documentation, airline program for weight and balance, manufacturer failure to detect problem, inappropriate regulatory support and oversight of weight and balance*

Note. *Analysis of several major aviation accidents investigated by NTSB, 1999 to 2006. Excludes investigations of four Sept. 11, 2001, terrorist events.*

This table presents only a sampling of the data reviewed. To view the complete table, visit www.asse.org/psextras.

NTSB organizes investigations of accidents, including all aviation accidents in the U.S. Based on analysis of accident sites, record reviews, interviews and more, NTSB produces a report that includes the attribution of probable causes and contributing factors.

Table 1 presents an excerpt of data reporting the concluded probable cause(s) for 12 of 27 accidents investigated by NTSB. As this excerpt shows, even in today’s world of safety management and accident investigation, the tendency is to assign causality to humans. In 26 of 27 cases reviewed (96%) (see full table online), people, usually the pilots or flight crew, are mentioned as a probable cause of the incident. In 21 of those 26 cases (81%), people are the sole cause reported. Even in the case where the cause appears purely mechanical (#12), the inspector in charge of manufacturing quality assurance is implicated in the contributing factors. Drivers, ramp agents, maintenance personnel, airline decision makers, and regulators are non-flight-crew-members implicated in the reports.

The vocabulary used is also telling. “Crew failure” or a similar term appears in 20 of 27 (74%) of probable causes; the remaining 7 cases contain language such as “inadequate planning, judgment and airmanship,” “inexperience” and “unnecessary and excessive . . . inputs.” Finally, it appears as if violations of known protocols were implicated as causes or contributing factors in 9 of 27 cases (33%).

Reviewing these data begs the question of whether causality is accurately assigned to human actions and failures because human actions were truly involved in or even necessary contributors to the accident. It is accurate to state that human action was involved, perhaps necessary, for most incidents highlighted. This is not unexpected, given that:

> Since no system has ever built itself, since few systems operate by themselves and since no systems maintain themselves, the search for a human in the path of failure is bound to succeed. If not found directly at the sharp end—as a “human error” or unsafe act—it can usually be found a few steps back. The assumption that humans have failed therefore always vindicates itself. The search for a human-related cause is reinforced by past successes and by the fact that most accident analysis methods put human failure at the very top of the hierarchy (i.e., as among the first causes to be investigated) (Hollnagel & Woods, 2005, p. 9).

However, it is more important to ask whether isolating human action as the cause of an accident is 1) sufficient, given that causation is often multifactorial, nonlinear and complex (Woods & Cook, 1999); and 2) meaningful for the designer or organizational decision maker interested in ensuring safety for the future. To isolate human action as the cause or to start with human action as cause and to not go deeper than that leads one to deprioritize engineering solutions and overprioritize behavioral control. Indeed, recommendations offered by NTSB are often aimed at administrative controls such as policy writing, regulation, training, better enforcement of compliance and reminders to pilots to be more attentive.

Is aviation a special case? Research in the domain of healthcare, where *blame culture* or *blame-and-shame* are commonly used to describe how medical accidents are viewed, suggests that it is not. Reason (2000) writes that "the person approach remains the dominant tradition in medicine, as elsewhere" (p. 768). Leape (2008) reflects further on the medical profession: "We strive to eliminate errors by requiring perfection, and respond to failure (error) by blaming individuals. Errors are assumed to be someone's fault, caused by a lack of sufficient attention or, worse, lack of caring enough to do it right" (p. 4).

Cause-finding in healthcare has traditionally relied on morbidity and mortality conferences, wherein clinicians meet briefly to discuss a recent accident. However, some note that "with the morbidity and mortality conference an adverse outcome is known and serves as the starting point as one works backward to connect the dots and find the culprits—a technique conducive to meting out a fair measure of shame and blame" (Henriksen & Kaplan, 2003).

The medicolegal environment and its tort process, at least in the U.S., reinforces the assignment, or, if possible, shifting, of blame to individuals (Studdert, Mello & Brennan, 2004). Formal cause-finding in the medical domain (e.g., morbidity and mortality conferences, root-cause analysis) is, as elsewhere, subject to the effects of attribution errors, hindsight bias (Blank, Musch & Pohl, 2007), outcome bias (Tostain & Lebreuilly, 2006), faulty reconstructive memory (Loftus, 2005) and other errors that attribute incidents to human actions at the "sharp end" of medical care. Examples in the medical domain abound:

- In 2003, a Duke University Medical Center physician was involved in two erroneous heart and lung transplants, in which the patient died. The public response was person-centered, often blaming, as exemplified by editorials with titles such as "Physician, heal thyself" (Lavin, 2003); moreover, the physician admitted ultimate responsibility in a clear example of medicine's institutionalized person-centered approach.
- In 2006, California doctors at a children's hospital removed the wrong side of a patient's skull during brain surgery. A California Department of Health Services report determined that the cause was "failing to follow proper procedures." New procedures were mandated to prevent future errors.

However, in a Rhode Island hospital that mandated those very procedures, three highly publicized wrong-site brain surgeries occurred in less than 1 year's time. Researchers investigating the incidence of wrong-site surgery commented that existing protocols are not always effective or efficient, and that better protocols are the solution for preventing wrong-site errors (Kwaan, Studdert, Zinner, et al., 2006).

- In 2006, a Wisconsin nurse was charged with a felony count of neglect, and was convicted of two misdemeanors on a plea bargain. In July, the nurse administered the wrong medication to a woman in labor, killing the woman. The nurse also did not use the hospital procedure for verifying the accuracy of the medication using a computerized bar-coding system. "This was my mistake," the remorseful nurse said, taking responsibility for the accident.
- In 2008, cases of patients dying during long waits in the emergency room made national news. In June, a 49-year-old woman died in New York after a 24-hour wait; in September, a 58-year-old man died in Dallas, TX, after a 19-hour wait; and a 45-year-old man died in Winnipeg, Manitoba, Canada, after a 34-hour wait. Earlier, in September 2006, a Lake County, IL, coroner's jury ruled that a 49-year-old woman's death after a 2-hour wait was a case of homicide, defined as "either a willful and wanton act or recklessness on the part of someone, whether that's by their actions or by their inactions."

Comments by public officials and experts such as "the system broke down," "the system's broken" and "obviously the system failed" at first glance appear to reflect a systems approach. Upon reflection, however, one wonders what the term *system* refers to and whether, perhaps, the word is a substitute used when no one person can be identified. Blame and focus on failure, whether that of a bad apple or a bad apple cart (i.e., system), may result in the same ineffective procedure-writing, training or poster campaigns.

The situation is no different outside aviation and healthcare. In 2005, an explosion at BP's Texas City, TX, refinery claimed 15 lives and caused many injuries and much destruction. The company's vice president of North American refining testified in 2007 that "our people did not follow their start-up procedures. . . . If they'd followed the start-up procedures, we wouldn't have had this accident" (Calkins & Fisk, 2007).

When it was found that the explosion was "years in the making" and that equipment was substandard, the company official questioned managerial decisions to use it. Examples such as these are so familiar in the public eye that the satirical publication *The Onion* (2005) lampooned the person-centered tendency with the headline "Investigators Blame Stupidity In Area Death."

A look at how expert investigators, managers and the public respond to accidents lends support to Dekker's (2002) argument that there remains a strong tendency to focus on human failure, human fallibility, and person-centered, internal causes of accidents. Evidence of psychological phenomena such as the fundamental attribution error suggests that this tendency is much broader, possibly affecting society or humanity as a whole.

Few modern safety professionals are naive to the importance of engineering solutions. They know that system problems require system-centered solutions (Goetsch, 2007). Practical guides to occupational safety espouse the view that engineering controls are the most effective and the most preferred (Reese, 2008). Although it is true that worker actions are often discovered to contribute to accidents, SH&E profession-

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Occupational Safety Examples: Tendencies to Attribute Cause

Example: Carly slipped on an oil spill in her work area. She managed to fall forward into a pile of cushions, avoiding serious injury. Roman, a coworker, observed this incident.

Fundamental attribution error: Roman believes Carly to have slipped because of internal causes: her clumsy nature and carelessness.

Actor-observer bias: Although Roman believes that Carly slipped due to internal causes, Carly believes that she slipped because of external causes: oil spills are uncommon and poor lighting conditions made it hard to see this particular spill.

Self-serving bias: Carly believes that she successfully fell into a pile of cushions because of internal causes: her quick reflexes and knowledge of the environment. Roman believes that the causes were external: a lucky fall and the fortuitous presence of pillows. The opposite pattern of self-other attributions is seen with regard to her failure (i.e., slipping, see above).

Correspondence bias: Roman infers from Carly's slip that she is a risk-taker, a careless employee or an absent-minded person in general.

Ultimate attribution error: If Carly belonged to a conspicuous (e.g., minority) social group, the cause of failure may be attributed to the traits of that group. Carly is female, and one might believe that Carly fell because women are clumsy and careless by nature.

als often search further for more distal and root causes as well. The problem is that even a knowledgeable and well-meaning professional may succumb to some of the cited biases of human nature.

Biases may have at least three specific effects. First, the bias to view incidents as products of a linear chain of causation may lead investigators to identify human action as the sole proximal cause, then to investigate the causes of human action. This is acceptable, except when the accident did not have a single proximal cause but rather resulted from a combination of co-occurring chance and nonchance events.

For example, the disaster at Chernobyl was characterized by the co-occurrence of reduced operating power, a disabled safety system, a lack of information on system state or feedback about the outcome of operator actions, and the fact that operators were unfamiliar with the unusual situation and the complex nature of the RBMK-1000 nuclear reactor (Vicente, 2006). These issues did not occur in sequence, as would be expected by a linear chain of events approach. The complexity of the reactor (like the inherent danger of placing a 400-ton airplane in the air) was probably a major contributor, yet this cause cannot be located on a timeline. Linear models of causation are common in safety management and they produce different approaches to investigations than do complex, nonlinear models, as shown in a recent study by Lundberg, Rollenhagen and Hollnagel (2009).

Second, the salience of human action, especially in retrospect, may obscure distal contributors to safety problems that may not appear to be as obvious. If so, limited resources will not be spent to investigate deeper, and distal systemic causes will remain undiscovered. This means that engineering solutions may not be attempted, even when their importance is recognized.

Perrow (1984) writes that "formal accident investigations usually start with an assumption that the operator must have failed, and if this attribution can be made, that is the end of serious inquiry" (p. 146). Although Perrow is overgeneralizing, variation surely exists in how many and which links of the causal chain are investigated.

What causes this variation? One determining factor may be related to the strength of the bias to attribute causality to human action. Another possible explanation is that investigators will focus on the type or level of cause that they can control (G.R. Gruetzmacher, personal communication, April 13, 2009). For example, NTSB investigators who suggest policy changes may investigate until policy flaws or violations are found, whereas a line supervisor's investigation may stop at human or machine failure.

Third, even when some erroneous or risky human action has prominently contributed to an incident, it is a challenge to overcome the tendency to attribute that accident to some characteristic of the worker. "Social psychological studies have consistently found that people have a strong tendency to overestimate internal factors, such as one's disposition, and underestimate the external factors driving people's behavior" (Horhota & Blanchard-Fields, 2006, p. 310). The same bias affects people involved in safety management. Thus, it is not surprising that theories popular in the first half of the 20th century that accidents are caused by inherently accident-prone or dysfunctional workers persisted in the second half of the century (Holcom, Lehman & Simpson, 1993) and even today (Gauchard, Mur, Touron, et al., 2006).

Other behavior-based approaches to safety management, however, recognize that human behavior has multiple causes and that changing behavior requires changing the whole system not just the person in it (DeJoy, 2005; Geller, 2001; Glendon, et al., 2006). However, some have suggested that a behavioral approach, even when it considers systemic causes of behavior, is problematic because the theory and practice of behavioral change is still in its infancy.

> Historically, little scholarly attention has been paid to understanding determinants of injury-related behaviors or how to initiate and sustain behavioral changes. . . . Many authors have noted the need to improve behavioral interventions by using better empirical data about determinants of behavior as well as theories and frameworks pertaining to change in health behavior (Gielen & Sleet, 2003, p. 65).

Nevertheless, expositions on behavior-based safety (BBS) theory (Geller, 2003; 2005) and recent reviews showing that BBS interventions are effective (Cooper, 2009) hold promise for future use of behavioral modification and other psychological approaches. Of course, advances in this area should not lead one to forget that behavior is only one factor in an interrelated web of safety and accident causation, and that engineering solutions which do not rely on compliance are sometimes the most effective. To quote the Western Electric slogan for designing hand tools with bent handles in order to avoid hazardous bent-wrist postures, "It is better to bend metal than to twist arms" (Helander, 2006). This is a concept that SH&E professionals know but may have trouble applying due to persistent psychological tendencies.

Violations of Safety Protocol: The New Face of Human Failure?

The person-centered approach is applied not only when individuals make unintentional errors, but also when they violate a rule or regulation, especially when they do so intentionally. Person-centered attributions of accidents by people who deviated from a prescribed standard are common in general and in safety management in particular. Even Helander (2006), in arguing for a systems approach to errors, says "the notion that the operator should be punished or personally made responsible is unwarranted, unless of course there is a clear violation of regulations" (p. 340).

In safety management, more attention is being paid to safety protocol violations (Phipps, Parker, Pals, et al., 2008), which are defined as "deliberate departures from rules that describe the safe or approved method of performing a particular task or job" (Lawton, 1998, p. 78). Violations of safety protocol have been found to contribute to disasters such as Chernobyl, the *Challenger* space shuttle and the Zeebrugge ferry. Studies also show that violations are prevalent in healthcare (Alper, Karsh, Holden, et al., 2006).

Violations, as well as work-arounds, shortcuts and noncompliant behaviors, are the new face of human failure. Many in industry and academics have shifted their focus from the clumsy to the risky, from the "error prone" worker to the "violation prone" driver (Reason, Manstead, Stradling, et al., 1990). Thus person-centered solutions continue to be applied to a new person-centered cause, by writing more rules, increasing regulations, providing skills training and raising workers' awareness of rules.

In both of the wrong-site brain surgery examples cited earlier, hospital and regulatory officials created new policies and training requirements within days. The key question is whether such solutions will work (they did not at the Rhode Island hospital). To answer that question, one must understand why people violate protocol (Mason, 1997).

Suppose a worker removes the machine guard on a cutting tool to speed work, or removes a jam without stopping the production line. The worker stands accused of violating protocol. He is trained how to use machine guards and how to stop the line, and is repeatedly reminded to do so. But this will not be effective if the causes of violations are not rooted in individuals who are ill-meaning or ignorant of the rules (Lawton, 1998; Reason, et al., 1990).

Causes may instead be rooted in the social nature of violations and the necessity to violate in order to complete the work. Violations are social, "governed by operating procedures, codes of practice, rules, norms and the like" (Reason, et al., 1990, p. 1316)—perhaps the norm at the factory is to put productivity first and safety second, and no assertions to be safe will override the piece-rate incentive and promotion system. Perhaps the cultural or social norms are to "keep the line moving," "cut corners" or to show off your skills (Mason, 1997).

Some maintain that violations may even be necessary to complete the work or to do so safely (Amalberti, Vincent, Auroy, et al., 2006; Reason, Parker & Lawton, 1998). Perhaps using the safety barrier does not work when machining large parts. Perhaps a jammed line cannot be stopped without the approval of a supervisor who is not present.

Thus, violations are sometimes adaptive and not irrational. When seen through the lens of local rationality—that is, given what the worker knew at the time, what was his/her mindset and what were his/her goals—most violations appear to be reasonable or at least understandable (Woods & Cook, 1999).

Violations are usually risky, but can result in either success or failure. Retrospectively, violations can be seen as foolish if they failed and adaptive if they succeeded. However, the tendency is to investigate only cases when things go wrong. Thus, accident investigations put workers in a double-bind situation: if workers violated the protocol and things went wrong, they are reprimanded for being risk takers; if they did not violate and things went wrong, they are reprimanded for being nonadaptive (Dekker, 2003).

Using rule-following as a litmus test for appropriate behavior is problematic. General rules do not apply to every situation and some rules are inappropriately written in the first place (Reason, et al., 1998; Wilpert, 2008). Sometimes rules are built into a system *ex ante* rather than being enforced *ex post.* For example, computer software can force workers to use it in a prespecified way. However, to the extent that the system is poorly designed, workers may feel the need to work around it (Koopman & Hoffman, 2003).

Holden, Alper, Scanlon, et al. (2008) describe how hospital clinicians apply innovative strategies to deal with bad systems, including "playing games" with overly rigid computer software. The authors suggest that although work-around behavior is sometimes necessary, it can increase risk, and they refer to Reason and colleagues' (1998, p. 291) example of the motorist speeding at 100 mph. The rule-violating motorist may 1) be unfamiliar with high-speed driving and, if so, 2) have a lower tolerance for error at such speeds.

Research suggests that familiarity and error tolerance are issues of design. That is, planning for deviant or work-around strategies and actually supporting those strategies through design (Karsh, Holden, Alper, et al., 2006) may 1) allow workers to become familiar with nonroutine modes of performance; and 2) reduce the risk of nonroutine performance. They note that certain systems are actually built in this way, and extend the 100 mph motorist analogy:

> By designing systems that support high-speed [driving], law enforcement officers can deal effectively with criminals . . . without a substantial risk increase. A siren is installed, training on high-speed pursuits is provided, cars on the road move aside, police cars are purchased for high-speed performance, and a well-developed system of pursuit is created wherein officers join and exit the pursuit, at different times (Holden, et al., 2008, p. 5).

(*Author's Note:* "Without a substantial risk increase" may be overstating the benefit of using design to support nonroutine performance. The statement attempts to compare systems using such design to healthcare systems that do not provide much support for workers deviating from planned routines.)

Violations and related concepts are important topics in modern safety management, but one can approach them in one of two ways. One could treat violations as the behaviors of bad people, and proceed with person-centered solutions. Or, one could treat violations as an indicator to better design those system properties that necessitate violations, and to design support systems that keep workers safe when they must circumvent protocol or work around a flawed system. Although many SH&E professionals advocate for the latter approach, the former person-centered approach appears to dominate in industry.

To put it simply: to blame is human. To put it more accurately: to attribute causation to individual actions and dispositions is a fundamental tendency in some cultures.

Implications for the Safety Profession

Thus far, this article has argued for the existence of a psychological (and, likely, sociological) tendency to think in certain ways about the cause of safety-related events. To put it simply: to blame is human. To put it more accurately: to attribute causation to individual actions and dispositions is a fundamental tendency in some cultures.

The tendency also appears to be a professional norm across industries. Preoccupation with bad apples and human failure has seen a resurgence, particularly in the recent focus on those who violate safety protocols. It is not that humans are uninvolved in accidents, rather that they are not typically the sole or primary causal agents. Nor are behaviors that contribute to accidents caused solely by internal factors.

What are the implications of person-centered tendencies and norms? What recommendations can be made to deal with the implications? To answer those questions, let's consider the three Es of safety: engineering, education and enforcement (Goetsch, 2007).

Engineering

Person-centered tendencies deprioritize engineering solutions and instead rely on education and enforcement. Purely technical engineering solutions that do not consider the human's role may not make sense to the person-centered practitioner.

However, many resources exist for improving systems as a whole, human and all. Numerous writings on human factors engineering are a good source of information on how to achieve fit between workers and the rest of the work system in order to improve safety and performance (Eastman Kodak Co., 2004; Helander, 2006; Salvendy, 2006; Sanders & McCormick, 1993).

What will it take for industry decision makers to view accident outcomes as the product of the interplay of multiple system components, human and nonhuman? Will a commitment to prioritize whole-system engineering solutions affect the tendency to attribute cause and blame to people? Can systems be successfully engineered to support expert workers who must deviate from predetermined actions? These questions remain to be answered. A starting point may be to demonstrate to industry leaders the efficacy and cost-efficiency of whole-systems engineering solutions (Hendrick, 1996; Kerr, Knott, Moss, et al., 2008).

Education

If one believes that incident causes are rooted in the person, one naturally turns to education (e.g., training, poster campaigns) as a solution. This may be ineffective, for example, in the case of a worker who is pushed by production pressures or inflexible technology to take risks. Should education be abandoned as a solution to all safety problems and used only when workers are truly uninformed? And what about educating future managers and SH&E professionals? If person-centered tendencies are fundamentally human, how can they be overcome through college courses or training seminars or articles such as this?

Again, these are empirical questions to explore. Many educators teach about different approaches to safety, about the fundamental attribution error and about the many reasonable causes of so-called unsafe behavior. Does this help students overcome the urge to assign cause or blame to people when people are not to blame? Or is telling people to think systems as ineffective as telling them to be safer?

Enforcement

Legal investigations, disciplinary actions and other attempts to hold people accountable for safety are also predicated on person-centered causality, reminiscent of fellow-servant and contributory negligence rules of the recent past. Violations of safety regulations may actually be caused by design problems that should be addressed through engineering solutions, not enforcement.

Is enforcement effective? When is enforcement appropriate? Enforcement is often the result of accident investigations, which themselves appear to be biased toward person-centered findings. Dekker (2002) suggests transitioning from the use of narrower investigative methods such as root-cause analysis, which tends to reveal that "the human did it," to something more holistic that permits discovery of a multicausal network.

What resources are needed to make holistic investigations plausible? Can better safety solutions be developed from investigations that do not result in assigning cause or blame predominantly to humans? What is the plight of retrospective investigations relative to proactive risk/hazard analysis? What affects whether one adopts a linear or nonlinear model of causation? What affects how or whether one investigates distal and root causes when investigating a linear chain of causation?

Whatever the answers to these questions about new methods of education, enforcement and investigation, the biggest challenge will be to produce successful engineering solutions to safety. These solutions both modify behavior by supporting workers' performance and eliminate the need for behavioral change when old behaviors are made safe in the new system (Holden, et al., 2008; Karsh, et al., 2006).

A focus on human failure is counterproductive. Fitts and Jones did not reduce human failure or fallibility. Rather, they improved the displays and controls in aircraft cockpits, which supported quick information processing and action on the part of WWII pilots. Thus, supporting worker performance resulted in fewer accidents.

Good performance is the essence of safety, and good system design is the essence of good performance. So, too, will good design that leads to good performance be cost-efficient (Helander, 2006; Hendrick, 1996), yet another reason to promote engineering solutions. Without systems solutions being available, it is too easy to give in to human-centered cause and blame tendencies. With adequate alternatives, however, it is possible to accept that to blame is human, but the fix is to engineer. ■

References

Alper, S.J., Karsh, B., Holden, R.J., et al. (2006). Protocol violations during medication administration in pediatrics. *Proceedings of the Human Factors and Ergonomics Society,* 1019-1023.

Amalberti, R., Vincent, C., Auroy, Y., et al. (2006). Violations and migrations in healthcare: A framework for understanding and management. *Quality and Safety in Health Care, 15,* i66-i71.

Blank, H., Musch, J. & Pohl, R.F. (2007). Hindsight bias: On being wise after the event. *Social Cognition, 25,* 1-9.

Calkins, L.B. & Fisk, M.C. (2007, Sept. 17). BP official blames Texas blast on workers. *The International Herald Tribune,* 14.

Cooper, M.D. (2009, Feb.). Behavioral safety interventions: A review of process design factors. *Professional Safety, 54*(2), 36-45.

DeJoy, D.M. (1994). Managing safety in the workplace: An attribution theory analysis and model. *Journal of Safety Research, 25,* 3-17.

DeJoy, D.M. (2005). Behavior change versus culture change: Divergent approaches to managing workplace safety. *Safety Science, 43,* 105-129.

Dekker, S.W.A. (2002). The reinvention of human error [Electronic version]. Retrieved Oct. 17, 2008, from http://www.usa.lu.se/upload/Trafikflyghogskolan/TR2002-01_ReInventionofHumanError.pdf.

Dekker, S.W.A. (2003). Failure to adapt or adaptations that fail: Contrasting models on procedures and safety. *Applied Ergonomics, 34,* 233-238.

Eastman Kodak Co. (2004). *Ergonomic design for people at work* (2nd ed.). Hoboken, NJ: John Wiley and Sons.

Fiske, A.P. & Taylor, S.E. (1991). *Social Cognition* (2nd ed.). New York: McGraw-Hill.

Gauchard, G.C., Mur, J.M., Touron, C., et al. (2006). Determinants of accident proneness: A case-control study in railway workers. *Occupational Medicine, 56,* 187-190.

Geller, E.S. (2001). *The psychology of safety handbook* (2nd ed.). Boca Raton, FL: CRC Press.

Geller, E.S. (2003, Dec.). People-based safety: The psychology of actively caring. *Professional Safety, 48*(12), 33-43.

Geller, E.S. (2005). Behavior-based safety and occupational risk management. *Behavior Modification, 29,* 539-561.

Gielen, A.C. & Sleet, D. (2003). Application of behavior-change theories and methods to injury prevention. *Epidemiological Reviews, 25,* 65-76.

Glendon, A.I., Clarke, S. & McKenna, E.F. (2006). *Human safety and risk management* (2nd ed.). Boca Raton, FL: CRC Press.

Goetsch, D.L. (2007). *Occupational safety and health for technologists, engineers and managers* (6th ed.). Upper Saddle River, NJ: Prentice Hall.

Harvey, P. & Martinko, M.J. (2009). Attribution theory and motivation. In N. Borkowski (Ed.), *Organizational behavior, theory and design in healthcare* (pp. 143-158). Boston: Jones & Bartlett.

Heinrich, H.W., Petersen, D. & Roos, N. (1980). *Industrial accident prevention: A safety management approach* (5th ed.). New York: McGraw-Hill.

Helander, M. (2006). *A guide to human factors and ergonomics* (2nd ed.). Boca Raton, FL: Taylor & Francis.

Hendrick, H.W. (1996). Good ergonomics is good economics [Electronic version]. Retrieved from http://www.hfes.org/Web/PubPages/goodergo.pdf.

Henriksen, K. & Kaplan, H.S. (2003). Hindsight bias, outcome knowledge and adaptive learning. *Quality and Safety in Healthcare, 12,* ii46-ii50.

Holcom, M.L., Lehman, W.E.K. & Simpson, D.D. (1993). Employee accidents: Influences of personal characteristics, job characteristics and substance use in jobs differing in accident potential. *Journal of Safety Research, 24,* 205-221.

Holden, R.J., Alper, S.J., Scanlon, M.C., et al. (2008). Challenges and problem-solving strategies during medication management: A study of a pediatric hospital before and after bar-coding. *Proceedings of the International Conference on Healthcare Systems Ergonomics and Patient Safety.*

Hollnagel, E. & Woods, D.D. (2005). *Joint cognitive systems: Foundations of cognitive systems engineering.* Boca Raton, FL: Taylor & Francis.

Horhota, M. & Blanchard-Fields, F. (2006). Do beliefs and attributional complexity influence age differences in the correspondence bias? *Social Cognition, 24,* 310-337.

Investigators Blame Stupidity In Area Death. (2005, May 25). *The Onion,* Issue 41.21.

Karsh, B., Holden, R.J., Alper, S.J., et al. (2006). A human factors engineering paradigm for patient safety: Designing to support the performance of the healthcare professional. *Quality and Safety in Healthcare, 15*(Suppl I), i59-i65.

Kerr, M.P., Knott, D.S., Moss, M.A., et al. (2008). Assessing the value of human factors initiatives. *Applied Ergonomics, 39,* 305-315.

Koopman, P. & Hoffman, R.R. (2003). Work-arounds, make-work and kludges. *IEEE Intelligent Systems, 18,* 70-75.

Kwaan, M.R., Studdert, D.M., Zinner, M.J., et al. (2006). Incidence, patterns and prevention of wrong-site surgery. *Archives of Surgery, 141,* 353-358.

Lavin, T.J. (2003, March 6). Physician, heal thyself. *Chicago Sun-Times,* 28.

Lawton, R. (1998). Not working to rule: Understanding procedural violations at work. *Safety Science, 28,* 39-50.

Leape, L.L. (2008). Errors in medicine. In M.G. Caty (Ed.), *Complications in pediatric surgery* (pp. 3-12). New York: Informa Health Care.

Loftus, E.F. (2005). Planting misinformation in the human mind: A 30-year investigation of the malleability of memory. *Learning & Memory, 12,* 361-366.

Lundberg, J., Rollenhagen, C. & Hollnagel, E. (2009). What-you-look-for-is-what-you-find: The consequences of underlying accident models in eight accident investigation manuals. *Safety Science, 47*(10), 1297-1311.

Malle, B.F., Knobe, J.M. & Nelson, S.E. (2007). Actor-observer asymmetries in explanations of behavior: New answers to an old question. *Journal of Personality and Social Psychology, 93,* 491-514.

Mason, S. (1997). Procedural violations: Causes, costs and cures. In F. Redmill & J. Rajan (Eds.), *Human factors in safety-critical systems* (pp. 287-318). Oxford: Butterworth-Heinemann.

Perrow, C. (1984). *Normal accidents: Living with high-risk technologies.* New York: Basic Books.

Phipps, D.L., Parker, D., Pals, E.J.M., et al. (2008). Identifying violation-provoking conditions in a healthcare setting. *Ergonomics, 51,* 1625-1642.

Reason, J. (2000). Human error: Models and management. *British Medical Journal, 320,* 768-770.

Reason, J., Manstead, A.S.R., Stradling, S., et al. (1990). Errors and violations on the roads: A real distinction? *Ergonomics, 33,* 1315-1332.

Reason, J., Parker, D. & Lawton, R. (1998). Organizational controls and safety: The varieties of rule-related behavior. *Journal of Occupational and Organizational Psychology, 71,* 289-304.

Reese, C.D. (2008). *Occupational health and safety management: A practical approach* (2nd ed.). Boca Raton, FL: CRC Press.

Ross, L. (1977). The intuitive psychologist and his shortcomings: Distortions in the attribution process. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 10, pp. 173-220). New York: Academic Press.

Salvendy, G. (Ed.). (2006). *Handbook of human factors and ergonomics* (3rd ed.). Hoboken, NJ: Wiley & Sons.

Sanders, M.S. & McCormick, E.J. (1993). *Human factors in engineering and design.* New York: McGraw-Hill.

Shaver, K.G. & Drown, D. (1986). On causality, responsibility and self-blame: A theoretical note. *Journal of Personality and Social Psychology, 50,* 697-702.

Studdert, D.M., Mello, M.M. & Brennan, T.A. (2004). Medical malpractice. *New England Journal of Medicine, 350,* 283-292.

Tostain, M. & Lebreuilly, T. (2006). Rational model and justification model in "outcome bias." *European Journal of Social Psychology, 38,* 272-279.

Vicente, K. (2006). *The human factor: Revolutionizing the way people live with technology.* New York: Routledge.

Wilpert, B. (2008). Regulatory styles and their consequences for safety. *Safety Science, 46,* 371-375.

Woods, D.D. & Cook, R.I. (1999). Perspectives on human error: Hindsight biases and local rationality. In F. T. Durso, R.S. Nickerson, R.W. Schvaneveldt, et al. (Eds.), *Handbook of applied cognition* (pp. 141-171). New York: Wiley & Sons.