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Case Study

Self-Designing Safety Culture: A Case Study in Adaptive Approaches to Creating a Safety Culture

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ABSTRACT: This Case Study represents an ongoing commitment on the part of the United States Forest Service to improve safety culture. It focuses on the contribution of a small group of leaders and researchers who engaged in interdisciplinary research and application of theory to create active dialogues in the agency and to change the organization's approach to accident and incident investigation. This small group of practitioners and researchers recognized that an organization's reaction to events shapes culture and influences workers to perform in certain ways. Commonly this influence is positive. It can benefit production, collaboration, communication, mission completion, and even safety. However, it can adversely affect trust when, with perfect hindsight, we point to individual failures and label them as causal. This case study will explore three significant pathways that led to an examination of safety culture, a challenge of contemporary models of safety culture, a recognition of the importance of language, and ultimately to interventions designed to create a safer work environment; the creation of a principle-based approach is designed to increase the capacity of the organization and workforce to learn, engaging the workforce in dialogues designed to challenge existing beliefs and the creation of an agency response to accidents and incidents that focuses on context rather than blame.

KEYWORDS: *safety culture, adaptive approaches, dialogue, reaction to events, learning, cultural change*

INTRODUCTION

The United States Forest Service (USFS) is made up of approximately 30 000 employees who perform duties ranging from wildland firefighting to scientific research. As the lead federal agency in natural resource conservation, the Forest Service provides leadership in the protection, management, and use of the nation's forest, rangeland, and aquatic ecosystems. Through the implementation of land and resource management plans, the agency ensures sustainable ecosystems by restoring and maintaining species diversity and ecological productivity that helps provide recreation, water, timber, minerals, fish, wildlife, wilderness, and aesthetic values for current and future generations of people. Since its inception, the Forest Service has been committed to wildland firefighting operations and stands as the nation's largest wildland firefighting organization. This is a high-risk occupation that absorbs over 39% of the total budget. Forest Service personnel are distributed across the United States. There are 154 national forests, 20 national grasslands, and 5 research and development laboratories in the USFS system.

The United States Forest Service (USFS) became well practiced in responding to fatality accidents when, during a period spanning 23 years, the wildland firefighting community suffered over 400 line-of-duty fatalities (between 1994 and 2012). The ensuing accident investigations were formed in response to guidance that overtly stated, if an accident occurred, then someone had made a mistake. This resulted in a series of accidents that blamed the fallen firefighters for their own deaths and brought litigation and adverse judgment of Forest Service programs by the media, public, and in some cases the US Congress.

The aftermath of accidents also brought laser focus on issues of firefighter safety and risk management, but the agentive nature of the investigation reports resulted in defensive posturing within the firefighting community, and information sharing began to suffer. The Forest Service was facing a crisis of trust as field personnel lost faith in the investigative process. Key changes to the investigation process were needed to repair the rift.

The need to develop a safety culture appeared as a recommendation following a fatality investigation in 2008. The accident report noted, "Assumptions and expectations (assumptive behavior) replaced verification and follow-up by fire leadership. This resulted in a lack of understanding of critical safety communications and positive feedback from all fire line personnel."[1] Subsequently, leadership assigned part of the creation of a safety culture to the Office of Innovation and Organizational Learning (IOL), which was headed by the author of this paper. Duty demanded that we conduct research to understand what a safety culture was and how we could influence such a diverse population. There were two immediate challenges in assessing safety culture in the Forest Service. The first was establishing a common understanding or meaning of

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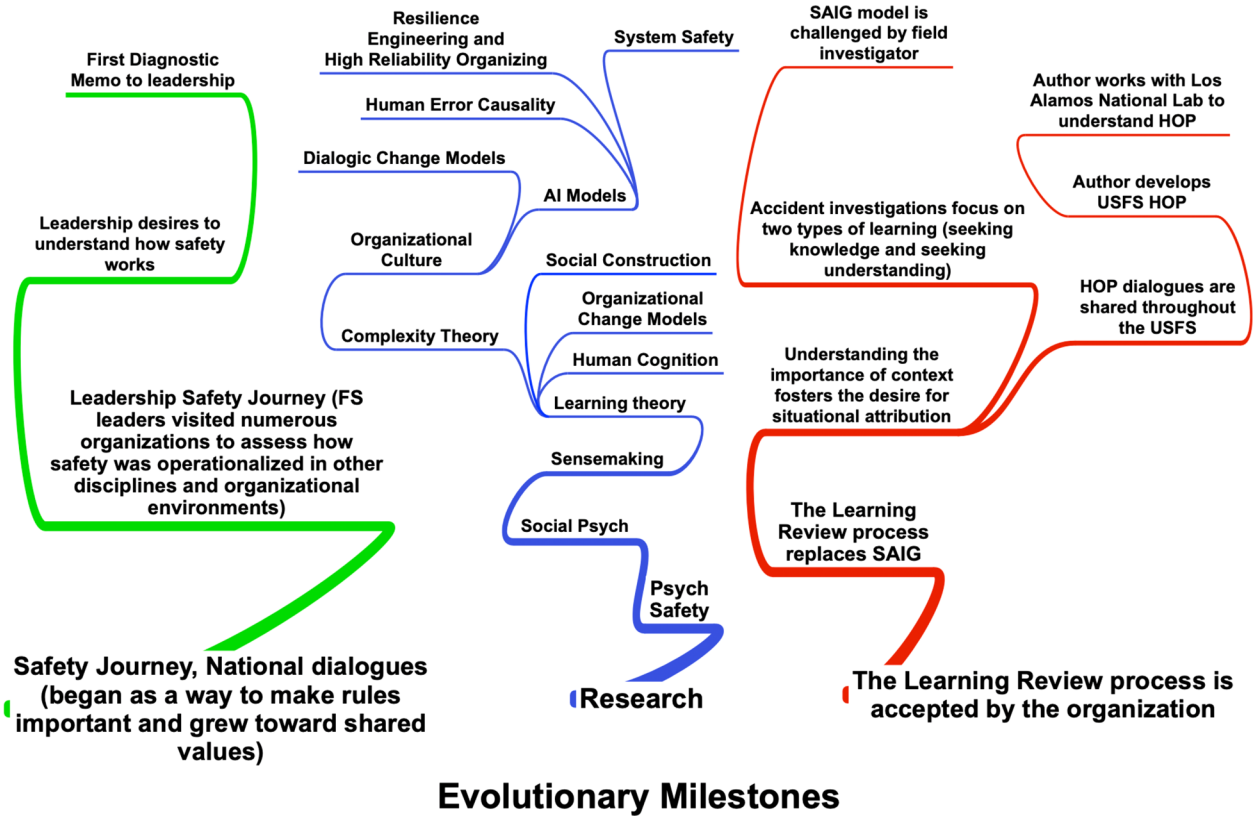

Figure 1. Evolutionary milestones.

the term "Safety Culture." The second was how to make the elements of a safety culture appealing to a wide audience of Forest Service personnel.

Early research began with trying to understand how safety culture could be defined. Even the term *safety* was viewed differently by the various hierarchical segments of the organization, as well as by the different divisions of the Forest Service. No single definition of safety culture, or even safety, could be found within the agency or in the academic literature. Leadership had a fundamentally different view of risk and safety than did field personnel. Leadership focused on traditional risk and error management processes and, following that model, demanded that the field "take no unnecessary risks." The field saw risk as part of the job, under the mantra, "there is no zero-risk option." Field personnel committed to the creation of safety at a personal level and felt that any risk they accepted was necessary to complete the mission. This position was frequently challenged in the traditional accident investigation reports, which increased the divide between leadership and the field.

MAPPING THE FOREST SERVICE JOURNEY

IOL was created as a research, development, and application group and was an integral part of an organization-wide learning journey. This journey had several milestones, each of which represented experiments in learning. Over time, initiatives began to coalesce, as the pathway itself evolved. In hindsight, it became clear that there were three mutually supportive learning pillars that occurred concurrently: the leadership *Safety Journey*, academic research, and the evolution of the organizational response to incidents and accidents (see Figure 1).

The leadership of the Forest Service engaged an outside contractor to help them understand their operational strengths and weaknesses. This generated a diagnostic memo to leadership, which moved them to self-reflection. A forward-thinking senior leader (John Phipps) led a movement to create the Leadership Safety Journey. This grew into leadership-led dialogues centered on workplace safety and cultural change.

Senior leadership organized and led these national dialogues, which included the entire workforce of 30 thousand USFS employees. IOL was involved in shaping some of these dialogues and in assessing the exit survey feedback that followed each dialogue. The first dialogue included a plea from leadership that the field agree to follow lifesaving rules that we called the 10 Standard Firefighting Orders:[2]

1. Keep informed on fire weather conditions and forecasts.
2. Know what your fire is doing at all times
3. Base all actions on current and expected behavior of the fire.
4. Identify escape routes and safety zones, and make them known.
5. Post lookouts when there is possible danger.
6. Be alert. Keep calm. Think clearly. Act decisively.
7. Maintain prompt communications with your forces, your supervisor and adjoining forces.
8. Give clear instructions and ensure they are understood.
9. Maintain control of your forces at all times.
10. Fight fire aggressively, having provided for safety first.

This plea was tied to an espoused leadership goal of becoming a "Zero Fatality" organization. These early dialogues began with senior leaders expressing their vulnerability as a genuine and somewhat effective way to demonstrate their commitment and resolve. The second series of dialogues responded to exit survey feedback and shifted to a more cooperative tone. These dialogues began to understand the challenges associated with

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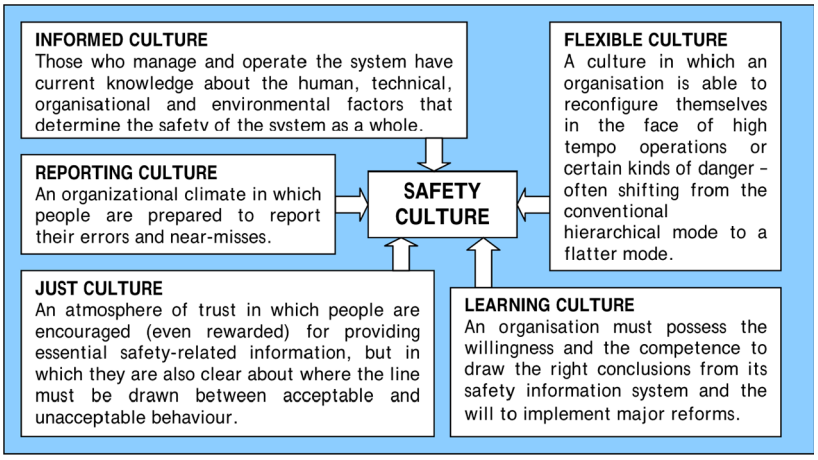

Figure 2. Components of safety culture, based on Professor James Reason's "A roadmap to a just culture: Enhancing the safety environment".[13]

Life Saving Rules (LSRs) and the problems with the zero-fatality mantra. Finally, in the last dialogues, LSRs became principles, as the feedback from field personnel made compelling arguments regarding the complex nature of the work environment. The field began to show signs of understanding the shared safety goal that leaders were advocating. The result of these conversations continues to emerge, as made evident by the Chief of the Forest Service recognizing the importance of psychological safety earlier this year.

Both formal and informal organizational dialogues shifted in tone to embrace the concept that prevention of accidents results from learning. Placing a priority on learning made it clear that information was the currency of safety, and it was important to facilitate the flow of information. Anything that could interrupt or impede the flow of information had to be intentional and purposeful. This changed the way the organization responded to accidents.

Shortly after the release of the diagnostic memo, the Serious Accident Investigation Guide (SAIG), which was the agency-accepted accident investigation process, was challenged. The SAIG directed investigators to underestimate situational influences (the role of the environment) and overestimate dispositional influences (the inherent qualities of the individual). This led directly to fundamental attribution error.[3,4] Investigation reports, under the SAIG, focused on individual error or violation, which often cited the actions of individuals as causal. The cost to the agency was a demonstrated lack of willingness on the part of personnel to share information, which was ascribed to a lack of trust in both the system and leadership. It should be noted that this is a common artifact of traditional investigation processes.[5,6] Acting independently, the author departed from the SAIG to create investigation reports that deviated from the tradition of norm of blaming those closest to the work. This initiated a critical shift in the organizational response to accidents and incidents and ushered in the development of the Learning Review as a replacement for the Serious Accident Investigation Guide (SAIG).

The willingness of senior leadership to replace the SAIG with the Learning Review process was a major step in building trust in the system of incident reviews. It provided tangible proof to the field of leadership's intent and dedication to learning. The most recent acknowledgment of the importance of creating psychological safety further demonstrates leadership's commitment to improving safety culture in the Forest Service.

Simultaneously, the author facilitated organization-wide dialogues that challenged the traditional models of accident investigation that lead to blame, often referred to as attributive models of accident causality (Human-Organization Potential or HOP). These dialogues were conducted in every Forest Service Region. These two initiatives were well received by leadership and resulted in the creation of the office of Innovation and Organizational Learning (IOL), a research, development, and application group attached to the Rocky Mountain Research Station.

These three seemingly independent initiatives, leader-led organizational dialogues, HOP dialogues, and new modes of investigation, were supported by academic research. IOL also sponsored Masters and Doctoral programs for personnel to increase research capacity.

RESEARCH TO UNDERSTANDING THE TERM *SAFETY CULTURE*

Academically, safety culture is also not unilaterally defined.[7] "Due to its interdisciplinary nature, the concept tends to be of interest to different academic disciplines, from social sciences such as sociology, psychology and anthropology to more technical disciplines such as maintenance, reliability engineering and systems safety. Consequently, the lack of a unanimous consensus on the concept is understandable."[8] It became clear that there was no single definition of safety culture that could serve as a guideline for the myriad of perspectives or operational missions in the US Forest Service. Recognizing these challenges, IOL moved toward an examination of safety culture history. Specifically, we asked where safety cultures were flourishing. We noted success in nuclear power and aviation, so these two professional areas became a research focus.

IOL turned to Professor Edgar Schein's work to add to our understanding of the qualities of culture. The essence of culture is defined by Schein as "a pattern of shared assumptions that the group learned as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think and feel in relation to those problems."[9] Though not specific to safety culture, this definition helped us to develop a model for our research, which facilitated understanding the multiple, conflicting ideas and deep assumptions surrounding safety culture.

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The term *safety culture* is prominent in the nuclear literature following the Chernobyl disaster. "After the Chernobyl accident in 1986, the International Nuclear Safety Group (INSAG) introduced the concept of safety culture. Today it is a common and widely used concept in the nuclear industry and in other safety conscious industries."[10] Following this accident "people began to detect and attach a great deal of importance to the critical role of human and organizational factors."[11] Process safety principles emerged as organizations and academics attempted to describe ways to create or enhance safety cultures beyond nuclear power.[12]

IOL recognized the existence of process safety management principles and saw the importance in an approach tethered to agreed upon values stated as principles. This was referred to as *doctrine* in the Forest Service, which began to rewrite rules as principles. Doctrine was actively pursued by the fire organization.

Professor James Reason's work was an initial cornerstone for one of the first accident investigations that departed from the traditional process. This approach was improved drastically by incorporating the work of Professor Sidney Dekker.[5] Professor Reason's work was recognized as a comprehensive synthesis of safety culture theory. The Global Aviation Information Network (GAIN) published a roadmap to a just culture in 2004 based on Reason's work. It contained a synopsis of Reason's, components of a safety culture, which posited that safety culture was made up of five subcultures: reporting, flexible, learning, just, and informed cultures (see Figure 2).[13]

This appeared to be a reasonable roadmap for the creation of a safety culture. Focus group dialogues and interviews explored the existence of these subcultures in the wildland fire organization and were facilitated to evaluate the efficacy of each. This led to the conclusion that we exhibited strong characteristics consistent with a flexible culture. However, we were deficient in the other four key areas.

Focus group discussions designed to explore just, reporting, learning, and informed subcultures pointed to three key areas of concern:

1. The sense in the field that the informed culture already existed, and additional work was not required in this area.
2. The sense that we do not need to report our errors and near misses, as they will make us look bad in the eyes of our peers and seniors.
3. Just culture dialogues specifically pointed out a lack of trust in the fairness of traditional investigations and that drawing a line between acceptable and unacceptable behavior was not a simple issue.

■ POSTACCIDENT VULNERABILITY

There is a great deal of safety literature focused on accident investigation and its tie to safety culture.[14−17] Investigation results are heralded as opportunities to learn and thus prevent accidents.[6,18] The author observed that Forest Service accidents and the subsequent investigation reports were emerging as culture shaping events.[19,20] As a result, intense study of investigative processes and techniques was initiated by IOL.

Traditional investigations focused on the identification of errors and the failures of individuals. Causal attribution models were built on the assumption that the individual closest to the accident was personally or individually disposed to error, the *bad apple* theory.[6] The approved Forest Service instruction, called the Serious Accident Investigation Guide, supported this supposition, "The causes of most accidents or incidents are a result of failures to observe established policies, procedures, and controls."[21] Accident investigation reports responded with the conclusions that pointed to the cause of accidents and incident was an accepted deviance from rules, regulations, policies, guidance, and controls. In summary, there was a belief that safety could be maintained through formal written instruction. This guidance culminated in the "10 Standard Firefighting Orders" (a form of life saving rules designed to prevent accidents).

Investigations, interviews, and focus group dialogues challenged the application of static rules and processes offered by leadership, which field personnel believed only fit specific situations. Innovation was believed to be critical for successful outcomes and to satisfy both social and organizational demands. The field focused on the key principle of resilience in the face of uncertainty, which they felt helped them prepare for and adapt to changing conditions common on the fire ground.

The field reaction to traditional accident investigations was one of resistance. For example, the South Canyon Fire of 1994 resulted in an accident investigation that examined the loss of 14 fire fighters. The results of this investigation was a statement that field personnel failed to follow the Ten Standard Firefighting Orders. The oversimplification offered no context and was openly resisted. The human factors specialist assigned to the investigation refused to sign the final report. Instead he facilitated the first USFS Human Factors Workshop (1995). This workshop posed very different questions regarding fatality events, which would go unanswered for the next 13 years.[22] The workshop published recommendations that went far beyond the organization's admonishment to "follow the rules". The recommendations began to explore ways to better organize wildland firefighting operations. Three key recommendations demonstrated the systemic approach and the challenge to the *status quo* adopted by the participants in the workshop:

- Contract to have organizational experts evaluate Fire and Aviation Management (F&AM) and propose ways to reorganize it into a high reliability organization able to function at a high tempo during fire season.
- Contract to have Crew Resource Management course materials adapted to wildland fire crews and teams.
- Contract to examine all the fire orders, situations, etc., to determine if they can be simplified and prioritized. Are any of them absolutes? Can what's left be followed and still put out fires?

Forest Service leadership did not act on any of the recommendations of this Human Performance Workshop.[23] Some of the recommendations were fulfilled by fire leadership personnel, who acted independently and without support of the organizational leadership.

Further division between leadership and the field grew with an oversimplification of risk and accountability. Leaders within the Forest Service insisted that field personnel "take no unnecessary risk". At first blush, this seems like a reasonable request, and it was certainly grounded in the best intentions. However, the field could not comprehend the request in the context of operations. Any risk could be seen as unnecessary in hindsight. Especially when that hindsight view follows an adverse outcome event. Additionally, every risk accepted by field personnel to complete an assignment seemed necessary at the time. The 10th Standard Firefighting Order demonstrates the conundrum, it reads, "Fight fire aggressively, having provided for safety first." Whether an act or decision is aggressive enough or safe enough is often only

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known when a mission is over. When the outcome was viewed as a success, innovations were rewarded; however, the same innovations when associated with adverse outcomes were judged to be errors and could bring punitive action under the heading of accountability.

Leadership's simplistic hierarchical definition of accountability decreased the willingness of field personnel to share information. The definition used by leadership was rooted in compliance. From a psychological perspective, compliance can be viewed as "conformity that involved publicly acting in accord with an implied or explicit request while privately disagreeing."[2] This implicit belief that field personnel were only begrudgingly following direction, increased the level of insistence that the rules be followed. The construct of accountability is also seen as "answerability" and can be connected to trustworthiness. In this form, it is most often seen as hierarchical, where leaders come down to hold the *untrustworthy* actor accountable for their decisions and actions (often independent of context). A deeper understanding was needed, and IOL developed a leadership dialogue around a four-axis accountability model: hierarchical, upward, peer-to-peer, and self. This model opened the door to discuss alternative values surrounding accountability and ultimately led to the Chief of the Forest Service creating a video, wherein he said, "following an accident or incident, we are *all* accountable to learn everything we can from that event."

The difference in perspective surrounding risk also distanced the organization from our goal of creating a safety culture. Risk management is often seen as the identification, evaluation, and prioritization of risks followed by a coordinated and economical application of resources to minimize, monitor, and control the probability or impact of unfortunate events or to maximize the realization of opportunities.[24] At an organizational level, this is usually condensed in a formal process that involves assessment of the probability and severity through calculations, which commonly result in a "go/no-go" decision. Risk perspectives change as the "go" decision is made and workers are committed to assignments. Focus group discussions and interviews with firefighters indicated that risk was less of a mathematical and more of a personal process. Field personnel offered that personal risk was defined by answering the question, "what risk am I willing to accept to meet the demands of the system or mission?" The answer to this question was context specific and was based on the individual's perception of risk, coupled with their sense of reward and individual propensity to take risk.[25]

Accepting some level of risk is necessary to complete all work assignments—there is no Zero Risk option.[26] IOL explored what the author labeled as a necessary exposure paradox: The conundrum for field personnel to determine what is aggressive enough and what is safe enough in the midst of complex work, where outcomes cannot be fully predicted. The paradox exists as innovations, which are perceived by the practitioner(s) to be safe, rather than simple executed processes. The outcome is not fully realized until the action has been completed, and in a complex work environment, outcomes are not fully predictable.

There was an incongruity between the assumptions held by leadership and those held by the field with regard to the creation of safety in fire operations. For the field, traditional command and control dominated the espoused way to create safety. However, safety was also believed to be associated with individual actions and abilities. Leadership saw safety as a function of compliance with rules, regulations, policies, and procedures but were often blind to learning about the network of safe interventions that were created each day in the field through sensemaking and innovation.

Mapping the disparity in the assumptions held by leadership and the field helped us to understand the context surrounding what was initially perceived as a resistance to change. We realized that the lack of shared language, variable sense of risk, belief in accountability, and inequitable justice contributed to an inability to agree on what would make the system of work safer. After an accident, these differences became more pronounced as the "factual" reports ignored context and cited failures to comply with rules as. A shift in basic assumptions was needed before we could proceed.

Shifting Assumptions through Application of New Investigative Techniques. The initial research and investigations conducted to highlight context were well received by leadership and field personnel. This reaction pointed to a critical need to change the process of investigation. The causal relationship reported in most accident investigation reports had lacked the context that field personnel knew existed; the "facts" presented in reports could not be understood without the context that surrounded them. Accident investigation emerged as a key leverage point for learning and shifting assumptions. Both leadership and the field wanted to know how to avoid catastrophic outcomes, and as a result, both were poised to learn. Developing context to understand human actions and decisions became a central point to help both the field and leadership understand each other and what learnings were important.

The first new-style USFS investigation was conducted 2007. This investigation was ordered on a fatality helicopter crash, the *Norcross Fire Fatality Investigation*, which was formally assigned to the National Transportation Safety Board (NTSB). Forest Service Director of Occupational Safety and Health convened a serious accident investigation team (SAIT) to investigate the incident, and the author of this paper was assigned as the chief investigator who transferred field investigation to the USFS Team. I built a team that included a subject-matter expert in ground-fire helicopter operations (the Forest Service helicopter operations specialist) and a professor of human factors and ergonomics from the University of Southern California. The NTSB directed the team to answer the binary question, "Was this accident mechanical, or was it human-caused?"

Forest Service guidance was limited to the 2005 Serious Accident Investigation Guide (SAIG), which called for a simple explanation of cause: "A causal factor is any behavior, omission, or deficiency that if corrected, eliminated, or avoided probably would have prevented the accident."[21] Once the team determined that there was no mechanical failure, the only cause available was human error, per the SAIG. The team, however, could identify a number of problems in the system, all of which could be considered causal, but none of which stood alone as a single cause. There also seemed to be an amalgamation of related conditions that supported the decisions and actions and contributed to the outcome. No decision was blameworthy.

As a result, the team created a list of conditions that set the stage for the actions of the participants. This was an early recognition, by the USFS, that human error does not stand alone as the cause of accidents. Other factors have to be in play for the error to have consequence. Each of these factors could be causal, but each had other conditions that influenced the actions of participants and the outcome. Unknowingly, the team had discovered an inherent complexity in Forest Service operations.

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This pointed to a network of causality that has to be in place for an accident to occur.

The result of this approach was profound in its ability to begin to unify leadership and the field. Field personnel embraced the context that was presented in the report. Leadership immediately recognized the importance of interrelationships between multiple causal factors and accepted the construct that the people were doing the best they could in a challenging situation.

Norcross became a starting point for greater discussion within the Forest Service. The shift was small enough that ardent opponents did not recognize its significance, but great enough that many people were left asking more questions. These questions resulted in genuine inquiry replacing simple judgment of action. Norcross went beyond the traditional accident investigation process by including context and human factors in the main body of the report. This report challenged traditional causal attribution and supported the concept that an accident could happen *even when no one did anything wrong*.

The Learning Review was created to include both analytical and sensemaking approaches. Applying analytical approaches was still recognized as applicable to investigating mechanical failures through methodological reduction of the system into component parts. The analytical frameworks help us to acquire knowledge, which is unique to the mechanical aspects of our system. Knowledge, in this case, is bounded by observing fundamental elements of the system in the absence of the environment. It is reductionist simply because it separates the elements from each other, in order to understand their function as discrete parts of the system.[27] This is important, even critical when we are looking at mechanical failures (e.g., the failure mode of an aircraft engine).

Sensemaking was developed to *understand* the role of the environment, including how the environment can influence human behaviors. Sensemaking is built on two main components, the creation of a complex narrative (one that includes multiple perspectives) and the creation of a network of influences map. In concert these two components serve to map systemic conditions and place them in the context of the event. The Learning Review shifted our response from blame, to understanding why it made sense for people to do what they did.

Some of the questions that were asked in the 1994 Human Factors Workshop were finally being addressed. The organization began to move toward deeper inquiry that would not be satisfied by simple causal attribution. The need to find the person who made a mistake was replaced by the desire to understand why it made sense for the individual to do what they did. This began to open a door to develop a new process for investigation. The approach also highlighted the importance of creating an atmosphere of trust, or psychological safety, in the organization. In other words, psychological safety means team members feel accepted and respected within their current roles which fosters their ability to provide feedback, criticism, or advice.[28]

■ THE CHANGE IN ORGANIZATIONAL DISCOURSE

Arriving at a point where safety culture was potentially part of our organizational dialogue represented a significant shift in the way many levels of the organization defined and understood risk, safety, failure, error, accident causality, and accountability. Leadership met this challenge and entered into a safety journey that involved engaging the entire community of Forest Service personnel in open dialogues.

Due to the myriad of definitions and meanings we found it difficult, if not impossible, to directly address *safety culture* and to change it for the better. However, the IOL team realized there were key elements that could lead toward a culture of safety. Central to this was understanding that "information is the currency of safety"[29] and that information sharing or, better said, *learning* was central to success. Our initial response was to explore the area of trust through the review of accidents and incidents, a process we later called the Learning Review,[27] which served as a platform to introduce the agency to the concepts of psychological safety and social psychology.[30] Learning is not simple, and we found it only takes place when the learners are willing.

Certainly, one measurement of a successful safety culture is the degree of compliance with rules, regulations, policies, and procedures. However, the difference between work as designed and work as performed can be significant. When the system delivers the expected, simple compliance works; however, safety culture is much more than simple compliance in complex adaptive systems.[10,31] "When complex technological systems, such as aircrafts and nuclear power plants, move from routine to nonroutine (normal to emergency) operation, the ... operators need to dynamically match the system's new requirements."[32] Professor Reuben McDaniel proposed that organizations develop sensemaking, learning, and improvisation skills to manage work in complex adaptive systems.[33] This doctrinal approach is consistent with many qualities of the subcultures described in the safety culture literature.

Military aviation is particularly good at developing crew capacity for sensemaking, learning, and improvisation. This observation was supported by the personal experience of the author, who was a military pilot, and compelled IOL to examine safety culture in military aviation. Compliance with guidance and prescription were recognized as accepted ways of doing business. However, there was latitude built into the military aviation system to depart from prescription in situations that are beyond prediction or the ability to be addressed through routine checklist driven responses.

This was particularly evident in Naval aviation where the Naval Air Training and Operating Procedures Standardization (NATOPS) General Flight and Operating Instructions always include a phrase that embraces the recognition of the need to depart from prescription:

"[NATOPS] provides the best available operating instructions for most circumstances, but no manual is a substitute for sound judgment. Operational necessity may require modification of the procedures contained herein. Read this manual from cover to cover. It's your responsibility to have a complete knowledge of its contents."[34]

Building doctrinal boundaries into policy/guidance recognizes what field personnel already know, that not all rules can be followed in all situations, and rules cannot be developed to meet every possible scenario. Incorporating flexibility into guidance builds credibility in the guidance and the trust in the organization. It also opens the door for information regarding innovations. This helps to create a willingness to follow instruction and guidance, as well as to provide feedback.

Aviation represents a functioning safety culture, for many reasons. Pragmatic understanding at all levels of the organization with regard to operational guidance is one, which facilitates information sharing and real-time learning. Perhaps of equal importance is the recognition on the part of flight personnel that there is significant risk in all aviation operations. This

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recognition creates a sense of positive unease or "constructive paranoia".[35] Research within the US Forest Service uncovered a related, yet opposite, phenomenon we called "normalization of risk",[19] which occurs when risk is accepted as a normal part of operations. In this case, risk is gradually accepted as normal, and the system drifts toward risk tolerance.[25] The concept of "normalization of risk", or its opposite, constructive paranoia, may be a key part of understanding why safety culture works in certain communities of practice and why it fails in others.

When people begin to do a dangerous task, like driving, they perform as novices and are predisposed to following rules, regulations, policies, and procedures in a rote. This quickly changes as they learn the system and where they can take shortcuts without adverse outcomes. Driving habits become efficient, and thoroughness is traded for this efficiency as expertise increases.[36] A gap between work as imagined (designed) and work as performed emerges.[37] This system works for two reasons—the experienced people in the system see unsafe (novel) situations and react to create larger safety margins, and the safety barriers (defenses in depth) designed into the system work. The longer a system appears to be safe, the greater the confidence in defenses and personal action becomes, and the larger the gap between work as imagined and work as performed becomes.[25]

"Studies have compared Americans' perceived ranking of dangers with the rankings of real dangers, measured either by actual accident figures or by estimated numbers of averted accidents. It turns out that we exaggerate the risks of events that are beyond our control, that cause many deaths at once, or that kill in spectacular ways—crazy gunmen, terrorists, plane crashes, nuclear radiation, genetically modified crops. At the same time, we underestimate the risks of events that we can control ("That would never happen to me. I'm careful.") and of events that kill just one person in a mundane way."[35]

Risk normalization can be seen as a normal human trait in high-risk, low-frequency work environments, like wildland firefighting operations. "It is clear that the human being is seen as a strategist, a planner, who attempts to optimize, not minimize, the level of risk-taking for the purpose of maximizing the benefits—economic, biological, and psychological—that may be derived from life. Taking risks greater than zero is rational."[38] Normalization fosters a situation where accident probabilities are underestimated.[25] The longer the system appears safe, the greater this underestimation. This undermines a major driving force for the creation and acceptance of safety culture that is measured by the faith workers have that rules will keep them safe.

This may be central to the success of a culture of safety in the nuclear industry, where compliance is seen as a significant defense against catastrophic outcome, and innovation is only required to respond to unpredicted operational anomalies, before there is an undesirable consequence. The nuclear industry cannot afford failure, for obvious reasons. The awareness of hazard is consistent and reinforced in the system as a fundamental of corporate learning. Although rare, examples of failures serve to remind operators and leaders of the inherent dangers. There is a willingness to comply with guidance and to innovate as needed, which is directly associated with the recognized severity of adverse outcome events.

The two examples of effective safety culture, aviation and the nuclear industry, point to an enduring belief by workers that the system is *not* safe. The normalization of risk is replaced with constructive paranoia, and the awareness and attentiveness of operators is a natural byproduct.[25]

In situations where we demand compliance, there is an attempt to manage behaviors through regulation and enforcement. This often results in a crisis of trust, like the one that the US Forest Service faced. Implementing a safety culture in that atmosphere was viewed skeptically by the workers. The Forest Service is not alone. Many industries attempt to coerce compliance with mixed results.

■ IF NOT SAFETY CULTURE, THEN WHAT?

In organizations where the sense of probability of adverse outcome is supplanted by a sense of safety, and risks are normalized or rationalized, coercing compliance and masking it as safety culture may not work. A common ground between the desire for simple compliance and the need for innovation must be found. Returning to Reason's safety culture model, a significant pathway was indicated by focusing on the creation of a set of principles designed to increase the capacity of the organization and workforce to learn. Learning is somewhat easier to accept in diverse populations. Within the US Forest Service, the concept of learning was widely received with positivity. Learning was consistently seen as a tool that can improve safety and productivity.

The phrase "learning organization" was posited by Peter M. Senge. According to Senge, organizations will achieve remarkable results when each employee shares his knowledge and learns from others. These organizations "will find out how to capture people's commitment and how to foster the ability to learn at all levels of the organization."[39] Shifting focus from developing a safety culture to a learning culture offered significant benefits. Learning was virtually unquestioned as a means to improve work and safety. Measuring the organizational resolve to learning was considered much easier than measuring safety culture. The Institute of Nuclear Power Operations (INPO) work on culture supported this observation, and this garnered more support from leadership to shift the focus to developing a learning culture.[40]

Complex systems typically deliver uncertain results. In complex systems the ability to predict is limited and ambiguity common, and sensemaking, learning, and innovation are required to create safe outcomes. These are qualities that center on experimentation as the outcomes are never fully predictable.[33,41] These organizations require institution-wide learning processes to facilitate adaptation and sharing of lessons learned. From a leadership perspective, learning can be easily seen as a preventative strategy. From a field perspective, learning is an acceptable alternative to agentive or punitive organizational responses. Organizational responses to adverse information must be adjusted to incorporate the principle of learning.

In the Forest Service, IOL experimented with learning and presented it as a synthesis of information, rather than a transactional teacher/student model. We looked at all levels of the organization as a body of learners. Leadership and field personnel each had learning roles in the model presented by the Learning Review. Multiple learning products were created for groups that had different learning needs. When the Learning Review products were presented to leadership as a new formal response to fatality events, the result was warmly received. The field personnel who came in contact with the process also welcomed the results.

Five Roll-out meetings to present the Learning Review process were held around the United States. Each meeting

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included diverse groups of supporters, as well as those who initially resisted the concept. Law Enforcement, Human Relations, Environmental Safety & Health specialists, and leadership were all invited to a series of meetings held around the nation. The first meeting was based on a well-planned agenda designed to present, what we thought was, a great idea to these different groups. The first 2 h of the meeting demonstrated we had underestimated the deep assumptions and strong attachment that some had to the old way of conducting investigations. The meeting was heading for a catastrophic failure. Following a break and a quick discussion between meeting planners, we dropped the agenda and focused, instead, on the creation of working principles of accident investigation. Each group was able to voice their desires, and we were able to recognize the commonalities, rather than argue about differences. The result of the first meeting was a list of 12 principles.

The remaining meetings focused on refining the first set of 12 principles. By the time we concluded the last meeting we had 5 working principles that served to connect the different groups together around the Learning Review. The 2017 Learning Review Guide listed these principles as follows:

1. Forest Service employees are well-intentioned and work within organizational systems to meet the expectations of leadership and the demands of the system.
2. Accidents and incidents can be a byproduct of the uncertainty inherent in complex systems.
3. Enhanced accountability:
    a. Prior to incidents, leaders and managers are responsible for knowing how the organization functions, and at this point, traditional forms of accountability can be valuable.
    b. After the incident, prevention is based on learning, and the organization becomes accountable to learn all it can from the event.
4. Actions and decisions are consequences, not causes. Following an event where the outcome was a surprise, the goal is to understand why the action or decision made sense to those involved at the time. This goal is based on the premise that "If it did not make sense to them at the time, they would not have done it."
5. Conditions shape decisions and actions; revealing these conditions will aid the agency and agency personnel in understanding how to recognize, change, and react to conditional pressures.

The meaning of "learning" was being refined for the organization. Rather than focusing on what to do or what not to do, the focus of learning shifted to understanding the environment, making sense in the moment, devising innovations, and then sharing the what was learned.

This approach was consistent with Senge's model of organizational learning and involved personal mastery, shared mental models, system thinking, building shared vision, and team learning.[39] The approach allowed us to incorporate concepts of psychological safety from Amy Edmonson, vulnerability from Brené Brown, sensemaking from Reuben McDaniel, diversity from Scott Page, culture from Edgar Schein, learning from Peter Senge and Daniel Kahneman, just culture from Sidney Dekker, social construction from Kenneth Gergen, resilience from David Woods, Erik Hollnagel, and Nancy Leveson, dialogue from William Isaacs, and HRO from Karl Weick. What emerged was an interdisciplinary approach to learning, as well as "learning how to learn".

The interdisciplinary approach that emerged also pointed to new ways to evaluate the efficacy and existence of positive shifts in culture. Three main metrics became clear, the *first* was the language used by leadership and the field to describe work, regardless of whether the outcome was positive or negative. The new language was less agentive and focused on understanding the work environment. Rather than simple cause and effect relations, the new language was context rich and reflected the newly penned principles mentioned above. *Second*, the organizational response to accidents and incidents changed to reflect the fundamental principles listed above. Reports focused on close examination of the context that surrounded decisions and actions, and the process was designed to develop learning products for multiple audiences, rather than a simplistic report designed to inform organizational leadership about "failures". *Third*, leadership's focus and demands changed. This was exemplified in the Safety Journey National Dialogues. The dialogues evolved in tone and content from coercive (leadership insisting on compliance with basic rules) to constructive (leadership began to ask questions without predetermining the answers) and, finally, to communicative (listening was a shared quality and led to understanding).

The interdisciplinary research application helped shift the emphasis from safety culture to learning culture, by showing the relationship between learning and safety. One espoused value that emerged in both dialogue and guidance was "Prevention through Learning."[27] Learning was a value that was found to be nearly universally accepted as critical to both safety and improvement of work. *Learning was defined as a shared value within the organization, which is defined by the needs of the learners and takes place before, during, and after all work events. Learners are encouraged to ask questions and rewarded for humble inquiry. Following an adverse outcome event, all members of the organization are accountable to learn all they can.*

■ CONCLUSION

Creating a safety culture is a fluid construct and must be uniquely designed for each environment or part of the organization, and its evolution is likely never finished.

Reflecting on the successes and failures of the experimental interventions described above, a spectrum of cultural interventions emerged as a plausible approach to improving safety culture. Our experience indicated that cultural change could take place through systemic interventions; however, the interventions were not necessarily effective when unilaterally applied. Complex systems, which frequently deliver the unexpected, responded better to interventions that accept uncertainty. Whereas, complicated, more predictable systems responded well to process-related interventions. It was also evident that, regardless of the level of complexity, all components of the system responded well to relational leading, valuing learning above simple punishment, and creating psychological safety.

This pointed to different needs for different parts of the organization. Some parts of the organization demonstrated higher degrees of predictability, and correspondingly, they responded well to compliance with procedures and command and control leadership models. The extremes of the spectrum were thus defined by the level of predictability or uncertainty inherent in the system. The more complex the system the greater the uncertainty, and at this end of the spectrum interventions had to be based on accepting innovation, learning in the moment, and developing the capacity of the members of the

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organization to make sense of conflicting information. Accepting the uncertainty associated with complex systems also means that there is a need to accept that developing learning capacity is never over as the system is not static.

The Forest Service experience indicates that cultural interventions can result from an interdisciplinary approach to understanding organizational functions and needs. There does not appear to be a recipe for success in creating a safety culture, as each organization will have to self-design a network of interventions to suit their specific operational, social, and organizational needs.

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Notes

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This paper is based on the author's experience, researching safety culture and building a team to create a safety culture within the U.S. Forest Service (USFS). As such, it represents a case study in experimentation, failures, and successes. Insights and observations reported in this paper are the direct result of over 100 formal and informal interviews, exit interviews following group discussions, a historical review of accident investigations, and focus group discussions with firefighters and senior leaders, many of which occurred following fatal accidents involving wildland firefighters.

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