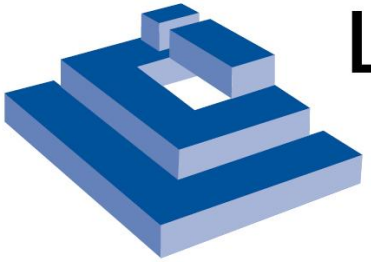

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Failure to adapt or adaptations that fail: contrasting models on procedures and safety

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Abstract

This paper introduces two models on procedures and safety and assesses the practical consequences these have for organizations trying to make progress on safety through procedures. The application of procedures is contrasted as rote rule following versus substantive cognitive activity. It reveals a fundamental double bind: operators can fail to adapt procedures when adapting proved necessary, or attempt procedural adaptations that may fail. Rather than simply increasing pressure to comply, organizations should invest in their understanding of the gap between procedures and practice, and help develop operators' skill at adapting.

Keywords: Procedures; Adaptation; Safety

1. Introduction

People do not always follow procedures. This observation is easy to make while watching people at work, and considered to be a large practical problem faced by managers, supervisors, and others responsible for safe outcomes of people's work. There exist two (implicit) models of procedures and work that guide how organizations think about making progress on safety. The paper considers evidence for each model. Recent research results suggest how organizations can monitor and understand the gap between procedures and practice.

2. Model 1: procedure application as rule-following

There is a persistent notion that not following procedures can lead to unsafe situations. For example, a study carried out for an aircraft manufacturer identified "pilot deviation from basic operational procedure" as primary factor in almost 100 accidents (Lautman and Gallimore, 1987, p. 2). From this study, as well as from the history of industrial disasters where lack of procedure- or rule-following was claimed to play a role (e.g. the Tokai Mura nuclear re-processing accident (Furuta et al., 2000)), a model of procedures and safety emerges:

- Procedures represent the best thought-out, and thus the safest way to carry out a job.
- Procedure-following is mostly simple IF-THEN rule-based mental activity: IF this situation occurs, THEN this algorithm (e.g. checklist) applies.
- Safety results from people following procedures.
- For progress on safety, organizations must invest in people's knowledge of procedures and ensure that procedures are followed.

In the wake of failure it can be tempting to introduce new procedures or change existing ones, or enforce stricter compliance. For example, shortly after a fatal shootdown of two US Black Hawk helicopters over Northern Iraq by US fighter jets, "higher headquarters in Europe dispatched a sweeping set of rules in documents several inches thick to 'absolutely guarantee' that whatever caused this tragedy would never happen again" (Snook, 2000, p. 201). It is a common, but not typically satisfactory reaction. Introducing more procedures does not necessarily avoid the next incident, nor do exhortations to follow rules more carefully necessarily increase compliance or enhance safety. To be sure, procedures, with the aim of standardization, can play an

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important role in shaping safe practice. Commercial aviation is often held up as prime example of the powerful effect of standardization on safety (e.g. Lautman and Gallimore, 1987; Goteman, 2001). But there is ambiguity and evidence that procedures are a more problematic category of human work.

First, a mismatch between procedures and practice is not unique to accident sequences. Not following procedures does not necessarily lead to trouble, and safe outcomes may be preceded by just as (relatively) many procedural deviations as those that precede accidents (Woods et al., 1994; Snook, 2000). This turns any "findings" about accidents being preceded by procedural violations into mere tautologies—typical for social research that selects its empirical cases on the dependent variable.

Second, real work takes place in a context of limited resources and multiple goals and pressures. Work-to-rule labour disputes and strikes show how it can be impossible to follow the rules and get the job done at the same time (e.g. Vicente, 1999). Aviation line maintenance is emblematic: A "job perception gap" exists where supervisors are convinced that safety and success result from mechanics following procedures—a sign-off means that applicable procedures were followed. But mechanics may encounter problems for which the right tools or parts are not at hand; the aircraft may be parked far away from base. Or there may be too little time: aircraft with a considerable number of problems may have to be "turned around" for the next flight within half an hour. Mechanics, consequently, see success as a result of their evolved skills at adapting, inventing, compromising and improvising in the face of local pressures and challenges on the line—a sign-off means the job was accomplished in spite of resource limitations, organizational dilemmas and pressures (Van Avermaete and Hakkeling-Mesland, 2001). Those most adopt are valued for their productive capacity even by higher organizational levels. Unacknowledged by those levels, though, are the vast informal work systems that develop so mechanics can get work done, advance their skills at improvising and satisfying, impart them to one another and condense them in unofficial, self-made documentation (McDonald et al., 2002). Seen from the outside, a defining characteristic of such informal work systems would be routine non-conformity. But from the inside, the same behaviour is a mark of expertise, fueled by professional and inter-peer pride. And of course, informal work systems emerge and thrive in the first place because procedures are inadequate to cope with local challenges and surprises, and because procedures' conception of work collides with the scarcity, pressure and multiple goals of real work.

Third, some of the safest complex, dynamic work not only occurs despite the procedures—such as aircraft line maintenance—but without procedures altogether. Rochlin et al. (1987, p. 79), commenting on the introduction of ever heavier and capable aircraft onto naval aircraft carriers, noted that "there were no books on the integration of this new hardware into existing routines and no other place to practice it but at sea… Moreover, little of the process was written down, so that the ship in operation is the only reliable manual". Work is "neither standardized across ships nor, in fact, written down systematically and formally anywhere". Yet naval aircraft carriers—with inherent high-risk operations—have a remarkable safety record, like other so-called high reliability organizations (Rochlin et al., 1987; Weick, 1990; Rochlin, 1999). Documentation cannot present any close relationship to situated action because of the unlimited uncertainty and ambiguity involved in the activity. Especially where normal work mirrors the uncertainty and criticality of emergencies, rules emerge from practice and experience rather than preceding them. Procedures, in other words, end up following work instead of specifying action beforehand. Indeed, the ecological approach to human factors tries to better understand and model such co-evolution of human and system (e.g. Hancock and Chignell, 1995).

Fourth, procedure-following can be antithetical to safety. In the 1949 US Mann Gulch disaster, firefighters who perished were the ones sticking to the organizational mandate to carry their tools everywhere (Weick, 1993). In this case, as in others (e.g. Carley, 1999), people faced the choice between following the procedure or surviving.

This, then, is the tension. Procedures are an investment in safety—but not always. Procedures are thought to be required to achieve safe practice—yet they are not always necessary, nor likely ever sufficient for creating safety. Procedures spell out how to do the job safely—yet following all the procedures can lead to an inability to get the job done. Though a considerable practical problem, such tensions are underreported and underanalyzed in the ergonomics literature. Ergonomics assumes that order and stability in operational systems are achieved rationally, mechanistically, and that control is implemented vertically (e.g. through task analyses that produce prescriptions of work-to-be-carried out). Despite commentary from within (Jens Rasmussen among the most prominent (see e.g. Vicente, 1999)) mainstream ergnomics often still understands and directs work using criteria from outside the setting in which the work takes place. Contributions from ethnography (e.g. Suchman, 1987), sociology (e.g. Vaughan, 1996; Snook, 2000) and organizational science (e.g. Weick, 1993) succeed better in illuminating the mismatch between procedures and practice by reconstructing the meaning that work has for people who carry it out. Instead of imposing work from the outside-in, they want to understand work from the inside-out.

Consequently, it is better able to "normalize" or "neutralize" people's non-conformity, using notions of competent performance honored and used in the particular work setting (Vaughan, 1996). Such research can interpret why, to people in the workplace, deviance is conformity—conformity to goals that stem from a complex of pressures, uncertainty, competition, scarcity and known routes to practical success.

3. Model 2: procedure application as substantive cognitive activity

People at work must interpret procedures with respect to a collection of actions and circumstances that the procedures themselves can never fully specify (e.g. Suchman, 1987). In other words, procedures are not the work itself. Work, especially that in complex, dynamic workplaces, often requires subtle, local judgments with regard to timing of subtasks, relevance, importance, prioritization and so forth. For example, there is no technical reason why a before-landing checklist in a commercial aircraft could not be automated. The kinds of items on such a checklist (e.g. hydraulic pumps OFF, gear down, flaps selected) are mostly mechanical and could be activated on the basis of pre-determined logic without having to rely on, or constantly remind, a human to do so. Yet no before-landing checklist is fully automated today. The reason is that approaches for landing differ—they can differ in terms of timing, workload, priorities and so forth. Indeed, the reason is that the checklist is not the job itself. The checklist is, in the words of Suchman (1987), a resource for action; it is one way for people to help structure activities across roughly similar yet subtly different situations.

Circumstances change, or are not as were foreseen by those who designed the procedures. Safety, then, is not the result of rote rule following; it is the result of people's insight into the features of situations that demand certain actions (e.g. Klein, 1993; Sanne, 1999), and people being skillful at finding and using a variety of resources (including written guidance) to accomplish their goals. This suggests a second model on procedures and safety:

- Procedures are resources for action. Procedures do not specify all circumstances to which they apply. Procedures cannot dictate their own application. Procedures can, in themselves, not guarantee safety.
- Applying procedures successfully across situations can be a substantive and skillful cognitive activity.
- Safety results from people being skillful at judging when (and when not) and how to adapt procedures to local circumstances.
- For progress on safety, organizations must monitor and understand the reasons behind the gap between procedures and practice. Additionally, organizations must develop ways that support people's skill at judging when and how to adapt.

Pre-specified guidance is inadequate in the face of novelty and uncertainty. But adapting procedures to fit circumstances better is a substantive cognitive activity. Take for instance the crash of a large passenger aircraft near Halifax, Nova Scotia in 1998. After an uneventful departure, a burning smell was detected and, not much later, smoke was reported inside the cockpit. Carley (1999) characterizes the two pilots as respective embodiments of the models of procedures and safety: the co-pilot preferred a rapid descent and suggested dumping fuel early so that the aircraft would not be too heavy to land. But the captain told the co-pilot, who was flying the plane, not to descend too fast, and insisted they cover applicable procedures (checklists) for dealing with smoke and fire. The captain delayed a decision on dumping fuel. With the fire developing, the aircraft became uncontrollable and crashed into the sea, taking all 229 lives onboard with it.

The example illustrates a fundamental double bind for those who encounter surprise and have to apply procedures in practice (Woods and Shattuck, 2000):

- If rote rule following persists in the face of cues that suggests procedures should be adapted, this may lead to unsafe outcomes. People can get blamed for their inflexibility; their application of rules without sensitivity to context.
- If adaptations to unanticipated conditions are attempted without complete knowledge of circumstance or certainty of outcome, unsafe results may occur too. In this case, people get blamed for their deviations; their non-adherence.

In other words, people can fail to adapt, or attempt adaptations that may fail. In the Halifax crash, rote rule following became a de-synchronized and increasingly irrelevant activity; de-coupled from how events and breakdowns were really unfolding and multiplying throughout the aircraft. But there was uncertainty about the very need for adaptations (how badly ailing was the aircraft, really?) as well as uncertainty about the effect and safety of adapting: How much time would the crew have to change their plans? Could they skip fuel dumping and still attempt a landing? Potential adaptations, and the ability to project their potential for success, were not necessarily supported by specific training or overall professional indoctrination. Civil aviation, after all, tends to emphasize model 1: stick with procedures and you will most likely be safe (e.g. Lautman and Gallimore, 1987).

Tightening procedural adherence, through threats of punishment or other supervisory interventions, does not remove the double bind. In fact, it may tighten the double bind—making it more difficult for people to develop judgment at how and when to adapt. Increasing the pressure to comply increases the probability of failures to adapt—compelling people to adopt a more conservative response criterion. People will require more evidence of the need to adapt, which takes time, and time may be scarce in cases that call for adaptation (as in the crash above).

4. The organizational charter: monitor the gap and develop skill at adapting

The double bind lays out the challenge for organizations wishing to make progress on safety with procedures. Organizations need to:

- Monitor the gap between procedure and practice and try to understand why it exists (and resist trying to close it by simply telling people to comply).
- Help people to develop skills to judge when and how to adapt (and resist telling people only that they should follow procedures).

4.1. Monitor the gap

High reliability organizations are characterized in part by their close monitoring and study of the gap between procedures and practice (Rochlin et al., 1987; Weick, 1990; Rochlin, 1999). In contrast, many organizations or industries do not even know, or want to know, about the gap. Take aircraft maintenance again A variety of workplace factors (communication problems, physical and/or hierarchical distance, industrial relations) obscure the gap (Van Avermaete and Hakkeling-Mesland, 2001). Continued safe outcomes of existing practice give supervisors no reason to question their assumptions about how work is done (if they are safe "they must be following procedures down there"). There is wider industry ignorance, however (McDonald et al., 2002). In the wake of failure, informal work systems typically retreat from view, gliding out of investigators' reach. Instead, hindsight inflates the causal role attributed to "violations"—at least what look like "violations" from the outside. What goes misunderstood, or unnoticed, is that informal work systems compensate for the organization's inability to provide the basic resources (e.g. time, tools, documentation with a close relationship to action) needed for task performance. Satisfied that violators got caught and that formal prescriptions of work were once again amplified, the organizational system changes little or nothing. It completes another "cycle of stability", typified by a stagnation of organizational learning and no progress on safety (McDonald et al., 2002).

The gap between procedures and practice is not constant. After the creation of new work (e.g. through the introduction of new technology), considerable time can go by before applied practice stabilizes—likely at a distance from the rules as written for the system "on-the-shelf". Social science has characterized this migration from tightly coupled rules to more loosely coupled practice as "fine-tuning" (Starbuck and Milliken, 1988) or "practical drift" (Snook, 2000), for example. Through this shift, applied practice becomes the pragmatic imperative; it settles into a system as normative. Deviance (from the original rules) becomes normalized; non-conformity becomes routine (Vaughan, 1996).

The literature has identified important ingredients in the normalization of deviance, which can help organizations understand the nature of the gap between procedures and practice:

- Rules that are overdesigned (written for tightly coupled situations, for the "worst-case") do not match actual work most of the time. In real work, there is time to recover, opportunity to reschedule and get the job done better or more smartly (Starbuck and Milliken, 1988). This mismatch creates an inherently unstable situation that generates pressure for change (Snook, 2000).
- Emphasis on local efficiency or cost-effectiveness pushes operational people to achieve or prioritize one goal or a limited set of goals (e.g. customer service, punctuality, capacity utilization). Such goals are typically easily measurable (e.g. customer satisfaction, on-time performance), whereas it is much more difficult to measure how much is borrowed from safety.
- Past success is taken as guarantee of future safety. Each operational success achieved at incremental distances from the formal, original rules, can establish a new norm. From here a subsequent departure is once again only a small incremental step (Vaughan, 1996). From the outside, such fine-tuning constitutes incremental experimentation in uncontrolled settings (Starbuck and Milliken, 1988)—on the inside, incremental non-conformity is not recognized as such.
- Departures from the routine become routine. Seen from the inside of people's own work, violations become compliant behaviour. They are compliant with the emerging, local ways to accommodate multiple goals important to the organization (maximizing capacity utilization but doing so safely; meeting technical requirements but also deadlines). They are compliant, also, with a complex of peer pressures and professional expectations in which unofficial action yields better, quicker ways to do

the job; in which unofficial action is a sign of competence and expertise; where unofficial action can override or outsmart hierarchical control and compensate for higher-level organizational deficiencies or ignorance.

4.2. Helping people develop skill at adapting: planning for surprise

Merely stressing the importance of following procedures can increase the number of cases in which people fail to adapt in the face of surprise. Letting people adapt without adequate skill or preparation, on the other hand, can increase the number of failed adaptations. One way out of the double bind is to develop people's skill at adapting. This means giving them the ability to balance the risks between the two possible types of failure: failing to adapt or attempting adaptations that may fail. It requires the development of judgment about local conditions and the opportunities and risks they present, as well as an awareness of larger goals and constraints that operate on the situation. Development of this skill could be construed, to paraphrase Rochlin, as *planning for surprise*. Indeed, as Rochlin (1999, p. 1549) has observed: the culture of safety in high reliability organizations anticipate and plan for possible failures in "the continuing expectation of future surprise", something that has been re-emphasized in Woods and Shattuck (2000), and alluded to in Westrum (1993), while Weick argued in 1988 (Weick, 1988) that such capacity (for example, as contained in people's skills) can critically affect people's ability to manage crises. The question of how to plan for surprise—how to help people develop skill at adapting successfully—however, remains elusive: "The issue of the specificity with which emergence procedures following should be trained is one for which more research is clearly needed" (Messick-Huey and Wickens, 2000, p. 210). Some novel insights are being produced (e.g. Woods and Patterson, 2000). As an example, Goteman (2001) recognized how commercial pilots would "shed" some tasks earlier than others when confronted with surprising or very busy situations. He developed the concept of "controlled shedding", by which an airline could help prioritize and train pilots to shed some tasks rather than others during busy times or crisis situations. In other words, helping people control task-shedding is one way to develop skill at adapting.

5. Conclusion

There is always a tension between centralized guidance and local practice. Sticking to procedures can lead to ineffective, unproductive or unsafe local actions, whereas adapting local practice in the face of pragmatic demands can miss global system goals and other constraints or vulnerabilities that operate on the situation in question. Helping people solve this fundamental trade-off is not a matter of pushing the criterion one way or the other. Discouraging people's attempts at adaptation can increase the number of failures to adapt in situations where adaptation was necessary. Allowing procedural leeway without investing in people's skills at adapting, on the other hand, can increase the number of failed attempts at adaptation. In order to make progress on safety through procedures, organizations need to monitor the gap between procedure and practice and understand the reasons behind it.

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