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ORIGINAL ARTICLE

“Those found responsible have been sacked”: some observations on the usefulness of error

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Abstract Erik Hollnagel’s body of work in the past three decades has molded much of the current research approach to system safety, particularly notions of “error”. Hollnagel regards “error” as a dead-end and avoids using the term. This position is consistent with Rasmussen’s claim that there is no scientifically stable category of human performance that can be described as “error”. While this systems view is undoubtedly correct, “error” persists. Organizations, especially formal business, political, and regulatory structures, use “error” as if it were a stable category of human performance. They apply the term to performances associated with undesired outcomes, tabulate occurrences of “error”, and justify control and sanctions through “error”. Although a compelling argument can be made for Hollnagel’s view, it is clear that notions of “error” are socially and organizationally productive. The persistence of “error” in management and regulatory circles reflects its value as a means for social control.

Keywords Error · Investigation · Cognition · Healthcare · Hollnagel

> It will be evident to anyone who has read the foregoing pages, that the history of the problem of error does not bear witness to a steady and well defined progress, from initial perplexity, through stages of ever increasing light, up to a final and triumphant solution. Perhaps it was hardly to be expected in the case of a question so baffling in itself, so open to evasions, and so dependent on others of positive interest. The same difficulties keep coming back under slightly difficult forms, the same postulates and general distinctions, the same ambiguities and incoherences; till one begins to wonder whether after all it is possible to give a rational and philosophic account of this irrational product of the mind (Keeler 1934).

1 Introduction

Organizations that operate in high hazard, uncertain, poorly bounded domains experience adverse events, but the way organizations deal with the potential and reality of those events varies. Erik Hollnagel’s work since the 1970s has studied systems, human performance, outcomes, why variation occurs, and what results ensue. This paper reflects on our experience with the investigation of adverse events in healthcare, the way that organizations respond, and considers the nature and use of error in light of Hollnagel’s body of work.

2 An adverse event case study

The following event occurred during a year-long study of multiple pediatric intensive care units (ICUs) (Nemeth et al. 2006) for which human subject research had been approved by institutional review boards. It demonstrates how features of a complex setting such as healthcare can create circumstances in which human performance is

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compromised, are not remedied, and remain in place. It also shows how the organizational response to failure illustrates how human error is valued, has multiple uses, and explains its durability.

In April of 2006, a patient was being prepared for spinal surgery and members of the surgical team placed the anesthetized patient onto a modular table. One member noticed that there was a slight tilt to the table and began to correct the table's position. The table swung loose, and the patient fell from the table to the floor but sustained no injury.

2.1 Findings

Our investigative team was notified, and four team members arrived on scene soon after the event. We invited the surgical resident to describe what happened, using the table and its controls to demonstrate. We recorded the description on audio tape, then asked a number of probe questions in order to fill in context details. We continued by examining the table to learn what might make it possible for the event to occur. During our analysis, it became clear that a number of factors had a bearing on the outcome.

- The table's ability to swivel around a centerline is essential to position a patient for spinal surgery. It also presents a hazard because the table's ability to freely rotate makes it possible for an anesthetized patient to fall.
- While the operating room team handled patient preparation and positioning as a group, no individual was assigned to be responsible to operate the table.
- Three controls are located at the head end of the table: a lever to tighten and loosen the table clutch, a control switch to lock the foot end of the table, and indicator lights. The housing is covered with labels that indicate how to operate the device and that warn what not to do. The investigation team spent a good deal of time during the first and follow-up sessions to understand how the table is operated and discovered a number of conflicting cues. The control/display design's complexity and ambiguity made it impractical for any clinician to understand it (Nemeth et al. 2005; Nunnally et al. 2004).
- Locking the table prevents it from swiveling freely. The clutch control lever that is located at the side of the base end housing requires substantial force to be exerted before the table is locked and may have required more strength than operators were willing, or able to exert.

The investigating team's response soon after the event made it possible to collect information on the context in which the event occurred. The team brought forensic skills to bear that medical professionals do not have to understand the nature of the table and its performance (Nemeth 2005). The team was also able to capture what happened in a well-grounded account that assisted the hospital organization.

2.2 Organization response

Days afterward, the hospital's risk manager convened a "root cause analysis" meeting that was intended to discover the event's underlying cause(s). The inquiry included members of the patient care team who were involved in the event, as well as OR equipment technicians, lawyers, risk managers, operations managers, and administrators. Members of our investigative team were invited to attend and played a significant role.

Discussion during the meeting centered on both what the participants knew and what they could influence. The attending surgeon had called and spoken to the president of the table's manufacturer. The surgeon's account included the president's expression of surprise about the event. This seems doubtful, as reports in the US FDA's Manufacturer and User Device Experience (MAUDE) database confirmed this kind of event has occurred with this table at other locations. Our team presented all aspects of the event, which shifted attention to the equipment's serious shortcomings rather than focus solely on what the team should have done. After a discussion of contributing factors, the focus quickly swung to proposals for solutions. The surgical team considered the table's features to be unique, which made it desirable to continue using it even though they acknowledged it had safety issues. The unit would not be removed from use, as no other product offered the features this one did. Changing the unit would be up to the manufacturer, not the hospital, and would not be a quick solution. Warranty and US FDA certification concerns precluded the medical center from modifying the equipment.

Options that remained available to the hospital would necessarily be less effective. They could add warning signs or labels, train members of the staff, restrict use of the machine to individuals who had been thoroughly trained, implement a checklist for its operation, or use a buddy system to check the unit's status. The hospital developed a report of the event to forward to the manufacturer that included our investigating team's input. It also produced a brief improvement plan that included training surgical care team members and use of a warning sign that the investigation team developed that could be hung from the lever on the side of the head end housing. In the end, each of the influences that led to the adverse event remained in place, including the prospect of clinicians being assigned blame for failing to operate the dangerous table correctly. The unit was not removed or modified. The warning was not used. Care providers were cautioned, setting the stage for further "errors".

3 Discussion

Both technical and social issues are at play in this example. The table control design induced ambiguity and confusion. The surgical team had not assigned formal responsibility for table control. It is the organizational response, though that is most telling. The source of the problem was not removed or changed. Instead, a report was sent and the default was to revert to a classic "blame and train" strategy for the operators. The organization was stuck, and in that circumstance sought a way to deal with it. How they dealt with it tells us about the manner in which organizations respond to adversity.

The example shows how systems retain multiple contributing factors to adverse events, including circumstances that induce erroneous acts. Efforts to understand hazards and improve performance were stalled because of the following:

- Identifying the causes of an adverse outcome is a daunting task. Factors that create a naturalistic work domain (Weick 2001) make it difficult to discover sources of dysfunction. These include time pressure, high stakes, practitioner expertise that is not readily divulged, information that is inadequate for individuals, ill-defined goals, rich context, and the need for coordination among all team members.
- The organization lacked the degrees of freedom and resources to effect true change. Regulatory limitations prevented action that might be possible is a less restrictive domain. Running at, or near, saturation limited the people, time, and funds that would be needed to make a useful change.

Lacking contingency plans (Hollnagel 1993) that would enable the organization to anticipate courses of action and to learn from the event, the option that remained was to cope. Management sought closure and followed a *satisficing* strategy (Simon 1996). The method that they used, root cause analysis is a "good enough" solution approach for them when dealing with tension between conflicting agendas like these.

Activities of organizations in high hazard sectors routinely produce positive, and occasionally undesirable, results. How the adverse events come about, whether they are amenable to remedies, and whether remedies are applied are all open questions for those in safety science (Hollnagel and Woods 1983).

3.1 The nature of "error"

Jens Rasmussen (1986:149), who is arguably the most foresighted of all those who write about error, observed "it is basically very difficult to give a satisfactory definition of human errors". While it may be that error is academically interesting, it is not particularly useful as a guide for designing safe systems (Rasmussen 2000). Present circumstances in healthcare and elsewhere confirm that view. The notion of "error" remains slippery, controversial, and indistinct (Hollnagel 1988:29). Hollnagel's (1983) observations at the Bellagio conference seem to have been prescient: "I do not think that there can be a specific theory of "Human Error", nor that there is any need for it… it is meaningless to talk about mechanisms that produce errors. Instead, we must be concerned with the mechanisms that are behind normal action. … Inventing separate mechanisms for every sing[l]e kind of "Human Error" may be great fun, but is not very sensible from a scientific point of view". If Hollnagel and Rasmussen are correct, that there is no such thing (or no stable thing) as "error" (Rasmussen 1990), then it does not make sense search for the relationship between error and failure or error and success. The occasion of an adverse event compels questions about the relationship between error and failure. An organization's leadership is expected to provide an answer.

3.2 Management versus operators

Media coverage of an adverse event routinely features an organization leader at a lectern, who likely refers to actions taken to ensure that "this will never happen again". Where does the surety of "never" come from, and why? These are "first stories": overly simplified accounts of the apparent "cause" of the undesired outcome, biased by knowledge of the outcome. They represent a kind of reaction to failure that attributes the cause of accidents to narrow factors that are at hand. "Human error" is a frequently cited cause. The February 2010 death of Olympic luger Nodar Kumaritashvili in the Winter Olympics provided yet another first story example. Despite record speeds and substantially more crashes across multiple sliding sports, the track was not altered…until after the fatal incident. Luge federation officials and members of the Vancouver Organizing Committee concluded "there was no indication that the accident was caused by deficiencies in the track" and that Kumaritashvili "did not compensate properly to make correct entrance into Curve 16" (Abrams and Branch 2010). First stories appear to be attractive explanations for failure, but they lead to sterile responses that limit learning and improvement (Woods and Cook 2002). What purpose do first stories serve?

Those who are closest to the sharp (operator) end of the healthcare organization understand the difficulty and uncertainty that underlies their daily activities. Those who are closest to the blunt (management) end are most remote from sharp end operations and are concerned with maintaining the organization, and threats to the organization are minimized by casting adverse events as anomalies. Identification and removal of the event's proximate cause gives the appearance of restoring the organization to "normal" conditions. This may explain the tendency Reason (1997:113) cited that "those who are at the top of the organization, possessing the largest degree of decisional autonomy, blame most of their safety problems on the personal shortcomings of those at the sharp end". This shifts energies away from learning and understanding.

While typically considered in terms of operators, management response can also be viewed in light of Hollnagel's (2009:12–13) efficiency-thoroughness trade-off (ETTO) principle. Understanding requires thorough consideration of how the event occurred, yet the ability to be thorough is limited by resource constraints. One influences what one can. This results in the construction of a reason rather than finding one. Extended inquiry can also be seen as "a lack of leadership and a sign of uncertainty, weakness, or inability to make decisions". Devoting further energies is inefficient. Instead, move on and restore routine operations.

The managerial point of view seems to reflect this theme, by seeing four dimensions of an adverse event: influence, impact, breadth, and duration. "Resilient managers are able to shift quickly from endlessly dissecting traumatic events to looking forward, determining the best course of action given new realities. They understand the size and scope of the crisis and the levels of control and impact they may have in a bad situation (Margolis and Stoltz 2010). From the management viewpoint, operational failures that erode productivity and reputation can impair an organization's financial performance (Frei et al. 1999; Adler-Milstein et al. 2009). The question a manager asks of herself or himself when adversity strikes is 'Which facets of the situation can I influence, no matter how impossible the situation may seem?' It's not about controlling everything, and everyone, to get what you want. It's about being able to influence something in the situation to make it better" (Stoltz 2000). In technically complex, resource-constrained conditions such as healthcare, the something that is most amenable to influence is the future: expectations that control will be restored, reputation will be maintained, and financial performance protected.

Being *in control* is having knowledge about the real world and ways to represent it, and using those ways to choose the right actions to take. "Conversely, if a system cannot do that it will have lost control. On the practical level the loss of control means that the predicted events do not match the actual events, in other words that the consequences of the actions are unexpected or surprising (Hollnagel 1998:33)" This element of surprise undermines the need of organizations and their leadership to *be* in control.

There is substantial evidence that we cannot make even relatively simple technologies work reliably, and this experience casts doubt on the proposals for technology to offset, or forestall, "human error". There are real problems here and they resonate strongly with the work of Hollnagel, Norman, Reason, Woods, and others. An aging population, shifting labor pools, and economic pressures loom large. Although technology is the leading contender for offsetting these factors, it is not at all clear that we have the ability to make technology that can fulfill that role. In the end, it seems, what is needed is not so much a *way out* of the error mess as a *way in*to a deeper appreciation of the complexities of technical work. But what are we to do with error? Is error of any value to us in, perhaps not the creation of safe systems but an understanding of why our present systems are unsafe? What uses can we make of error?

Perhaps the answer is not in what error *is* but in how people *use* it.

4 The uses of error

Even though the notion of erroneous acts, or "error", may be ill behaved, this does not make it valueless. People do think that it means something and they use it as though it is concrete and well defined even though little attention has been paid to the *value* of error. Our understanding of adverse events changes through time as our thinking about them evolves. In the 1960s, technology and equipment was a popular cause, declining in the mid-1970s as attribution to human performance grew. Attributions to human performance have peaked in the last 40 years, which suggests that attributions to the organization are on the rise (Hollnagel 2004:46). Given that the notion of error remains part of the organizational response to adverse events, it must have value. We contend that it does. "Error" serves a number of functions for an organization: as a defense against entanglement, the illusion of control, as a means for distancing, and as a marker for a failed investigation.

4.1 A defense against entanglement with accidents

Halting post-event analyses with the diagnosis "human error" provides a valuable organizational defense. In his unpublished doctoral dissertation *The Social Construction of Human Error*, Leo Tasca (1990) notes that shipping companies may reduce their liability by lodging the cause of accidents with the human operator. This practice restricts subsequent investigations and constrains the countermeasures within narrow boundaries. This paradoxically makes error quite safe, at least as far as the larger organization is concerned. By directing attention to an isolated human failure, the organization avoids entangling itself in open-ended inquiry that might prove damaging, or costly, or even reveal characteristics that it wishes to keep hidden.

Tasca points out that treating error as a stochastic event minimizes the liability following shipping accidents. But stochastic mechanisms do not explain the confluence of factors observed. "A deeper analysis of accident causation indicates that the observed coincidence of multiple errors [sic] cannot be explained by a stochastic coincidence of independent events. Accidents are more likely caused by a systematic migration toward accident by a company operating in an aggressive, competitive environment or an organization working under time and funding pressure" (Rasmussen 2000:31).

The best (least cost) solution is for the accident to be understood as flowing from a sporadic human operator error; unpredictable and unheralded. While the chronically intoxicated ship captain produces liability for the company, the unusually drunken one is a virtual godsend. Human (operator) error needs to arise from unpredictable, unforeseen, and *unforeseeable* factors in order to make the defense effective. Tasca shows how the usual post-accident investigations of shipping accidents are exercises in filling in a template based on this model.

As an organizational defense, human (operator) error serves as a kind of lightning rod that conducts the potentially harmful consequences produced by an accident along an (organizationally) safe pathway. This is commonly found in healthcare and other domains. Researchers may, therefore, use the nomination of human error as a cause of an accident as evidence of organizational defensiveness.

4.2 The illusion of control

If accidents flow from error and error may be lodged in an individual, then exerting control over the individual may be used to prevent accidents. Situating error in the individual raises the prospect of creating an orderly, rational world in which accidents are less likely. If failure comes from individual error, then attention may be safely directed to restrain or contain the individual.

If error is not a property of individuals, the sources of accidents are harder to identify and the opportunities for control are harder to see. In this case, the conditions that give rise to failure are systemic. Making future failure less likely demands substantive changes to be made in work conditions. The frequently irrational, unpredictable character of human performance paradoxically makes this form of failure seem amenable to correction. Problems such as production pressure and working conditions are difficult to affect. When the source of failure can be shifted to the unpredictable human operator, though, productivity and conditions do not need to be considered.

Organizations and institutions need to assert that they have control over the circumstances that gave rise to the failure in order to retain independent authority and freedom of action and to restore a public image of reliability. The assertion that "this will never happen again" is based on the illusion of control. Of course "this" *will* happen again, possibly in a different time or way place, because control over the real world is not complete.

Khatri et al. (2006) suggest that the current control-based culture and management systems in healthcare organizations are inherently inadequate to deliver high-quality patient care and safety. Their solution implies that commitment-based management "… will foster collaboration, communication, coordination, and teamwork—the essential mechanisms for reducing medical errors and rendering high-quality health care".

The illusion of control plays a role in other activities as well, such as efforts to create "taxonomies" for error. Taxonomies and associated incident "reporting" paraphernalia create the impression of understanding and progress toward control. Taxonomies of "error" frequently serve as maps of the impoverished understanding of human performance that pervades both the interesting domains and much of the community attempting to do research on "error" (Bowker and Star 2000).

4.3 A means for distancing

The research community regards assessments that accidents are caused by human error as excessively narrow, but this narrowness has distinct advantages. It serves as a way to distance individuals from the implications of overt failure at work (Cook and Woods 2007). Pejorative qualities that are often attached to human error promote distancing, such as suggestions that error arises from sloth or moral failing. Others feel less at risk if error can be ascribed to a practitioner's deeply seated, but personal, flaws. If accidents arise from forces and circumstances in the environment, then the experience of my colleague has relevance for me and the event increases my sense of hazard and uncertainty. By attributing my colleague's accident to his inattention or stupidity, though, I make it possible to believe that the accident has no relevance for me, This is because I do not believe that I am either inattentive or stupid. Distancing limits and obscures the deeper examination of the sources of accidents. It marks an area of research interest, but it also sharply limits the value of post-accident attributions.

4.4 A marker for failed investigations

The most important value of "human error" is that it provides an acceptable end point for adverse event investigation. Rasmussen pointed out that investigation halts most often when the traceback process encounters a human with apparent freedom of action. This appearance forms a "cognitive barrier" beyond which investigators do not make much progress, mainly because it is so difficult to work through the psychology and behavior of human agents. The cognitive wall is not impenetrable. Indeed, most of the advances in safety over the past two decades have come from discovering cracks in that wall or even by drilling through it using a variety of methods (Woods 1988; Woods and Hollnagel 1987).

Hollnagel and others regard failure to get through the cognitive wall as flawed *technical* investigation. But investigation of accidents is also a *social* activity that has important implications for the organizations involved and the ability to close an investigation with human (i.e. operator) error can be of great social value. The original Air Ontario crash investigation concluded that "pilot error" caused the accident. The later Moshansky Commission investigation including the human factors analysis by Helmreich largely penetrated this cognitive wall, despite its being extensive, expensive, and organizationally disruptive. In so doing, the Commission's investigation opened up pathways for major damage to the organizations involved. It essentially destroyed Air Ontario as a commercial entity and exposed significant and embarrassing flaws in both the structure of air transportation and the regulation of air travel in Canada. Narrowly condemning analyses that halt on the "discovery" of "human error" fails to appreciate how useful "error" often is in organizational terms. Indeed, concluding that "pilot error" caused the crash is a consistent feature of simulations of the aftermath of the Air Ontario crash (Patterson et al. 2001).

To be sure, "error" is not merely a technical cover for social features that organizations wish to remain ignorant of or hide. If this were so, "error" would quickly lose its value. Instead, "operator" or "user error" is a catchall term for those events that cannot be identified as overt mechanical failure. Manufacturers routinely assert that reported failures that cannot be duplicated in their post-accident investigations are caused by user error. The possibility, for example, of device designs that contribute to mis-operation through complexity and human engineering deficiencies is virtually absent in such reports. The term "user error" thus encompasses a variety of phenomena and in itself is not specific.

The identification of "human error" by accident investigators is now taken by Hollnagel and his community of researchers as a marker for an incomplete or failed investigation. "Human error" has become a way for researchers to identify accident investigations that have ended prematurely. High rates of "human error" point to a particular form of human error problem. This is not error by the practitioners who were involved in the accident, but rather error by the analysts who assessed the accident's source and evolution. Ironically, this use for error may ultimately be the greatest contribution of human error to the creation of high reliability systems.

Complexity alone may frustrate investigations in ways that lead to application of the label "error". The other uses of error can modulate this, by lowering the threshold for "error" and increasing the incentive to truncate understanding what happened.

Each accident generates multiple assessments. A suitably detailed study of error would account for the variety and disparity of the ways in which error is used. A map of the variety of views may provide insight into the contributions of the four uses that we have described here, and the others that will surely be discovered as work continues. This seems to be a rich area for future work.

5 Conclusion

What are the uses of error? Whatever underlying intellectual basis research on "human error" may have, the notion of "error" is useful to practitioners, organizations, and institutions. Researchers also find it useful because it points to organizational defense, an effort to gain the illusion of control, the need for psychological and social distance from the threat of future accidents, and incomplete investigation.

Each of these uses could serve as the basis for research on error that would meet the criteria of scholarship. The study of any one of these would require the application of multiple, converging research methods, a thorough understanding of the details of technical work in the domain, the nature of trade-offs and uncertainty, and a thorough characterization of the ways that complexity shapes the demands and opportunities. It seems as if the study of error necessarily heads toward these sorts of issues.

Failure investigations' tendency to stop tracing back after encountering the first human in the chain remains as true today as it was two decades ago. Error is useful not in spite of its misapplication, but *because* of it. We need to take error seriously not because it is an accurate assessment but *because it is inaccurate*; inaccurate in particular sorts of ways that serve individual and organizational needs. Treating "error" as technical inadequacy comparable to noise fails to understand the value of "error". Paradoxically, it also blinds researchers to the workings of organizational portions of the socio-technical system that give rise to accidents. It is not surprising that organizations continue to treat "error" as useful and objective. But this organizational behavior provides critical information about accidents that can be used to understand their genesis, evolution, and responses to them.

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