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Overcoming dysfunctional momentum: Organizational safety as a social achievement

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ABSTRACT

Research on organizational safety and reliability largely has emphasized system-level structures and processes neglecting the more micro-level, social processes necessary to enact organizational safety. In this qualitative study we remedy this gap by exploring these processes in the context of wildland fire management. In particular, using interview data gathered from 28 individuals involved in wildland firefighting, we explore the validity of the idea that a deterrent to organizational safety is an inability to redirect ongoing actions once they are underway. The findings suggest four major themes. First, individuals and groups redirect ongoing action as a result of re-evaluating that action. Second, noticing early warning signs, while necessary, is not sufficient to drive change. Third, two social processes – giving voice to concerns and actively seeking alternative perspectives – appear to be key drivers of re-evaluation. Fourth, the process of redirecting action is moderated by two social factors: institutional pressures and self-interest. We discuss the implications of these patterns for organization theory and for future research.

KEYWORDS

high reliability organizing ■ knowledge sharing ■ organizational safety ■ sensemaking ■ social construction ■ voice

In recent years, both theorists and practitioners have become concerned with the challenges of maintaining safety in organizational systems that are increasingly complex, interdependent and subject to environmental uncertainty. In particular, research exploring the human factors (physical, psychological and social) that may contribute to or undermine safety has become more prominent, particularly in the fields of aviation and healthcare (Orlady & Orlady, 2002; Rasmussen, 2003; Shappell & Wiegmann, 1997). Much of the work in this area uses what Reason (1995) terms 'the person model'. Human errors or 'actions that deviate from the intended goals' are seen to arise from individual dispositional factors (Fahlbruch et al., 2000: 10). These may also be influenced by workplace factors such as work characteristics and job design (Parker et al., 2001; Turner et al., 2005).

However, a rising awareness of vulnerabilities in national infrastructures such as intelligence, nuclear power, electrical grids, and healthcare systems has led to a new emphasis on system level disasters or breakdowns. The systems view of organizational safety suggests that human error is often only the proximate cause of disaster. Mistakes or slips can be viewed as the 'sharp end' of an accident sequence. That is, disasters are frequently caused by latent factors or critical failures upstream in a chain of complex and interdependent events (Reason, 2005). In this study, we build on the systems view of organizational safety to explore some of the specific social interactions within those complex chains of events.

The systems view of organizational safety

One of the fundamental premises of the systems view of organizational safety is that vulnerability is a product of system structure. Specifically, when the components of a system are interactively complex (interactions are unforeseen and difficult to predict) and its processes are tightly coupled (highly time dependent and invariant), small mishaps can concatenate. These can escalate into larger crises that can have serious untoward consequences (Perrow, 1986; Sagan, 1993). For example, in their study of aircraft carrier crews Weick and Roberts (1993) show that something as small as a bolt left on the flight deck can pose a critical threat to the functioning of the entire carrier. (A bolt sucked into a jet engine would cause an explosion, and would lead to fire, potential loss of life and equipment, interruption of critical military tasks and so on.)

Within the systems view, two approaches to inquiry have arisen, sometimes referred to as the 'pessimistic' view and the 'optimistic' view (Fahlbruch et al., 2000). The so-called 'pessimistic' view has arisen from extensive

studies of system failures, such as disastrous accidents (Turner, 1976) or medical errors (Reason, 2004, 2005). It is consistent with Normal Accident Theory, developed originally by Perrow (1984) to explain the Three Mile Island disaster. Perrow suggests that the combination of interactive complexity and tight-coupling within a system will inevitably lead to failure and accidents. Given this view, the best approach to improving system reliability and safety is to change the system itself – reduce its complexity or tight coupling.

In contrast, the ‘optimistic’ view focuses on how some organizations manage to function safely *despite* the hazards of complex systems. Research on ‘high reliability organizations’ (HROs), organizations ‘that behave under very trying conditions’ (LaPorte & Rochlin, 1994: 221) such as nuclear power plants, air traffic control systems, and incident command teams, demonstrates how organizations that must function reliably are able to do so in spite of risky technologies, complexity and uncertain environments (Rochlin et al., 1987; Shulman, 1993; Weick & Roberts, 1993; Weick & Sutcliffe, 2007). These organizations are unique in their abilities both to prevent and to manage mishaps before they can spread throughout the system causing widespread damage or failure. These abilities are generally traced to dynamic organizing. That is, HROs purportedly have mechanisms for monitoring and reporting small signals that the system may be breaking down. They also have the flexibility and the capabilities to respond in real time, reorganizing resources and actions to maintain functioning despite peripheral failures (Weick & Sutcliffe, 2007). Unlike Normal Accident Theory, HRO theory suggests that reliability and safety are achieved through human processes and relationships, rather than through changes to the system structure (Roberts et al., 1994). We situate our study within this view of organizational safety.

Recently, the literature on HROs has become both more integrated and more widely generalized as researchers have recognized the importance of using HROs as templates of adaptive organizational forms for increasingly complex environments (Weick et al., 1999: 82). Theoretical integration has been accompanied by an emerging stream of empirical studies seeking to understand the conditions under which ordinary organizations resemble HROs and how these organizations can replicate the exceptional performance of HROs (see Vogus & Sutcliffe, 2007a, 2007b; Vogus & Welbourne, 2003). Although the HRO literature has provided insight into broad organizing principles through which safety and reliability in complex systems are created, much less is known about the micro-level interactions that underlie dynamic organizing. Yet, it is through micro-level social processes that the organizational practices that contribute to safety are enacted.

For example, Weick and Sutcliffe (2007) suggest that reliable organizations are sensitive to and constantly adjust to small cues or mishaps that if left unaddressed, could accumulate and interact with other parts of the system, resulting in larger problems. By constantly adapting, tweaking, and solving small problems as they crop up throughout the system, organizations prevent more widespread failures and improve safety. This theory highlights the criticality of ongoing adaptation. To maintain safety, organizations must continue to respond to small cues by making small adjustments and alterations. In this study, we explore this issue and answer the question: Under what conditions do individuals and groups redirect ongoing action?

Cues, interruptions and dysfunctional momentum

Multiple and diverse literatures have suggested that individuals are notoriously bad at overcoming entropy (e.g. Salancik, 1977). While engaged in an ongoing plan or activity, individuals (and organizations) are unlikely to reconsider or re-evaluate those actions, much less change them (Kline & Peters, 1991; Salancik, 1977). Much of the work on organizational safety and reliability suggests that one reason organizational actors fail to redirect actions when they should is because they simply miss those small cues that suggest change is needed.

In his classic study of the development of disasters, Turner argues that many accidents result from 'failures of foresight'. He describes this as the 'accumulation of an unnoticed set of events which are at odds with the accepted beliefs about hazards and the norms for their avoidance' (1976: 381). For example, Weick and Sutcliffe (2007) recount the failure of maintenance personnel at the US Davis-Besse nuclear power plant outside of Toledo, Ohio, to pay serious attention to rust particles that had been clogging air-conditioning and water filter systems over a two-year period. The clogging required that maintenance personnel change filters every two days when the industry norm was to change the filters once a month. The rust accumulation was a weak signal of plant-wide problems (signaling corrosion in the 6.5 inch metal liner containing the radioactive material), which could have been disastrous had personnel not found the problem before a breach occurred. This line of reasoning suggests that disaster results from a failure to notice critical cues.

However, there may be an alternative explanation. We propose that individuals may fail to redirect their actions not because they miss cues signaling the need for change, but because they are so embedded in the unfolding situation that they fail to stop and incorporate those cues into a

new understanding of that situation. In other words, failure to redirect action is a problem of sensemaking. Sensemaking is 'the ongoing retrospective development of plausible images that rationalize what people are doing' (Weick et al., 2005: 409). Arising from action and interpretation rather than from evaluation and choice, sensemaking occurs as we address the questions, 'What's the story here?' and 'Now what should we do?' Sensemaking is the act of reassessing an ongoing situation and giving meaning to our actions.

Critically, Weick and his colleagues (2005) point out that sensemaking occurs when individuals or groups face a discontinuity in their experience. As Weick et al. (2005) propose, when 'an expectation of continuity is breached, ongoing action becomes disorganized, efforts are made to construct a plausible sense of what is happening' (p. 414). This means sensemaking or the act of rationalizing or reassessing ongoing activities is most likely to occur only after those activities have been disrupted. Interestingly, much of the work on organizational safety and reliability has focused on preventing or minimizing interruptions, rather than on creating them (see Weick & Sutcliffe, 2007).

Given this line of thinking, an important question to ask is does the *lack* of interruptions pose possible threats to system safety? That is, in the absence of disruptive problems, might individuals be less likely to re-evaluate, adapt and adjust ongoing actions? Like the reluctant bride or bridegroom caught up in pre-wedding activities, momentum may simply carry her or him along.

Through the remainder of this article, we refer to the behavior of continuing in a course of action without re-evaluation as 'momentum'. By using this word we hope to suggest three specific characteristics of the phenomenon. First, momentum implies a flow of action uninterrupted and, critically, not re-evaluated. Second, we differentiate momentum from *inertia*. Overcoming momentum requires slowing or stopping action whereas overcoming inertia requires starting (or increasing) action. Finally, the word momentum implies direction. It implies not just energy, but also purpose in the action. Individuals are engaged in action towards a specific end. Momentum, itself, is neither good nor bad, but merely implies a lack of interruption. However, when individuals or teams continue to engage in a course of *failing* action, we refer to this as 'dysfunctional momentum'.

If we take seriously the idea that dysfunctional momentum is a threat to organizations' abilities to adapt and adjust flexibly, this raises the question what motivates and enables individuals and groups involved in high stakes work to redirect ongoing actions?

We investigated this question in the context of wildland firefighting, a context in which teams of individuals take action amidst ambiguous,

uncertain, and dynamic environments. This is a good setting for examining our theoretical question because organizational and system safety must be achieved despite work that is very complex, often unpredictable, and requires ongoing action. Thus we can explore the conditions under which individuals and groups involved in high-stakes work are more or less motivated and enabled to redirect ongoing actions and with what effects.

Method

Wildland firefighting as a research context

Normally wildland firefighting is reactive – people literally put out fires. In recent years wildland firefighting in the United States has become more proactive and preemptive to manage forests that have become filled with dead trees and debris on the forest floor. More generally, wildland fire management refers to the suppression and management of fire within wilderness areas. This can include efforts to extinguish wildfires (known as suppression), purposeful setting of controlled fires to reduce hazardous fuels (known as prescribed fire) and overseeing but not interfering with naturally occurring wildfires, also used to reduce hazardous fuels (known as wildland fire-use fire). Each of these types of fire events is overseen by a team of individuals structured within a formal hierarchy, called an Incident Command system.

The team is led by an Incident Commander (IC) (sometimes called a ‘Burn Boss’ or ‘Fire-Use Manager’) who has full responsibility for managing the response to the fire. In larger suppression fires, this person is aided by an ‘overhead’ team consisting of individuals responsible for planning, operations, finance, logistics, public information and safety. In smaller fires, the IC handles these functions him- or herself. Reporting to the head of operations (and ultimately, to the IC), may be various team leaders, each of whom coordinates the activities of an engine crew, ground crew or other resource. In larger fires, additional levels of overseeing may be added to ensure an appropriate span of control. For example, crew bosses will report to division supervisors who in turn report to the head of operations.

Researchers have paid significant attention to the incident command system (e.g. Bigley & Roberts, 2001) and have noted that in theory, this structure puts into place much of what is required to be highly reliable. Yet, in practice this doesn’t always work. In part this is because individuals must carry out the work of the system and they often differ in their behaviors, expertise, and interactions. Moreover, an incident command system takes place within a larger social context in which institutional pressures and power come into play.

What constitutes a good fire outcome differs for different situations, but in general, wildfires are successfully managed to the extent that they are put out quickly with the least amount of property or other damage. Prescribed and wildland fire-use fires are considered successful to the extent that the burn accomplishes the planned objectives (e.g., amount of undergrowth eliminated) and that the fire does not 'escape' into areas not scheduled for burning. Should this happen, it is declared a wildfire and must be extinguished as quickly as possible. In all cases, firefighter and civilian safety is the top priority (in theory) and any type of injury, deployment of emergency fire shelters or even unsafe conditions or behaviors are also considered 'bad' outcomes.¹

Sample

The population for this study included individuals involved in fire management 'on the ground'. The management of fire involves many people in a wide variety of organizations, a large number of whom provide critical infrastructure, planning and support but do not physically become involved in a fire incident on the ground. Much of the work of fire management occurs long before any flames are seen. However, since we were interested in the ongoing action of managing a fire on the ground (and when that action did or did not change), we chose to focus exclusively on the activities of people who are called upon to physically manage or suppress a fire.

For this study, we used a purposive/convenience sampling method. First, following principles of purposive sampling, we identified important sources of variation in the population (Singleton & Straits, 1999). Within this population, there are three important sources of variation among fire activities. The first source of variation concerns the type of fire event: prescribed fire, wildland fire-use fire, or suppression fire. The second source of variation concerns the agency managing the event. The United States Forest Service, the Bureau of Land Management, the Bureau of Indian Affairs, the National Park Service, and the US Fish and Wildlife Service all have resources for managing and fighting wildfires. The third source of variation concerns the role of the acting individual (e.g. Incident Commander, Task Force Leader, Engine Crew Boss). We identified a sample of individuals that maximized these sources of variation. That is, although the final sample was a convenience sample, the types of fire events in which they were involved, their roles, and the agencies for which they worked varied. The interviews took place in two locations (one in the Southwest and one in the Northwest United States). However, the fire events that respondents described occurred all over the western half of the country.

Data collection

We collected data from 28 individuals using a semi-structured interview protocol lasting from 60–90 minutes. In each interview we asked respondents to narrate, in some detail, their experiences on a particular fire event, from start to finish. The purpose of this approach was two-fold. First, by focusing on a specific event, respondents were more able to delve into the details of their experience rather than provide generalized responses which may have been biased towards ‘by-the-book’ actions. We were less interested in what individuals were supposed to do than what they actually did. Second, by asking them to relate, step-by-step, their actions within a specific event, we gathered data that are rich in behavioral information rather than only attitudinal (Ajzen & Fishbein, 1977). We collected additional information from secondary sources such as fire manuals and peer-reports of near misses, which provided useful contextual information.

Analysis

We started the project with a general question: what motivates and enables individuals to redirect ongoing action? To analyze the data, we identified every unique ‘story’ or description of a particular fire event and developed them into small case studies. The case approach allowed us to focus our efforts on conceptually useful stories (those describing some kind of ongoing action) while still retaining theoretical flexibility around the elements that made up that action. We then used a case analysis methodology (Eisenhardt, 1989; Yin, 1994). Beginning with within-case analysis, we examined each story, mapping out what occurred over the course of the fire and what factors appeared to influence the behaviors of those involved. We incorporated as many details as possible into each case, including such things as the type of fire incident, the behaviors and stated beliefs of the individuals involved and the outcome of the event (e.g. whether the fire was contained or escaped its boundaries). We paid special attention to noting when action continued on unchanged and when it deviated from previous activities. The purpose of this stage was to allow the unique patterns of each case to emerge before generalizing across cases.

Next we searched for cross-case patterns. We derived these patterns by traveling back and forth between the data and our emerging theory, refining and adjusting our theorized framework and going back to the data to check new interpretations (Charmaz, 2004; Glaser & Strauss, 1967). Critical to this stage is the use of divergent tactics for analyzing the data. For example, Eisenhardt (1989) suggests that researchers group cases by different

categories and for each grouping look for within-group similarities coupled with intergroup differences. This allows a researcher to avoid reaching premature or false conclusions as a result of various information-processing biases. We grouped cases by event outcome (bad versus good), by whether or not cues were noticed early on and by action (ongoing versus interrupted) and for each grouping, compared and contrasted the behaviors, stated beliefs and actions of the case actors. Based on these analyses, we ascertained that momentum was, in fact, a key factor in many of the bad outcomes and was interrupted and redirected in almost all of the good outcomes. We then developed a theory regarding the social processes involved in disrupting dysfunctional momentum.

Findings

Each respondent related multiple stories about fire incidents in which they were personally involved resulting in a dataset of 62 cases (i.e. incidents). The described incidents varied widely in terms of the size of the fire (from a few acres to tens of thousands of acres) and in terms of the degree to which the activities were routine (from relatively uneventful prescribed burns on small plots of land to stories of desperate and unsuccessful attempts to stop runaway fires). The outcomes of these incidents varied as well. A few individuals described horrific outcomes in which people were badly injured, had to run for their lives or take shelter in portable 'fire shelters'.² A few individuals described extremely successful outcomes – fires were successfully managed within the planned burn area or were rapidly extinguished.

The majority of the described incidents, however, fell in the middle. They had good outcomes, for example fires that remained within planned areas or were eventually suppressed but only after significant struggles or operational mistakes. Or, they had poor but not disastrous outcomes such as escaped fires that were eventually caught or 'near misses' – fire events that were becoming very dangerous but curtailed in time, either through the actions of the fire crews or by sheer luck (i.e. heavy rains). We assessed an outcome as poor or bad if the incident resulted in deployment of shelters, injury, escaped fires, fires jumping lines, financial loss, or safety violations. We assessed an outcome as good if the incident did not result in any of these. Of the 62 incidents recounted by our respondents, 24 incidents had good outcomes, 36 resulted in poor or bad outcomes and two incidents did not include enough information to judge the outcome.

We then categorized these according to the action that took place, considering whether ongoing operations were changed in some way (e.g.

switched from a direct to indirect approach to fighting the fire, stopped fighting the fire and backed off, turned over incident to a higher level team). Of the 62 incidents, seven did not contain enough detail to determine whether or not action changed and were dropped from subsequent analysis. This left us with a dataset of 55 incidents. These were spread quite evenly across the 28 respondents, with no respondent contributing more than three events. Of the 55 events, 22 included instances of changed action (19 of which resulted in good outcomes) and 33 included instances in which action continued in basically the same manner until either the fire event ended or a significant bad outcome occurred (e.g. fire escaped). Of these, 29 ended in bad outcomes. We then analyzed all 55 incidents, looking for patterns of behavior, beliefs and attitudes that seemed to contribute to the changed or unchanged action.

In exploring the question ‘what enables or motivates individuals or groups to deviate from ongoing action’, our data revealed patterns of behavior suggesting four major themes. First, individuals and groups redirect ongoing action as a result of re-evaluating that action. Second, noticing early cues or warning signs that events may go awry, while necessary, is not sufficient to drive change. Third, two social processes – giving voice to concerns and actively seeking alternative perspectives – appear to be key drivers of re-evaluation. Fourth, the process of re-evaluating action and making changes to that action is moderated by two social factors: institutional pressure and self-interest. Below we present our findings and then consolidate our findings into a model that suggests the social processes through which ongoing operations are halted, reassessed and redirected.

I. Reassessment triggers change

Reason (2004) points out that the ‘path to adverse incidents is paved with false assumptions’ (p. 32). Similarly, Turner (1976) notes that failures do not develop instantaneously. Instead there is an incubation period in which discrepant events develop and accumulate unnoticed. Preventing error, therefore, often entails some form of assessing or reassessing working assumptions. Our findings show that almost all of the incidents ending well included a significant redirection of action, which generally resulted from individuals, often leaders, taking the time to reassess the current situation and operations. ‘Sizing up’ a fire occurs many times throughout an event, sometimes in the form of formal procedures, for example, morning and evening briefings in which operations personnel evaluate the fire and its ongoing management. At other times, however, individuals re-evaluate the fire more informally in the course of the days’ activities. Given the uncertain and dynamic nature of

fire, this ongoing re-evaluation appears to be particularly critical to instigating a change in action. For example, one respondent recalls re-evaluating a prescribed fire part way through the burn, despite initial success with a test burn. As a result of the re-evaluation, the decision is made to quit the burn.

The test fire . . . was satisfactory . . . And then we applied a few [fire igniters] across the slope and then, you know, things were just too hot . . . [I] had a conversation with the burn boss . . . just told her what I was seeing. This is what's going on and said that, 'You know, I think, you know, we need to shut it down' . . .

The previous quote contrasts sharply with an initially similar situation in which a prescribed fire continues after a satisfactory test fire, but in this case, the burn is never re-evaluated and, despite spiraling problems, is not halted and ends badly.

We did a test fire and . . . it did burn actively but we were kind of anticipating active fire behavior anyway . . . We started lighting right off the road edge . . . And we started picking up spot fires almost instantly after the test burn . . . and a couple of people went in and got it and they said, 'Oh, we got another one'. And they went to get the other one, by the time they took care of the second one, there was five or six [more fires] . . . [The] end result is people got a lot of smoke inhalation and . . . ah, throwing up and headaches and . . . it was a real mess.

The pattern of findings suggest that what sets these and many similar events apart is whether or not key personnel reassess action once it is underway, not just at formal decision points. In sensemaking terms, do they ask (again) 'What's the story here?' When actors re-evaluate their actions and the situation frequently and throughout the day, they have more opportunities to change direction and are more likely to do so. What then causes individuals to re-evaluate their situations?

II. Noticing small cues is not sufficient

As mentioned earlier, many theorists have suggested that accidents often arise because individuals or groups fail to recognize weak cues signaling system problems (Reason, 2004; Weick & Sutcliffe, 2007). The assumption is that once weak signals are recognized, the organization is better positioned to respond early and can thus head off a disaster before it happens. Consequently, safety should be improved to the extent that organizational members

notice critical cues that signal impending failure. Yet, one of the most striking findings that emerged from our data was the fact that in almost all of the cases in which groups failed to stop or change a disastrous course of action, missing important cues was *not* the problem. To the contrary, both individuals and the groups with whom they worked recognized cues – small things that were going wrong – and appeared to correctly interpret these cues as indications that the system as a whole was at risk. This is exemplified in the following quotes in which teams preparing to light prescribed fires noticed signs that the conditions were not good.

It was really windy . . . And me and all the other leadership roles. . . we were sitting on the hoods of our trucks. Actually, sitting on one hood of a truck, looking at each other saying, ‘Hm, kind of windy isn’t it?’

We knew that was a bad place [to light the fire] . . . Because of the terrain. It was a steep slope up . . . trying to stop it at mid slope . . . rarely works. It was a pretty good chance that that was going to be a loser . . .

In both these situations, despite the fact that crew members noticed and sensed (correctly) that conditions were likely to lead to bad outcomes, and had the authority to change course, they did not re-evaluate the situation or their plans to burn. In both cases the result was an escaped fire. Why then didn’t the firefighters redirect what they suspected would be a dangerous if not disastrous path of action?

III. Social processes leading to re-evaluation

Although noticing small signals is important, our findings suggest that noticing is not sufficient to interrupt ongoing patterns of action and to stimulate re-evaluation. Rather, we found two critical social processes – giving voice to concerns and seeking alternative perspectives – that appeared to stimulate interruptions and consequently reorient the actors involved. Once interrupted, actors were more able to re-evaluate the situation and this re-evaluation sometimes, but not always, led to a cessation or change in ongoing actions.

Voicing concerns

In his seminal work *Exit, voice and loyalty*, Hirschman (1970) emphasizes the potential benefits of voice to organizations experiencing decline (i.e.

failures). By voicing concerns rather than exiting the system (either literally or socially), individuals provide critical information to the organization about what is happening, why problems may be occurring and even what might be done about it. Within a fire organization, voice appears to provide a similar benefit. A key difference between incidents that ended badly and those that did not was the extent to which individuals voiced their concerns about the early warning signs. That is, they not only noticed and mentioned cues, but also articulated the implications of those cues to others. We found evidence suggesting that in the many incidents with negative outcomes, individuals saw indications that the fire might go badly, but they did not speak up. One respondent recalls talking with her colleagues after a prescribed fire had escaped and become a wildfire:

People then were starting to express concerns that maybe the decision had been wrong to go ahead and light [the fire]. But as my FMO pointed out, you guys didn't speak up. Nobody knew any different . . . because nobody was willing to speak up. Months later, they've discussed a little bit with each other over beers and going, 'Oh, *!#!, you know, I saw that coming,' but nobody spoke up at the time.

This did not appear to simply be a case of hindsight bias, because even at the time of the fire, crew members acknowledged various warning signals. The conditions were very dry, there was more than the usual amount of brush and tinder in the area, and humidity was low. Everyone on the fire knew of these conditions and their implications. Furthermore, both the respondent and her co-workers recalled that they had experienced discomfort at the thought of starting the burn. Yet no one articulated their concerns to others. In contrast, in many cases in which individuals changed course, the change seemed to come about directly as a result of individuals articulating their concerns about the cues they noticed.

Consistent with other studies, we found that voice is one path by which critical information is transmitted or diffused to those who need it (e.g. Dutton et al., 1997; Milliken et al., 2003). Interestingly, however, we also found that voicing concerns is important even when others in the system have seen and recognized the same cues. In other words, although voicing concerns is a way of sharing information with decision-makers who may not have had access to those critical cues, often it serves to make actionable that which everyone has already seen. The following quotes are illustrative:

I told [my boss] what we were experiencing and that I didn't feel safe working in there . . . I guess, just by hearing . . . one person saying that,

you know, it wasn't worth it, that was enough to make [him] realize that yeah, you know, it is a safety concern . . . In a way, it was almost like he was waiting for somebody to say something.

And I think [the incident commander was] thinking the same thing about that time . . . as the incident commander you start listening to what radio traffic you're hearing and you start noticing people getting stretched out and I think [he] just needed somebody to be able to say, hey, it's okay if we do this [change our tactics].

Beyond sharing (e.g. diffusing) information, voicing concerns enables the process of re-evaluation in two ways. First, by audibly suggesting that conditions are dangerous enough to warrant reconsidering the plan of action, individuals create a kind of artifact – a statement that now hangs in the air between group members and must be acknowledged or denied, but in any case, responded to. Whether or not others interpret the cues as being valid causes for reaction, the *statement* about the cues is real, and must be acted upon in some way. Second, when a concern is voiced, it no longer resides only in the heads of each individual, but is now the property of the collective. As such, less is required of the leader. Since the *reason* for reassessing the situation is understood at the group level, he or she only has to engage in that reassessment rather than also having to develop support for doing so. This shared artifact creates an interruption in ongoing action (or at least the thought processes around that action), and creates an accompanying space for a re-evaluation to occur.

Despite the benefits of voicing concerns, it is not surprising to find that individuals sometimes remain silent. This is consistent with other research investigating 'organizational silence' (Morrison & Milliken, 2000). What is surprising, however, is the reason. Previous research suggests that individuals refrain from speaking up because they fear negative social consequences (Milliken et al., 2003; Pinder & Harlos, 2001) or because the organizational climate is not safe (Edmondson, 1999). Our findings suggest an additional factor. Respondents reported that while they felt safe to speak up, they remained silent out of deference to the expertise of others.

Enablers of voice

Shifting decisions to individuals who have the expertise to resolve the problem at hand, especially in high tempo times, is one of the hallmarks of a highly reliable organization (Roberts et al., 1994; Weick & Sutcliffe, 2007). When faced with dynamic and uncertain environments, organizations must be adept at finding, recognizing and utilizing expertise within their systems.

Most organizations attempting to implement a more reliable system work to create a culture that respects expertise and a structure that allows decision making to flow to those who have the most useful knowledge about an unfolding situation (Roberts et al., 1994). However, there are two difficulties that can arise from this strategy.

First, when organizations create a culture of deference to expertise, low status individuals may become overly reliant on ‘the experts’ and abdicate their own responsibility for monitoring and contributing to the safety of the situation. This becomes particularly dangerous if the perceived expert is not, in fact, terribly knowledgeable. The second danger of deference to expertise arises when individuals and groups mistake general expertise for situational knowledge. That is, especially in very dynamic and complex situations, it is unlikely that one person holds all the necessary knowledge to managing that situation, regardless of their years of experience or training. There are simply too many moving parts and changing realities. When individuals equate general expertise with situational knowledge they create and rely on unrealistic expectations of those ‘experts’. We saw this repeatedly in our interviews. In both the following quotes, the respondents deferred to their more experienced colleagues despite the fact that they (the respondents) had more knowledge about the specific conditions in which they were working:

It seemed like [my boss] was experienced . . . knew what he was doing . . . You could just kind of tell by the way he acted . . . he was competent and I felt comfortable working for him because it seemed like he was experienced . . . and that might have been part of the reason why it took me a little while to say that, you know, this isn’t right.

Respondents were particularly unlikely to speak up when they deferred to those with expertise and when they *lacked* confidence in their own experience level:

I didn’t feel comfortable about it, but I had the least experience of anyone out there. I had the least experience of any of the permanent staff in those fuels, in that area, in that topography. So I was like, ‘It doesn’t look great, but what do I know? I’m really pretty ignorant here.’

But our findings show a positive side to this. Because the culture has such respect for expertise, when firefighters viewed someone as *inexpert*, they seemed more likely to speak up. That is, skepticism of another’s expertise appears to trigger voice. For example, having viewed what he perceived to be a very chaotic and poorly managed fire camp, this respondent did not hesitate to make his concerns known:

I walked down there and there's gambles oak over your head within 50 feet of this one area with grass up to just over your ankle . . . If this thing blew up there's no *!#** safety zone. [I said,] 'You don't have the time to do this stuff, people!' And I started needling the crew boss and the squad bosses on the crew that I was with . . .

Not surprisingly, raising issues with a superior was somewhat more complicated and sometimes, though surprisingly rarely, status played an inhibiting role. Previous studies have also found evidence of this deference to status when, for example, lower status flight crew members neglect to voice concerns to a pilot (Helmreich & Merritt, 2000). Interestingly, however, our study does not suggest that this reticence arises from a respect for status or power per se, but rather arises from the assumption that those in power have a greater understanding of ongoing events. So, although we found a few examples in which individuals remained silent because they perceived themselves as being powerless over decisions, it was more often the case that individuals remained silent because they presumed that the high status person was a situational expert. That is, they assumed that their boss saw the same cues but did not view them as a threat to operations. On the other hand, when firefighters perceived their boss as being incompetent, they were more likely (rather than less likely) to voice concerns (albeit, in a more diplomatic way than they might express with peers or subordinates):

I was in a very odd precarious position where I was constantly telling my boss what to do and trying not to point it out to everybody on the planet that he has no clue. Because I didn't want to erode anybody's confidence they had in him by pointing out that he really wasn't in tune with the [fire] plan, and I am.

In most cases therefore, even with superiors, perceived competence rather than status or fear prevented voice and perceived incompetence often triggered it. Thus, while deference to expertise appears to play a very important role in safety insofar as decision-making is transferred to those who have the most situational expertise, it must be tempered with a willingness to speak up, even in the presence of respected experts.

Seeking disparate viewpoints

Another theme that arose from the data and seemed to impact whether or not ongoing action was re-evaluated was the extent to which individuals actively *sought out* discontinuities or cues that all might not go well. By searching for or making themselves easily available to disparate information

and perspectives, individuals were presented with more triggers to re-evaluate the situation. Because fire is so complex, changing and flaring up in one area before dying down unexpectedly, firefighters need to continually check their assumptions with others or find ways to update their information. Our findings revealed many instances of this kind of behavior. By actively seeking out disparate perspectives on the situation, individuals interrupted their own thought processes and actions, creating space to re-evaluate the situation and potentially take different actions. This is illustrated in the following quote:

I wanted to get input from the other people too, to see if there were any different views on it to see if anybody had a different idea because you have a wealth of experience there, so I like to use it all . . . even when I go out to look at the piece of land that we're going to be working on, I'll ask for other people's opinions, you know, this is how I think we should do it. What do you think? And somebody might say, 'Well yeah, that's a good idea, but maybe we should do this.'

Our respondents noted repeatedly that this went beyond simply listening to the voiced concerns of others. Rather, they noted that superiors and leaders, in particular, had to *actively* seek out disparate knowledge, and that this required the recognition that they did not, on their own, hold all the requisite information:

[You have to] stimulate debate. You encourage it. And you don't enter in as a decision-maker. You don't start throwing your knowledge around. You don't want to say, well, I did so and so and such and such and blah, blah, blah because that just shuts them down. What you want is to encourage an open discussion of it among the technical experts, among the people who have knowledge. And if you can do that, it's amazing what you can find out.

Sometimes, actively seeking out different perspectives allowed individuals to gather local knowledge, not otherwise available and generally considered critical to developing a safe fire plan:

I really like going into warehouses, the local unit warehouse . . . the people who have the bad knees because they fought fire there for 25 years . . . the dozer operator that's overweight now and cranky . . . these are the people that have been there for years and years and years and have seen fire burn over time, have probably seen fire in the same drainage . . .

In contrast, many of the stories in which action continued along a disastrous path included examples of individuals who not only failed to seek out other perspectives, but deliberately made themselves unavailable to those perspectives, sometimes physically:

He kind of disappeared from the radar. He got there and my suggestion to him was to get to a high point so he could see what was going on, and he ended up down in the bottom somewhere where you couldn't even talk to him.

[The operations team] just . . . made their plan. Matter of fact they came in early [to] make it . . . you come [to] the meeting and everything's on the board all done and they're off doing something else. It's all on purpose. And so everybody [else], logistics people and transportation people and myself come in and . . . there's no input into the plan . . . and they would have their get-togethers in a trailer, with just enough seats for them, you know, so, nobody else could sit down.

Enablers of seeking diverse perspectives

The difference between those who sought out and made themselves available for disparate information and those who did not appeared to stem from differences in their attitude about themselves with respect to fire. Many respondents as well as their co-workers held the view that fire was so unpredictable, so inherently unmanageable that it could not ever be fully understood. As a result, they questioned and tested their own assumptions and expertise. This perspective appears to reflect what Weick has referred to as 'an attitude of wisdom' (1993) or the knowledge that they 'don't fully understand what is happening right now, because they have never seen precisely this event before' (p. 641). Importantly, it is a situated humility, arising not out of personal insecurities, but rather from deep experience with the uncertainties of fire. In other words, individuals might be perfectly confident in their own skills and abilities, but still maintain a belief that *the job* is so uncertain that no matter how skilled they are no-one can be fully knowledgeable under the circumstances. As one very experienced firefighter put it:

As old as I am and as experienced as I am in relationship to these large fires, the next fire that I walk into initially I won't know anything. So I'm not going to come in there full guns blazing on the go.

In contrast to humility exhibited in incidents with good outcomes, in many of the situations resulting in bad outcomes, the leaders exhibited a striking

hubris with respect to their ability to understand and predict the situation. In describing a fire that burned past the planned area, one respondent relates her difficulties with a forest ranger who insisted that he knew what the fire would do and discounted the evidence that the area was overly dry and ready to burn:

[The ranger] had the attitude that 'I know best' . . . He had some folks up on this line and he's telling people . . . 'You know, this is going to hold. They have safety zones up there. This isn't going to burn and it's going to be fine.' It was like, 'Well, no, those areas you don't want to put people up there. It's going to burn. Everything is cured.' Sure enough, I think it was within the next day or so it did burn [out of control].

This kind of hubris often seemed to arise out of early successes. Recall that situated humility is context dependent. It is not a personality trait but rather an attitude towards the task at hand. While it is likely that some people are more predisposed than others towards this attitude, there was also evidence that it could change over time. In particular, as individuals became more and more confident in their ability to manage a particular fire, they became less vigilant and less likely to seek out new or different perspectives on the ongoing set of actions. For example, one respondent recalls her feelings right before a fire that should have been stopped earlier, escaped:

It had gone really, really well, until the time when it had those first couple three spots . . . up to that point, I was starting to really relax because I thought, 'Well, yeah, . . . it is going okay.'

When individuals related to fire in a humble way, they recognized that their own personal abilities were limited. This recognition seemed to drive a search for additional knowledge and expertise. In almost all the cases in which an individual initiated a change in the ongoing action, he or she had demonstrated an attitude of wisdom and sought out other perspectives. This process was conspicuously absent in cases ending in disaster, particularly when they started with success.

IV. Social factors that moderate the process of redirection

The picture we have presented thus far seems rather simple. Individuals appear to be more likely to reassess an ongoing set of actions if they or others have voiced concerns and/or sought out disparate perspectives and both these processes are hindered if individuals have too much confidence in themselves

or others. However, the evidence reveals a more complicated story. Even if ongoing actions are reassessed, activities *still* are not always halted or changed in the face of likely disaster. This phenomenon is much closer to classic escalation of commitment in that at this point, individuals have reassessed the situation and *decided* to continue. However, while undoubtedly this decision is influenced by publicity, accountability and irrevocability as suggested by escalation researchers (Staw & Ross, 1987), our findings suggest two other factors that appear to specifically moderate the re-evaluation process: institutional pressure and individual interests. Both of these contribute to a bias towards ongoing action.

Institutional pressure

We found evidence suggesting that an agency's, institution's, or key constituency's goals can exert a strong influence on firefighter behavior. In suppression fires there is a tremendous pressure to do whatever it takes to put the fire out before it causes too much damage. This is evident in well-publicized disasters in which firefighter safety was subordinated to the goals of protecting structures and property. A more recent source of problems has arisen from prescribed fire plans (plans to burn certain areas) and goals to use more naturally occurring fires to burn out areas that need thinning (fire-use fires). As with most organizations, the establishment and pursuit of plans and goals result in enormous pressures to act in a timely manner even when conditions may be less than ideal. In the following story, the respondent recalled a situation in which institutional pressure resulted in an escaped fire, despite participants having seen the warning signs:

We probably could've added things up. It's pretty windy. We can't get the extra two engines we want. This is the hardest burn unit we're going to do. There is the most at risk. We didn't get the calculator out and do the math on that and said, 'This is probably not the one or the day to do it.' Because we knew, if we didn't do it, we were going to fall behind and probably not going to be able to do all the units. And so there was that kind of overt pressure to get the whole thing done. 'The whole region's kind of hoping you'll get this done.' And we let that influence us . . .

When individuals feel pressure to move forward despite dangerous conditions, they tend to do so with blinders on, neither looking for nor accepting input from others. In other words, the institutional pressures keep momentum going, suppressing potential interruptions.

Individual interests

A second factor that appears to moderate the social processes described earlier is the fact that humans don't always act in the best interests of the organization. This is not to say that individuals deliberately undermine the system, but rather, their own personal interests sometimes affect their judgments, resulting in a bias towards continuing action. We found multiple examples of situations in which individuals' desires for certain outcomes (e.g. start the job on time, maintain control of the team, have a 'successful' fire) coincided with a belief that they would achieve those outcomes. In many of these cases individuals experienced some early success despite cues that the fires might be tricky. This heightened their sense of possibility – that they would obtain their goals despite the known obstacles. Unfortunately, they quickly turned that sense of possibility into a *probability* and acted accordingly, even when events began to turn against them. This was most obvious in statements like 'We can pull it off' or 'We can hang in there'. What started as a wish became wishful thinking and expectation:

And he says our intentions are to have a 10,000 acre fire. And I said is that number arbitrary . . . Well, he said, when it gets to 10,000 acres, I've instructed the boys to put a line down both sides where it turns into grass and stop it right there. So I said, okay, that would be quite a feat in that environment because it's extremely steep. And I said does your staff feel that that would be successful? He said they thought they'd give it a good try. But he said that's what I want. [This fire later escaped.]

As with the political pressure, wishful thinking affects the process of reassessing action in two ways. First, it dampens the search for alternative perspectives and second, it blinds people to incorporating these perspectives into a changed plan of action.

In many cases, even when their thought processes were interrupted, these individuals simply maintained a sense of optimism. They re-evaluated the situation with a bias towards action and as a result, their plans did not change. In this example, a line officer asked a fire analyst for his perspective and then proceeded to ignore the information he was given:

And the first stage of the wildland fire implementation plan, you ask, basically, 'Is everything okay?' Well, it wasn't, but our Line Officer, at that time, really wanted a fire-use fire, and just kind of put the blinders on and says, 'Well, then we'll keep it on our side of the river.' And I said, 'You're not going to keep it on your side of the river.' And I said,

‘This is not a good bet. This should not be a fire-use fire.’ He said, ‘I’m going to make it a fire-use fire.’ And it was. And within two days, it was on the other side of the river . . .

Discussion

Given the inherent uncertainty of managing organizational safety in complex, high-stakes and dynamic environments, organizations must be able to respond, adjust and adapt. However, organizational systems are enacted by individuals and once engaged in ongoing activities or plans individuals often fail to redirect their actions. Many pressures, both psychological and contextual, create momentum. Overcoming that momentum cannot be achieved merely through structural or procedural processes because it is, at least in part, a social process. By drawing on case examples of firefighters in actual field operations, we found evidence to support this line of thinking.

Individuals and groups are more likely to redirect ongoing activities if they have an opportunity to stop and make sense of their situation and operations, particularly in real time. Sensemaking is unlikely to occur unless individuals are in some way interrupted. Two social processes – giving voice to concerns and seeking alternative perspectives – appear to trigger such interruptions. Once interrupted, actors appear to make unfolding situations ‘sensible’ and in the course of this re-evaluation, they cease or change their original action. Figure 1 portrays a model of our findings.

As Figure 1 shows, two factors, situated humility and skepticism of expertise, are antecedent to the social processes by which interruptions are created. When individuals respect the situation as inherently unknowable, that is, when they exhibit situated humility they are more likely to be open to and seek out disparate perspectives in an attempt to bolster their understanding of the situation. When individuals recognize the limitations

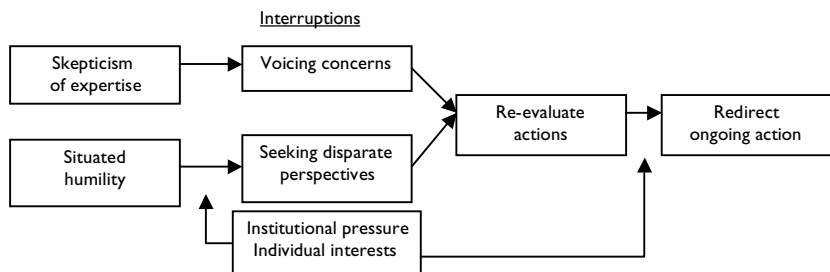


Figure 1 Overcoming dysfunctional momentum

of expertise, they are more likely to voice their own concerns. If, however, they are overly deferent to expertise or they assume that high-status experts have full situational knowledge they tend to remain silent. They assume that the 'experts' know what they need to know and are acting on that knowledge. These two processes, seeking disparate views and voicing concerns each create a kind of interruption. Under many circumstances, these socially constructed interruptions prompt individuals and groups to re-evaluate the ongoing action, which can result in deviations from that action. However, two other factors moderate this process. Institutional pressures and self-interests also lead to a bias for continuation. These can prevent individuals from seeking disparate views (thus preventing sensemaking and re-evaluation) and they can also corrupt reorientation. In the latter case even having re-evaluated the situation, individuals fail to redirect their actions.

Our model highlights the criticality of interruption and re-evaluation as a mechanism that enhances system safety in the face of dynamic uncertainty. If action continues uninterrupted, individuals are less likely to reflect. This can mean that they fail to make critical adjustments and changes to ongoing action. Interruption is critical to this process because it provides an impetus for re-evaluation. Interruptions, whether mental or physical, contribute to a break in ongoing action, stalling momentum. Consistent with the sensemaking perspective (Weick et al., 2005), interruptions create an endpoint or bracket for experience, providing an individual with a definable chunk of activity upon which to reflect. Interruptions provide opportunities for individuals to step back and make sense of current and past activities. Furthermore, interruptions tend to bring to the forefront what was previously only background noise. John Dewey notes that routines and habits get 'turned inside out' (2002: 182) when they are interrupted. That is, when routines or ongoing actions are interrupted individuals become more conscious of what was entailed in those routines. Specific elements of the routines or actions are revealed. Interruptions, therefore, provide the space for making sense and allow for re-evaluation and reorientation of action.

In high-risk endeavors, there are often planned opportunities for reassessing situations (Waller et al., 2004). In fire management, for example, crews reassess the fire each morning and evening during 'briefings' using a check list of specific elements (e.g. weather, resources in use, fuel conditions). Similarly, scheduled transitions and handoffs often include reassessment. In healthcare, for example, clinicians frequently re-evaluate patients during shift changes, handoffs or transfers between care-givers or departments. The problem is, of course, that most critical problems don't arise conveniently during or just before these periods. Therefore, in very dynamic or uncertain situations, individuals can not rely on planned interruptions. Rather, they

must interrupt themselves in order to make space for sensemaking and re-evaluation.

Contributions to the literature on organizational safety

While systems views of the organization provide insights into key structural and procedural elements that affect organizational safety, our findings reinforce the critical roles played by social factors and sensemaking. To maintain vigilance and adaptability, organizational members must continue to ask 'What's the story here?' so that they can determine 'now what': continue to act as they have been or change their course of action? This sensemaking is influenced by individual beliefs (e.g. about the expertise of others and the predictability of the situation) and individual interests.

Also, by focusing on the *processes* of safety we have taken a step towards expanding our understanding of organizational safety beyond those elements at play *within* a system. One of the criticisms of HRO theory is that it tends to focus on the internal workings of an organizational system and the interplay between different system practices (Perrow, 1994). Aspects of the environment are considered insofar as they create uncertainty to which the system must respond. However, specific causal mechanisms arising from the environment are seldom addressed. Similarly, while individual activities are critical to the functioning (or failing) of a system, individual interests are not generally an explicit part of the equation. In his review and discussion of safety literature, Perrow (1994) calls for increased attention to the fact that even systems designed to be highly reliable exist within institutional environments and are enacted by individuals who are driven, at least in part, by their particular and unique individual interests. We found that these two factors (institutional pressure and individual interests) created a bias for action that interfered with the social processes of interruption either by preventing interruptions or by corrupting the re-evaluation.

Finally, our study suggests that organizational safety is situated. It arises not just from particular processes or procedures, but from the ways in which individuals and groups relate to events as they unfold. Safety appears to hinge not just on how or whether we can control an uncertain environment, but also on how we relate to that environment. As we saw with the firefighters, those who related to unfolding events with humility and active inquisitiveness were much more likely to update and adjust their understanding of events, incorporating information and cues that might otherwise have gone unaddressed.

Contributions to the literature on voice

Our research also contributes to the literature on organizational voice. ‘Voice’ or speaking out about issues is a social process (Dutton & Ashford, 1993). Previous research has suggested that individuals’ beliefs about the interpersonal context influence their willingness to speak out (Dutton et al., 1997). In particular, they are less likely to voice their concerns if they feel that by doing so they may be punished or experience negative reactions from others in their groups (Blatt et al., 2006; Edmondson, 1999). This belief can create a norm of silence within an organization (Hirschman, 1970). However, we identified a previously unexplored aspect of interpersonal context that also plays a role: the perceived expertise of others involved. When individuals believe others to have relevant expertise, they may be less likely to voice their own concerns or observations. This is particularly likely when self-confidence (with respect to their own expertise or experience) is also low. Moreover, skepticism of others’ expertise, especially leaders, was a factor *driving* voice. Thus, it appears that silence arises not only out of fear, but also out of deference to expertise.

Future research

Several avenues for future research arise from this study. We explored a number of social processes that appear to impact organizational safety by creating psychological and physical interruptions to ongoing action. This is not to say, however, that these are the only social processes involved. In fact, our data hinted at several others. For example, when people become pre-occupied with a specific threat they may fail to re-examine their assumptions about other possible sources of danger. By focusing on one stream of action, they are, by definition, blind to other foci. In one of the most extreme incidents reported to us, a respondent reflected on his preoccupation with logistical matters just before he, his crew and several other crews were overtaken by an escaped fire. Although all survived, they were forced to huddle in their individual fire shelters while the flames passed over them three different times. Looking back on the events right before the escape, the respondent recalled:

So I’m logistically trying to supply the division with the tools to do the job which pulled me away from why I was there, and that was the fire. And so I’m not making the connection anymore . . . between fires. And what was actually going on was the spot fires [were] gaining mass over

time . . . It was gaining position . . . And then what happens is the way the atmosphere comes together in this plume domination, it really accelerated vertical energy. And they were able to coalesce. And so it developed a momentum. And it just screamed out of there. And I missed all of it. I missed it. I missed it because I was trying to co-ordinate tools, you know, so that everybody had a tool.

In this case, the ongoing action created a corresponding stream of thoughts and concerns that were increasingly unrelated to what was actually happening then and there with the fire.

Second, our study focuses primarily on the steps of an individual process. However, as La Porte points out, high reliability organizing requires 'a level of personal engagement and attentive behaviour that is unlikely merely on the basis of formal rules and economic contracts' (1996: 64). The tendency of individuals to engage in the steps we explored will be determined, in part, by the norms, shared perceptions and informal traditions that make up an organization's culture (LaPorte, 1996). For example, situated humility may be reinforced and even constructed from a culture that rewards failure-preventing activities (Rochlin & Vonmeier, 1994). Cultural norms may similarly affect individual beliefs about expertise, the importance of diverse perspectives and the need to re-evaluate situations. Furthermore, while we have explicated one important set of actions that contribute to organizational safety, these actions emerge from and determine organizational beliefs and structures. Insofar as safety is 'a property of the interactions, rituals, and myths of the social structure and beliefs of the entire organization' (Rochlin, 1999: 1557), it may be useful to explore how action and culture reflexively determine safety.

Finally, in his call for more constructivist social approaches to understanding organizational safety, Rochlin (1999) argues for research that views safety as an expression of agency as well as structure, of positive action and not just the avoidance of accidents. By focusing on sensemaking we offer to future researchers a framework of exploration that views safety as actively constructed. Sensemaking is the mindful engagement with unfolding events (Weick, 1993; Weick & Sutcliffe, 2006), and as such, is a means for creating safety as much as preventing failure.

It is our hope that future research will both test and expand the model of organizational safety that we have suggested. For example, future studies might consider in what ways interruptions help curtail thoughts and actions that are becoming more and more tangential to the events at hand (as in the example above). Moreover, while we propose that fire management is similar to many other organizations concerned with creating safety in complex and

dynamic environments, these insights should be investigated in the context of other organizations and industries. We hope to expand this model to include contexts such as emergency rooms and industrial teams.

Conclusion

Much of the literature around organizational safety and reliability emphasizes system-level structures and processes and says little about the micro-level, social processes necessary to enact organizational safety. Furthermore, much of the literature focuses on how to maintain action in the face of interruption. Here, we were interested not in how systems maintain action, but rather in how individuals redirect ongoing action. Evidence from this study suggests that interruption becomes a critical driver of safety insofar as it triggers sensemaking and re-evaluation. Furthermore, rather than waiting for environmental factors to interrupt action (by which time it is usually too late), organizations will be safer to the extent that the individuals involved create their own interruptions by articulating their concerns and by actively seeking out disparate perspectives on the events underway. These findings should be useful to researchers studying organizational safety in many contexts, including industrial and medical. We hope also that this study will serve as a springboard to additional research considering the micro-social mechanisms through which organizational safety is achieved.

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Notes

- 1 Given the many environmental uncertainties over which firefighters have no control (e.g. wind, terrain, etc.), the question might be raised how reliable or safe could they hope to be? In fact, this varies quite a bit among different teams and individuals. However, differing outcomes are rarely attributed to a sudden shift in the wind or

drop in temperature. These are normal uncertainties. Rather, performance arises from individuals' and teams' abilities to *manage* the process of firefighting. They can not change the wind, but they can be alert to changes in it and respond with different approaches to the fire. They can not change drought conditions, but they can use less drastic ignition methods. In fact, as with many other organizations struggling to become more reliable, most of the problematic events in fire result less from uncontrollable natural conditions and more from teams failing to notice, interpret and respond to those conditions.

- 2 The deployment of fire shelters is considered an extreme measure and is treated almost as seriously as the loss of life, requiring extensive and formal inquiries into fire management operations.

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