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NOTES

Accidents are Normal and Human Error Does Not Exist: A New Look at the Creation of Occupational Safety

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"Human error" is often cited as cause of occupational mishaps and industrial accidents. Human error, however, can also be seen as an effect (rather than the cause) of trouble deeper inside systems. The latter perspective is called the "new view" in ergonomics today. This paper details some of the antecedents and implications of the old and the new view, indicating that human error is a judgment made in hindsight, whereas actual performance makes sense to workers at the time. Support for the new view is drawn from recent research into accidents as emergent phenomena without clear "root causes;" where deviance has become a generally accepted standard of normal operations; and where organizations reveal "messy interiors" no matter whether they are predisposed to an accident or not.

human error accidents procedures investigations safety

1. TWO VIEWS OF HUMAN ERROR

Occupational mishaps and large-scale industrial accidents are often blamed on "human error." But human error is a deeply problematic category, if indeed it is a separate category of performance at all. People use the label "human error" in different ways—sometimes as judgment, sometimes as cause, sometimes as process, sometimes as effect (Amalberti, 2001; Woods,

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Johannesen, Cook, & Sarter, 1994). There are currently two ways of looking at human error (e.g., Dekker, 2002; Woods & Cook, 2002). In the "old view"

- Human error is the cause of accidents.
- Systems are basically safe; safety is inherent in the systems we build and operate.
- The major threat to safety comes from the unreliable human element. Basically safe, well-built systems get degraded by unpredictable human behavior.
- Progress on safety is made by protecting systems from human unreliability, through selection, training, procedures, automation, disciplining.

After an accident, engineers, designers, and governing bodies may claim that the system is basically safe; that it has been tested, approved; and met all applicable standards; that it contains appropriate information and warnings—if only people would look at them. Accident investigations can conclude that human error is the cause. Human error, by any other name (complacency, deficient supervision, inadequate attention to procedures), is an adequate explanation of failure. The "new view", in contrast, says that human error is not an explanation, but rather demands one (Reason, 1997):

- The new view does not see human error as a cause, but as a symptom; as an effect of failure deeper inside the systems in which people work.
- Safety is not inherent in systems. Systems are contradictions between multiple goals that people must pursue simultaneously. People create safety through practice at all levels of the operation and organization.
- Human error is systematically connected to features of peoples' tools, tasks, and operating environment. Progress on safety comes from understanding and influencing these connections.

Protagonists of the new view resist focusing on individual people or devices or groups. They point to long-standing deficiencies in the organization, the operation, the system, using words like "latent failures." Latent failures imply that basically safe systems do not even exist—that every system, however well-designed and well-built, has a number of hidden vulnerabilities packed into it and its operations. Adherents of the new view will use terms like "system accident" to attest to the multitude of factors, all necessary and only jointly sufficient to produce a failure, and show how the human contribution is only one of many. Whether explicitly or not, ergonomics has worked on the systems premise ever since World War II. Its purpose is to help design systems—both engineered and organizational—that minimize opportunities for error, and maximize opportunities for error detection and recovery.

2. ANTECEDENTS AND IMPLICATIONS OF THE TWO VIEWS

2.1. The Old View

Traditional ergonomics believes that order, stability, and safety can be achieved mechanistically. Engineers construct and test systems, planners determine performance prescriptively (e.g., through task analyses), and managers send directives for the system's operations from above (e.g., standard operating procedures). To make progress on safety, the human contribution is limited through proceduralization or automation. The old view typically sees the human mind as an information processing mechanism, where errors result from internal deficiencies or limitations. For example, if people do not notice things, or do not comprehend available information, this may derive from the limited capacity of working memory, inadequate information sampling, motivational shortcomings, or decision biases. Automation and proceduralization can supplant human work, thus reducing the influence of unpredictable human performance degradations (this is called the substitution myth). The tradition from which these ideas come has a grip on ergonomics because it suggests engineering ways (decomposition into linear components of human information processing) to deal with engineering problems (integrating an unreliable human element into an organized or machined ensemble). Such dehumanization (Batteau, 2001) has come in for critique as it ignores, and is unable to model, important contextual influences on people's risk assessment and decision making (see Vaughan, 1996).

The removal or demotion of those who commit "errors" is also a way to make progress on safety in the old view. This is neo-behaviorist. By blaming and punishing operators, the idea is to prod others' operational behavior along more acceptable, safer directions. Reprimands are falsely believed to send a message to the entire operational community: be vigilant, careful, compliant—or else. The neo-behaviorist argument of "setting examples" is epitomized in court cases where individual operators are charged with, for example, professional negligence. But threatening operators with punishment (even by seeing others being punished) is invariably counterproductive. Instead of conditioning operators to be more careful and avoid erring, threats of punishment condition operators to avoid getting caught when they err. Operators stop reporting about safety-related events (North, 2002); more of the actual operational work will go "underground," sponsoring the creation of informal work systems that retreat from view under formal scrutiny

(McDonald, Corrigan, & Ward, 2002). Information sources about real safety issues dry up. Progress on safety grinds to a halt.

2.2. The New View

The new view has its roots in the very beginning of what we know as ergonomics. Through Fitts and Jones's (1947) foundational work, human error was no longer the unpredictable outcome of hidden mental processes, but systematically connected to features of people's tools and tasks. This is called "systems thinking" today. The original systems thinkers were engineers, and the ergonomic world was the engineered interface between human and machine. Ergonomics has since moved into the operational and organizational world as a system that is equally important in shaping operators' assessments and actions; in imposing opportunities and constraints on activities of operators at the "sharp end." People who "err" are not the instigators of failure, but rather the recipients of failure—of failure that stems from other places, higher up and farther away. Systems thinking, however, is not an excuse for shoving blame higher up into an organization. Instead, it is about understanding that neither success nor failure reside in individual people, groups, departments, devices, or organizations.

In the wake of accidents, new view adherents reconstruct the situation in which people found themselves, lifting out factors that influenced people's assessments, decisions, and actions (see Dekker, 2002). The starting point of the new view is the local rationality principle (Simon, 1969): People do not come to work to do a bad job. What people do and decide has to make sense to them (i.e., it has to be locally rational) given their knowledge, their perspective, their understanding of the situation at the time, otherwise they would not do it. If what people did does not make sense to similar actors who would find themselves in the same situation (also called the substitution or neutral observer test), then the accident may rather become a result of sabotage or psychiatric disorder (both of which are extremely rare as causes of disaster in most industrial applications). People do what is locally rational: human error, as separate, deviant performance category does not even exist (Amalberti, 2001).

Such thinking is consistent with ecological psychology: Rather than explaining performance problems by reference to constraints on internal information processing mechanisms, ecological psychologists focus on how the environment imposes constraints on people's goal-directed behavior (Vicente, 1999). A gap can exist between people's responsibility and their

authority. Society and organizations can give operators the responsibility for carrying out a task safely (by paying them a lot of money, according them a high status, etc.), but subsequently deny them the authority to live up to this responsibility. Authority is always limited, curtailed, because real work takes place in resource-constrained worlds where scarcity and uncertainty abound and where multiple goals compete for operator priority. This goes for operators at all organizational levels. Safety is never the only goal: Punctuality, maximizing capacity utilization, image, cost savings, customer satisfaction, production—all these are more or less explicit goals that constrain what operators can do at any time in the pursuit of safety. The dilemmas and trade-offs operators face in these goal conflicts circumscribe their authority. They cannot act as all-powerful agents independent of any context or organizational pressure.

3. NORMALIZING THE ABNORMAL

The new view suggests that a search for the cause of failure is illusory—that there is no such thing as *the* cause of an accident; that trying to find out *the* cause of an accident is just as bizarre as trying to find out *the* cause of not having an accident. Indeed, causal models of accidents are but one way to understand system breakdown, easily leading to oversimplification. Recent work points instead to accidents as emergent phenomena (e.g., Amalberti, 2001; Snook, 2000; Vaughan, 1996), which result from normal, regular interactions between components that make up a system. Accidents do not have their source in one, or a few, broken parts, whose breakage is a unique and unusual occurrence. On the contrary, as Amalberti (2001, p. 117) points out, systems are typically

> …laden with minor breakdowns and errors, which are almost normal in a context of increased pressure on production and fierce competition. Normal operations, where the system works at its highest productivity level … are tolerated by institutions even though they imply working at quasi-incident levels (deviance becomes a standard of normal operations).

So nothing needs to be broken in order to produce an accident (Amalberti, 2001; Vaughan, 1996). Accidents are a normal, to-be-expected by-product of the pursuit of success under the constraint of limited resources; the result of "normal people, behaving normally in normal organizations [with] nothing abnormal happening" (Snook, 2000, p. 204). People inside organizations develop a definition of operational risk that allows them to carry on as if

nothing is wrong—even in the face of evidence that showed in hindsight that something was wrong (Vaughan, 1996). People inside organizations convene at collective definitions of risk that gain acceptance upon repeated successful practice. Looked at from the outside, or after an accident, this same organizational interior looks "messy." People's acceptance of what is "normal" gets judged as highly deviant, or even negligent. But branding it as deviant truncates our ability to learn—we miss the very mechanisms that normally make the system work in the face of scarcity, competition, and risk. The question that dominates the new view is not "Why did they behave so bizarrely?" Rather, it is "Why was it normal for them to behave this way?"

Some systems rely a great deal on normalized "deviance" for their very functioning. Aircraft maintenance for example, is sustained by vast informal work systems, where a third of maintenance jobs cannot be carried out if the formal procedures are followed—such are the pressures, local surprises, distances, and unanticipated difficulties. Almost all mechanics use illegal, unofficial documentation because the official rules are not available in a way that supports a close connection to actual work (McDonald et al., 2002). What mechanics do may look like routine violations from the outside, and indeed, these can expose the system to greater risk. But mechanics actually show highly adaptive responses anchored in a strong professionalism that comes from being able to get the job done despite the limits of the surrounding organization (Amalberti, 2001; McDonald et al., 2002). Operators' strategies make the operation successful and safe despite resource constraints. The same principles, then, can account for making the organization work successfully and safely, and for making it vulnerable to breakdown. This paradox is canonical to the new view, and to seeing accidents as emergent from the everyday interactions that make up normal organizational life, whether successful or not. There is no difference between studying failure and studying success—the same underlying operational, engineering, procedural, coordinative, organizational processes and mechanisms that make up normal work account for both. The new-view studies how practice normally creates success—how people at all levels organize their practice to create success and safety in the face of (known) hazards, and how these same processes sometimes break down.

4. TO MAKE PROGRESS ON SAFETY, STOP LOOKING FOR CAUSES

But if accidents are no different from normal operations, if each organization in reality reveals a similarly "messy interior" that often produces success and

occasionally failure; if these interiors are messy no matter how close the organization is to having an accident, is that not profoundly scary? Indeed, there is increasing recognition in the literature that the inability to find a "eureka part" in investigations feeds a fundamental fear on the part of managers, regulators, consumers. As Galison notes (2000, p. 32):

> If there is no seed, if the bramble of cause, agency, and procedure does not issue from a fault nucleus, but is rather unstably perched between scales, between human and non-human, and between protocol and judgment, then the world is a more disordered and dangerous place. Accident reports, and much of the history we write, struggle, incompletely and unstably, to hold that nightmare at bay.

Similarly, Snook (2000, p. 203) comments on his own disbelief at a lack of "cause." He documents his struggle in analyzing the friendly shootdown of two U.S. Black Hawk helicopters by U.S. fighter jets over Northern Iraq in 1993:

> This journey played with my emotions. When I first examined the data, I went in puzzled, angry, and disappointed—puzzled how two highly trained Air Force pilots could make such a deadly mistake; angry at how an entire crew of AWACS controllers could sit by and watch a tragedy develop without taking action; and disappointed at how dysfunctional Task Force OPC must have been to have not better integrated helicopters into its air operations. Each time I went in hot and suspicious. Each time I came out sympathetic and unnerved.... If no one did anything wrong; if there were no unexplainable surprises at any level of analysis; if nothing was abnormal from a behavioral and organizational perspective; then what *have* we learned?

But rather than asking how learning is possible if we cannot find "causes" of accidents, the new view asks us to acknowledge that we have already learned something about the generation of failure if we stop looking for causes. Not that this is a popular notion in all circles (as Galison, 2000, alludes to). Indeed, the battle between the two views will continue to play out in many fields, many situations. The higher the stakes, the greater the tension. Are occupational accidents fundamentally deviant; and those who "cause" them irredeemably deficient components in an otherwise smooth system? Or are accidents normal—the to-be-expected by-product or side effect of the pursuit of success under the constraints of limited resources? Where some people or organizations would like to locate the seed of failure in a narrow space-time continuum; in a few failed assessments or actions of a few indi-

viduals (e.g., their "loss of situation awareness"), others deny such condensed accounts. They will endeavor to zoom out, to reveal a larger, longer, more diffused route to the eventual failure. Pressures to not zoom out, to not reveal, or expose systemic contributions can exist, and postaccident investigations can be as much about managing political reality as they are about finding out "what happened" or about organizational learning. The ambiguity between the interpretations means that stories about human error are almost never stable; that different accounts always compete for primacy and attention. There is always a tension, an instability between the old view and the new view, between condensed and diffused accounts of failure, between individual or systemic accident stories. Indeed, in the wake of an accident, there no truth—only versions.

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