The Transformation of Accident Investigation From Finding Cause to Sensemaking

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Abstract

This dissertation introduces a network of practices that transformed the United States Department of Agriculture (USDA) Forest Service accident investigation. This is an exceptionally important topic to the Forest Service for several reasons. First, the Chief of the Forest Service has committed to creating a "zero fatality organization," and the organizational response to accidents is believed to play a significant role in achieving this goal (Tidwell, 2013). Second, the previous method of investigation created second victims; these were workers who were blamed or cited as having caused the accident. This outcome was not intentional; however, the process demanded the identification of cause, and cause was translated into blame. Third, the linear traditional method of investigation was overly simplistic and eroded the confidence that the workforce had concerning the organization. Fourth, the fatality accident rate for wildland firefighting operations was "unacceptable" (Tidwell, 2013)—the wildland[1] firefighting community lost 1,075 firefighters between 1910 and 2014 (this number does not include off duty deaths). Under the traditional method of accident investigation, the accident rate increased.

This dissertation uses case studies to show the interweaving of organizational and individual journeys, each of which began with the strength to inquire and to challenge assumptions. The case studies show how constructed realities, including my own, were challenged through inquiry and how four practices emerged that supported sensemaking at both the field and organizational leadership levels of the organization. The application of a single one of these practices can improve investigative processes; however, as the last case study demonstrates, together they form a network that transformed Forest Service investigations.

There is also a realization that this was—and in many ways—still is a learning journey. The process of change spanned eight years and the journey is not yet complete. In that eight-year period, the Forest Service has accepted new processes for the review of accidents and incidents. The Learning Review process, which replaced accident investigation, embraces four practices designed to engage a wide range of participants through targeted learning products. Where we used to construct accident investigation reports to place the incidents behind us, these new learning products are designed to invigorate communities of practice to discuss, question, and explore the incidents in ongoing dialogues that add perspectives, knowledge, and experience in order to develop applicable lessons learned.

I did not begin my journey as a social constructionist and only discovered this orientation once I was well along the path. I realized almost all the organizational and individual transformation practices represented the application of constructionist concepts.

[1] Wildland firefighting is differentiated from structural firefighting. Wildland fires burn in forest and grasslands, whereas the term structural firefighting is specific to houses and other manmade structures.

Acknowledgements

When I first began to write this dissertation I did not understand that the transformation I was about to expose was as much about me as it was about the USDA Forest Service. I learned that change can be so incremental as to be imperceptible. I also learned the importance of an emerging sense that we should be less drawn to finding specific solutions to problems in complex systems. Instead, the focus of our effort should be to facilitate collaboration across hierarchical boundaries through dialogues that result in creative pathways that fit specific situations. Then we must dedicate effort to reflect—only in reflection can we learn.

I want to thank those who helped conceptually, spiritually, and technically; that list would likely fill the page. It would not be reasonable to continue without mentioning some of the most critical members of the cast of people who supported me and contributed to this dissertation: Crista, my wife, best friend, and editor; Heather, my dear Canadian friend and conceptual cohort; John, for challenging my ideas and being really clever about it; Ben, for beginning his journey with me and for trusting; Curtis, Heath, Wayne, Gwen, and Jay for helping to bring ideas into practice; Sidney, for lighting a fire that would not go out; Todd, for changing me and changing with me; Diana, for holding my feet to the fire; and every person who challenged my ideas, ran small experiments, provided feedback, and otherwise agreed or disagreed—we have all come a long way.

There is a greater thanks that must be offered—to my mom—she already knows what she did to inspire the drive that I needed just to get this thing done!

There is another group of people who deserve the utmost recognition: the lost friends who, in the pursuit of their dreams, were with me at dinner one night and were gone the next. Alongside them are all the other firefighters, frontline operators, and pilots who have been made into second victims by a process from which justice cannot be achieved and learning is of little or no interest. In particular is Pete, whose story about the Thirty-Mile investigation was etched into my mind!

May the only things we bury be “root-cause” and “blame.”

Introduction

Navigating this Journey

This journey can be described as moving through three main areas of study: The first focused on how the USDA Forest Service arrived at the process delineated by the Serious Accident Investigation Guide (SAIG). The second addressed academic research that could be used to frame a different approach to investigation. The third was an empirical exploration of the application of theory and practice during actual investigations. These areas of study are viewed through the lens of social construction (Chapter 10).

Why was transformation needed? Traditional models of investigation ignored the voices of participants, communities and leaders in an effort to resolve the event to a single narrative that made sense to the team. Narratives, while espousing to be unbiased, offered a plausible explanation that was represented as a factual report. The stories created with this methodology were more linear, plausible and less messy than the complex events they were modeling (Dekker 2002). Often lost in the process were valuable perspectives that offered the context needed for those outside either the event or the investigation to make sense of the event themselves. In this way, learning became explicit rather than transactional. Facts were offered through reports that drew conclusions, made assumptions and defined cause in terms of the judgment of actions and decisions, leaving little room for individual or group sensemaking. However, when the conclusions of these investigations were deemed to be a surprise or well outside the societal construct of reality, they were challenged. This dissertation recounts a series of such challenges.

The case studies explored in this dissertation evoke questions that could not be explained or understood using the formal guidance or training that had been provided to me in the SAIG or formal accident investigation courses. Together the training and written guidance formed a process that advocated the search for what was absent in the system, environment or people involved in the incident. This approach avoids consideration of positive aspects of individual performance explored through positive questions (Whitney, Trosten-Bloom, & Cooperrider, 2010). “Positive questions are keys to treasure troves of best practices, success stories and creativity” (Whitney, Trosten-Bloom, & Rader, 2010).

Each accident posed unique issues, concerns, and opportunities to the assigned teams, which required conversations that explored contextual influences, adaptive responses and interrelationships. Actions were not seen as negative contributors to the event, rather they were explored as the best-fit solutions that were developed by well-meaning individuals. The conversation that emerged in the investigative teams was open, unscripted dialogue, largely absent the prescriptive causal guidance of the SAIG. An

alternative approach to investigation emerged that was based on inquiry and advocated for sensemaking and learning to take place at multiple levels of the organization.

My Evolving Role in Accident Investigation

My initiation to the investigative process came through military investigation training, where I was fully accredited in the organizationally approved processes common to traditional accident investigations. It was in the Coast Guard that I received my first experience with investigation, a helicopter fatality. In these early years, I worked diligently to bring individual flare to my creations and created factual reports (stories) that I fervently believed would result in corrections and fixes to specific problems uncovered during investigations. I also believed that my work would prevent the next accident. There were a lot of statistics that seemed to point to success and served to reaffirm that the process was working. Moreover, I liked what I did.

Some context is therefore needed to understand why I became compelled to move away from this path and to influence change in the way we conducted investigations. I was a Coast Guard pilot for 10 years and during that time, I knew three people who died in aircraft accidents. The Coast Guard touted the best flight safety record in the military, and statistics proved that our accident rate was better than most aviation operations. I believed that it was our actions and layered defenses that were delivering these great results and that the investigation process produced many of these defenses.

After the Coast Guard, I joined the Forest Service as a lead plane pilot. Lead plane pilots fly low-level over fires; establish tactics; scout routes for heavy air tankers loaded with fire retardant; and then guide them to the drop zone, in support of ground fire operations. In many ways, this world seemed similar to that of the Coast Guard, yet I would learn that it was also strikingly different.

I was hired in May with a report date of August, along with another pilot. I would learn later that the original solicitation asked for one pilot, but there had been a mid-air collision that took the life of a lead plane pilot, and thus the hiring official selected a second applicant. Clearly one of us was replacing this fallen comrade.

The national average for aviation fatalities for the Forest Service was 2.5 human losses per year. The wildland fire statistics were telling a very different story than the Coast Guard statistics. The investigation reports that resulted from each fatality unilaterally pointed to errors on the part of the flight crews. As my experience grew, I began to realize that it had to be more than just pilot error—something did not fit.

Each aviation fatality represented a friend to me; these were people with whom I had dinner one night and were gone the next day. Each accident report listed error as a cause,

often implying or openly stating that it was human caused and citing a friend at fault. I knew these people and at a deep level, I knew it wasn't as simple as error on their part. After all, I had made mistakes, and I was often doing the same things they were. This fueled a fire within me to learn more, which ultimately grew into a desire to change the system.

People were being blamed for accidents as though they had intended to crash, and in that way the process was creating second victims (Dekker, 2013). I saw good people—suddenly by the virtue of a report—transformed into flawed, error prone, risk-takers that clearly didn't have the right stuff. One day they were upheld as heroes for successful outcomes like saving a section of fireline, or a house, or in one case an entire town. Days later, these same people could find themselves labeled as “rogue pilots” (Kern, 1999) simply because they were involved in an accident.

My interest in safety became more intense with each fatality and after a few years I became a regional aviation safety manager (RASM) and began to pursue accident investigation as a collateral duty. I completed several civilian courses, which augmented my military training, and following a seemingly short apprenticeship; I was assigned as the chief investigator to the Norcross helicopter fatality accident. The incident would become pivotal to my own growth, as well as that of the Forest Service.

I went to the incident armed with all the latest techniques, tools, and the most recent interagency SAIG. I was nervous about the new responsibility and carefully reviewed the guide contents to ensure that I could deliver the product that the organization desired. What I found was that the guide offered too much help—step-by-step instructions that, in some cases, provided conclusions before any information had been gathered. The guide asked me to view the incident from the perspective that everything is knowable, discoverable, or observable and all I had to do was to look harder, deeper, or more carefully to find the single truth, the error. The SAIG specifically recommended that investigators judge human actions and decisions as bad or good, largely based on the assumption that there had to be a violation or error for an accident to occur (Wiegmann & Shappell, 2003).

The Norcross accident investigation, as will be explained later, inspired me to inquire—as I began to inquire, the thin veil of realism began to rapidly fall away. What remained challenged almost everything I had been taught in accident investigation training, uprooted the principles of the interagency SAIG and shattered my belief in causality. The very nature of these reports was based on factual accounts, and I found myself challenging the very existence of facts.

Three realizations paralleled the recognition that there was more to accidents and incidents than simply finding facts. First, I realized that humans are naturally biased and that our biases influence what facts we find or create (Kahneman, Slovic, & Tversky, 1982;

Kahneman & Klein, 2009). For example, if I enter into an investigation to find error I will find it (Hollnagel, 2008). This guidance can be explicit as it is in much of the SAIG. Or it can be implicit, embedded in the language or in investigative process itself. The classic example of this is root-cause analysis, which implies that there is a single or root cause, a truth that can be discovered (Hollnagel, 2008; Dekker, 2006).

My second realization and break from the established norm was an understanding that time is a significant construction, and it can influence judgments in ways that can be harmful to learning. For example, time is easily accepted as a fact, which is reinforced by the way time is incorporated into modern society as a measurable entity. However, its role in the review of accidents can point to individual human failures and omit important context. Statements like 'it took five minutes' can be interpreted in a number of ways—they had five minutes; they only had five minutes; or they had five minutes! Simple time references, without context, can be meaningless and yet can result in judgments that affect the creation and interpretation of an accident report.

The third realization was that the same adaptations that result in success could also result in failure. Our culture often rewards outside-the-box thinking, which encourages innovation and independence. Our heroes are often those who buck the system and stand as outliers, seemingly ignoring organizational guidance or even laws. We often uphold these individuals as the change makers in our society, and their success is heralded. However, following an accident or failure we commonly overlook that the same innovation and adaptation can also lead to failure. If cause-effect exists, then each action should deliver the same effect—clearly actions delivered a myriad of outcomes ranging from success to failure. To me this challenged the basis of the cause-effect relationship, a central principle of traditional accident investigation processes.

My accident-investigation role evolved rapidly, as I began to recognize and capture these three concepts in three particular fatality investigations, starting with Norcross, then Panther, and culminating in Saddleback. Through the reports and dialogue that emerged from these investigations, Forest Service leaders realized the importance of learning from events and began to tie learning to prevention. The most significant shift in my role occurred when I was asked to develop a guide to replace the accepted interagency SAIG. The creation of what became known as the Learning Review required deep personal introspection and challenged deep assumptions within me.

Purpose

The purpose of this dissertation is to demonstrate how the USDA Forest Service accident investigation process was transformed from finding cause to sensemaking and learning.

Case Study Format

When I consider the personal and organizational transformation described in this dissertation, I only see it as a story. Human beings are story-telling creatures—a point Fisher (1987) makes when he bestows the title *homo narans*. Stories knit together settings, actors, events, pressures, conditions, and ethical considerations. As such they can be an intense medium to help people make sense of seemingly related or unrelated factors (Schrader, 2004). Understanding the importance of story to the evolution of the Learning Review and presenting it in writing was challenging. The linear medium of writing by its nature makes it difficult to describe non-linear events. It became apparent that the only way to describe this story was to explore the stories that contributed to the transformation.

The research methodology needed to explore inter-related and embedded stories must be capable of integrating event, activity, progress, and influences for a wide variety of individuals. Case studies emerged as a qualitative method to achieve this goal. "Case studies are a strategy of inquiry in which the researcher explores in depth a program, event, activity, process or one or more individuals" (Creswell, 2009, p. 13). This is strengthened by the idea that the objects of a case study must be "similar enough and separate enough to permit treating them as comparable instances of the same general phenomenon" (Ragin & Becker, 1992, p.2).

The structure of the case study method also allowed for the emergence of concepts that would result from the recognition of connections during the study and writing. This happened on several occasions during the creation of this dissertation. As Ragin & Becker (1992) state, "What is this case of will coalesce gradually, sometimes catalytically, and the final realization of the case's nature may be the most important part of the interaction between ideas and evidence" (p. 6).

Within the methodology of case study research there are provisions for the type of research conducted. "In case studies, sampling is purposive. They will be most instructive when they are methodologically based on open case-sensitive approaches like the narrative interview and ethnography" (Flick, 2009, p. 134). Each of the cases used in the dissertation fit this description. The selection of case study format for this dissertation also meets the intense guidelines for case study research described by George and Bennett (2005). These criteria are described in three parts (2005, p. 69):

> First, the cases must all be instances of… only one phenomenon. Second, a well-defined research objective and appropriate research strategy to achieve that objective should guide the selection and analysis of the…cases under investigation. Third, case studies should employ variables of theoretic interest for the purpose of explanation.

Case study literature clearly delineates a framework that is well suited for this study.

Mapping the Journey

This dissertation knits together a series of narratives and begins with a short history of the Forest Service, which is designed to provide context for the reader. This is followed by two chapters that explain the origin and concepts of technical investigation and the SAIG. Four cases (three Forest Service and one external) are used to demonstrate why transformation was needed and how it emerged in the course of this study. These cases demonstrate how sensemaking can be used to enhance learning and develop specialized learning products tailored to specific audiences. The case studies also demonstrate the emergence of the principle that accident prevention can take place without doing further harm to people.

Woven into the cases and their conclusions is the story of my personal journey from a realist to a constructionist.

Chapter 1: **The History of the USDA Forest Service** presents the way that information, beliefs and feelings merged in the national political landscape to shape a maturing land management philosophy. This chapter describes several ways stakeholders perceived the Forest Service. It also reflects how the agency views itself and the way employees tell its stories, thus introducing ways that they (we) construct its reality. Additionally, this chapter focuses on pivotal changes in the organization, which are reflected in progressions of language and perspectives. An apparent transformation from a simple model of land management to a more complex systemic view is described. This profound change from a realist perspective to a constructionist view was directly tied to the recognition that realist constructs are challenged by the uncertainty that emerges naturally in complex adaptive systems, such as forest ecosystems and the society that values and uses them (McDaniel & Driebe, 2005).

Chapter 2: **The Evolution of Accident Investigation** shows how early models of accident investigation seem to have shifted from a human centric view to a mechanical perspective and how this shift resulted in the construction of cause, creation of single truth, and epistemological self-confidence. This chapter exposes some of the major influences of this transformation. Consideration is also given to places where the realist perspective may be useful such as in the assessment of mechanical component failure. This material establishes a contrast between simple and complex systems and demonstrates how different approaches may be required for different situations.

Chapter 3: **The Serious Accident Investigation Guide (SAIG) – Pressure to Standardize the Approach to Investigation** depicts how realist values and beliefs about facts dominated attempts to prevent accidents and how they dominated the accepted investigation processes, the SAIG. Wildland fire is fundamentally a social activity, and it is

quite possibly one of the few work environments that is not significantly influenced by technology and human-machine interactions. Yet wildland fire is where socio-technical models/processes came to dominate investigative guidance through the SAIG. The chapter describes some of the safety improvements that resulted from this approach, as well as assumptions and beliefs that may have prevented people from learning from events.

Chapter 4: **The Norcross Case Study** was a helicopter fatality investigation on the Klamath National Forest in northern California. This case study represents the first departure from the espoused mechanical model of prevention. It avoided the traditional admonishment of participants (workers) by attempting to place actions and decisions in context. The study, while quite tempered, represented the first level of inquiry and challenge to the status quo and the SAIG.

Chapter 5: **The Panther Case Study** was a fire entrapment[2] fatality investigation on the Klamath National Forest in northern California. Panther was the first investigation to explore the concept of complex systems in wildland fire, which initiated a significant challenge to realist perspectives. During the investigation, it became evident that the cause-effect approach did not explain the incident in a way that could positively influence safety improvements in firefighting operations. The chapter explores how this investigation challenged the process (Serious Accident Investigation Guide or SAIG), as well as the epistemology of the traditional approach. The Panther investigation report opened a door, which led to the discovery of social construction and pointed out how the SAIG supported a realist perspective that was potentially harmful to leaning from events. This case study shows the growth of inquiry that initiated research, which ultimately challenged the way the Forest Service designed preventative strategies.

Chapter 6: **The Importance of Sensemaking Communities to Accident Prevention** uses an aircraft crash investigated by the National Transportation Safety Board (NTSB) as a case study to demonstrate how sensemaking naturally emerges, regardless of the desire of the organization to control or shape learning. It shows that even the most exhaustive and extensive factual report means nothing without the dialogue and honest inquiry of learners and that a questioning community forms relationships and connections that can exceed the limitations of even the most highly regarded investigative body (the NTSB); proving that relationships and connections can mean as much or more than the most complete technical report. The chapter recognizes that even the best ideas can only be carried forward through relationships—a community will try to heal itself despite the report quality or content. This exposes a shift in the role of the investigator beyond technical investigation to recognizing, understanding, and supporting community

[2] A situation where personnel are unexpectedly caught in a fire behavior-related, life-threatening position where planned escape routes or safety zones are absent, inadequate, or compromised. An entrapment may or may not include deployment of a fire shelter for its intended purpose. These situations may or may not result in injury. They include *near misses*. (National Wildfire Coordinating Group NWCG, Glossary).

sensemaking, which the chapter demonstrates increased the potential for accident prevention.

Chapter 7: The **Learning from Error** chapter explores the importance of recognizing workers as assets to safety, especially in a complex environment. It explores five specific categories of the traditional approach, including language, and demonstrates the impact these have on the investigative process and learning. Ultimately, the chapter challenges the subjective judgment of actions and decisions that frequently result from traditional approaches and shows the importance of moving to the creation of dialogue-based learning without judgment.

Chapter 8: **Agreeing to the Concepts of the Coordinated Response Protocol and Learning Review** introduces the concept of the Coordinated Response and Learning Review and how a small group of dedicated advocates gained alignment and acceptance of the concept. The chapter shows how discordant positions in the leadership, safety, and law enforcement communities were ultimately brought into dialogue and how that dialogue led to the recognition of common principles. The discussion will focus on the conceptual process as it was presented to the community of safety practitioners and other stakeholders. This agreement allowed for the experimentation that resulted in the development of the Learning Review process.

Chapter 9: **The Saddleback Case Study** represents the first attempt to use the Learning Review process concerning a tree-strike fatality on the Modoc National Forest in northern California. This case study represents the first experimental application of a process that ultimately became the Learning Review. This was the first time that the learning needs of the organization and the field were addressed in separate products. It integrated the major concepts developed to this point, even before a guide had been created. It also represented an example of a shift from the previously accepted realist models based on causality and mechanical process to an approach designed to make information available, so that all levels of the organization could engage in their own sensemaking.

Chapter 10: **Reflections on Transformation through the Lens of Social Construction.** This chapter presents key aspects of the dissertation through a constructionist lens. Each chapter is explored through the lens of social construction, which is followed by contrasting the current accident investigation model with a constructionist approach to the organizational response to incidents.

Chapter 11: **Summary and Conclusions.** This chapter summarizes the shift in five key assumptions that support traditional investigations and then introduces and explains five key practices that emerged from the research and experience chronicled in the cases explored in the dissertation. It also presents recommended areas for further research and personal conclusions and experiences, which led to my transformation during the course of the research for this dissertation.

Chapter 1: History of the USDA Forest Service

Introduction

> *…where conflicting interests must be reconciled, the question will always be decided from the standpoint of the greatest good of the greatest number in the long run. –Gifford Pinchot, first Chief of the United States Forest Service*

In the late 1800s the western world seemed almost obsessed with the control and exploitation of land and the resources of the planet. The culture of the New World influenced people to view the United States as a limitless source of essential materials, with timber among the most prized of them all (Pyne, 2010a). Wood was the principal resource supporting the infrastructure of the burgeoning United States. There were wooden roads, buildings, wagons, ships, and sidewalks along with wood-burning locomotives. East coast timber was being harvested at a rate that far exceeded its ability to regenerate, in a process that was called "cut and run" (Steen, 1976). The forests of the East were being cut and cleared at an alarming rate and by the late 1800s many in Congress feared a "timber famine" (Staff, 1905).

The first attempt to protect the nation's forests began with the Forest Reserve Act of 1891, which allowed the President to set aside areas of land as public domain. This established what were called forest reserves but did little to guide the caretakers as to how these areas were to be managed (Pyne, 2010a). Several early leaders and visionaries, such as Theodore Roosevelt, Gifford Pinchot, scientists, conservation organizations, and newly trained forestry professionals, led the successful effort in developing ways to manage what became millions of acres of federal forest land (Steen, 1976). Their knowledge and principles would be challenged and changed as the nation reconstructed goals based on shifting views and priorities.

The history of the Forest Service and of wildland firefighting is not unlike a lot of professions and systems developed since 1900. At first, the agency seemed seduced by the power of man to control the environment and developed a simple approach to both fire and land management. Then agency leadership was influenced by the industrial and technical revolutions and attempted to make difficult situations seem routine by employing processes, procedures, rules, and regulations (barriers) to create safety and improve efficiency. One profound influence was the publication of Taylor's *Scientific Management*, which resulted in *Taylorism*. The Forest Service was profoundly influenced

by this work, the focus of which is the improvement of economic and labor efficiency (Steen, 2004).

The assumptions and beliefs that kept these mental models alive were challenged by the eruption of Mt. Saint Helens in 1980, which redefined the concept of waste and destruction to an understanding of ecosystem recovery and resilience. Employees began to understand concepts of resilience and complexity and recognized the need for a much different approach—one that respected, honored, and encouraged adaptation and innovation and simultaneously assessed the viability of those adaptations.

Aldo Leopold was another key influence in Forest Service development, and his life story may be seen as a mirror of how the Forest Service evolved. His individual journey follows the same initial solid belief in a simple definition of multiple-use of the land. However, over his lifetime Leopold moved from a place of certainty to a place of inquiry. His greatness was not in his steadfast belief; instead it was found in his ability to challenge personal beliefs and to learn from them. In so doing, he influenced the Forest Service to do the same. Leopold's story is interwoven with that of the Forest Service. He was instrumental in the creation of the Wilderness program and is a nationally recognized father of the environmental movement (Lorbiecki, 1996).

This chapter shows the importance of the transition from knowing to questioning, in terms of both the organization and the individual. It explores how the vision of key people became fertile ground for the greatest good and the importance of inquiry and understanding when dealing with complex systems.

Birth of the Forest Service and the Profession of Forestry

Timber was among the most demanded resources of the mid-1800s. The Civil War highlighted its importance, and timber became a focus of attention for the US Congress. At that time, most United States infrastructure was in some way tied to wood products (Steen, 1976). By 1900, there was deep concern in the United States that timber reserves were in jeopardy of being exhausted by overharvesting (Bramwell, 2012). By 1905, Congress approved the creation of the Forest Service to manage the timber reserves of the United States.

First Forest Service Chief Gifford Pinchot described the organization's goal this way, "America's land should be managed by all—as a democracy for the greatest good" and asked the new agency to determine, "What is the greatest good?" (Steen, 1976). Answering this question became the foundational goal of the Forest Service, and there would be many lessons to learn along the way. The greatest good would be defined many ways over the next 100 years and would even change at one point to "common good." Each time the definition changed, the philosophy of the Forest Service had to follow. Some of these lessons came at a significant cost. What began with a belief in a simple

concept of using the land for multiple purposes evolved over time to an understanding that there are unexpected costs to even the best-intended actions within a complex system. One thing that seems to have been constant in the ethos of the Forest Service is captured in its current motto, "Caring for the land and serving the people" (Forest Service, 2014a).

Leading up to the creation of the Forest Service, clearing trees from the land to make room for agriculture was considered the greatest good. Many European immigrants had never owned land, so they embraced this policy and welcomed the opportunity to own their own farms (Pyne, 2010a). Land was stripped of trees that were sent to market, and then the cleared land was sold to farmers. The timber industry was considered the fourth largest industry in the United States (Pinchot as cited in Steen, 2004). The cut and run technique was common. The Pinchot family made their fortune on timber in this market. For a number of reasons the Pinchots changed their perspective on this practice and by the time their son Gifford was 21, they gave him a copy of George Perkins Marsh's newly published book *Man and Nature*, later renamed *The Earth as Modified by Human Action,* for his 21st birthday (Lewis, 2005).

The Earth as Modified by Man and Nature compared the devastation of the timber supply in Lebanon, which had been exhausted by overharvesting that left an inhospitable desert behind, with the way Americans were stripping the land of trees in the eastern United States (Lewis, 2005). It was an outright criticism of the unbridled timber harvests, which were common at the time.

The book had a profound effect on young Pinchot, who as a Yale University student, approached the staff and asked how he could become a forester. He found that there was no program for forestry in the United States, and so he arranged to study forest management in Germany (Lewis, 2005; Steen, 1976). There he learned how German foresters enacted the concept of multiple land use as the simultaneous management of land to support harvesting timber, extracting minerals, and recreation (Lewis, 2005).

The United States Department of the Interior (DOI) General Land Office (GLO) was created to administer, survey, and initiate disposition of the public domain lands. The GLO was giving land away to rail and mining concerns, as well as to farmers who would develop and homestead the land. The conservation and management of land or resources was not part of their charter. The US Congress recognized the need for establishing timber reserves in a way that resembled today's strategic oil reserves (Steen, 2004). Congress' first action was to grant Presidential authority to set aside timber reserves in the United States and its territories. The idea was to keep some lands aside to be managed for resource benefit as supported in section 24 of the Forest Reserve Act:

> That the President of the United States may, from time to time, set apart and reserve, in any State or Territory having public land bearing forests, in any part of the public lands wholly or in part covered with timber or

> undergrowth, whether of commercial value or not, as public reservations; and the President shall, by public proclamation, declare the establishment of such reservations and the limits thereof. […] Land on the public domain is set aside and are not available for occupancy, sale or settlement – they are not for disposal they are set-aside for the future (Forest Service, 2014c).

By 1893, President Benjamin Harrison used this authority to designate 15 reserves across the western United States. However, there was no guidance regarding what should be done with these lands. Questions arose regarding how the land should be protected—should it be used for aesthetic or recreational value or for open use by the local community? President Grover Cleveland doubled the size of the reserves but still did not specify how the land was to be used or establish guidance for its management (Lewis, 2005).

Some in Congress fought the establishment of simple forest reserves, which would remain untouched until needed. Instead these members advocated continued use of the land to meet economic and cultural demands (Lewis, 2005). There was growing support for watershed management and the development of a sustainable timber supply (known as *scientific forestry*). The Organic Act was created, which established guidance that formed the basis for sustainable multiple-use forests (Steen, 2004).

> No public forest reservation shall be established, except to improve and protect the forest within the reservation, or for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of the citizens of the United States (University, 2014b).

This act opened the way for Gifford Pinchot to begin a sustainable forestry program (Steen, 2004). He had been appointed as the special forest agent for the GLO, the organization that had oversight over the forest reserves. The scientific expertise, however, was in the Department of Agriculture (USDA). Within a year, a new office was created in USDA, called the Division of Forestry, with Pinchot named as its chief. The Pinchot family built a home in the District of Columbia capable of entertaining congressmen and senators, and Pinchot became the first political forester (Lewis, 2005). The family also commissioned a Department of Forestry at Yale, which became the training ground for foresters, who ultimately populated the new division.

Vice-President Theodore Roosevelt was propelled into the White House when President William McKinley was assassinated on September 14, 1901. Roosevelt had a long history of advocacy for conservationist ideas, and he directly supported his friend Gifford Pinchot. With the President's open support, in January of 1905 Pinchot organized the American Forest Congress, which supported the transfer of the forest reserves to USDA

(Lewis, 2005; Steen, 2004). Following the advice of this Congress, Roosevelt moved the forest reserves out of the GLO and into the control of Pinchot's Division of Forestry.

With the stroke of a pen, the Bureau of Forestry became the United States Forest Service, and the forest reserves became national forests—the first nationally owned, controlled, and managed forests.

> Shall, from and after the passage of this Act, execute or cause to be executed all laws affecting public lands heretofore or hereafter reserved under the provisions of section twenty-four of the Act entitled "An Act to repeal the timber-culture laws, and for other purposes," approved March third, eighteen hundred and ninety-one, and Acts supplemental to and amendatory thereof, after such lands have been so reserved, excepting such laws as affect the surveying, prospecting, locating, appropriating, entering, relinquishing, re-conveying, certifying, or patenting of any such lands…Forest Supervisors and Rangers shall be selected, when practicable, from qualified citizens of the States or Territories in which the national forests respectively, are situated (University, 2014a).

The name national forest is somewhat misleading, as it did not pertain to land covered in forests (Lewis, 2005; Pyne, 2010a). In fact, over 50 percent of the land under Forest Service control was grazing land or was dominated by ice and rocks (1890 census in Steen, 2004). There was a growing concern that the newly formed bureaucracy was grabbing land over which it would place restrictions on commercial enterprise. It is unlikely that the Forest Service would have been formed if it had not openly embraced the multiple-use concept (Steen, 2004). The definition of greatest good was beginning to undergo transformation.

Gifford Pinchot needed to define USDA's view of conservation and greatest good and wrote, "Conservation is common sense, for the common good." He published and circulated *The Use Book*, which was 26 pages long and fit in a forest ranger's back pocket. It contained the doctrine or principles of the Forest Service. Pinchot believed *The Use Book* was all a ranger needed as guidance to discharge his duties. It became immediately apparent to his rangers that he intended the Forest Service to focus on multiple use of the land to serve the greatest number of people (Lewis, 2005).

The Multiple-Use Philosophy

> *I recognize the right and duty of this generation to develop and use the natural resources of our land; but I do not recognize the right to waste them, or to rob, by wasteful use, the generations that come after us. -- Theodore Roosevelt*

Conservation champions such as Bernard Fernow, Gifford Pinchot, and Theodore Roosevelt believed that forest resources were at critical enough levels and that only planned, sustainable use could provide timber for future generations (Bramwell, 2012). In his book The Fight for Conservation, Pinchot laid out three principles of the conservation movement that formed the essence of what he considered the common good and the multiple-use philosophy (1910).

"The first principle of conservation is development. Conservation can only work if people use natural resources, as without these, there would be no need for conservation" (Pinchot, 1910). Many conservation critics at the turn of the century believed that conservation would stifle industrial development. Pinchot argued that development is a key aspect of conservation.

Pinchot's second conservation principle was the prevention of waste. The late 19th and early 20th centuries were a time of unabashed recklessness on the part of industry. It was not uncommon for logging companies to clear-cut[3] massive tracts of forestland. The trees that could not be shipped off were simply burned. Because clear-cutting destroys young trees as well as old ones, it was nearly impossible for these lands to recover on their own. Pinchot intended that large-scale users should be forced to curb their wasteful practices and to develop more conscientious means to extract resources (Steen, 2004).

The third conservation principle stated that natural resources must be used to benefit the many, not for the profit of the few (Pinchot, 1910). A small number of individuals were utilizing the nation's natural resources and prospering greatly from them. Pinchot returned natural-resource use to average American citizens and removed it from big business. Pinchot believed that conservation was a grassroots campaign. "The most valuable citizen of this or any other country is the man who owns the land from which he makes his living. No other man has such a stake in the country" (Pinchot, 1910). By making Americans responsible for their natural resources, he believed he could force people to make decisions that would benefit the population as a whole instead of allowing large businesses to make those decisions.

During his first term, President Roosevelt was fairly conservative in his use of the Forest Reserve Act. He used Presidential authority to set aside approximately 20 million acres of land by proclamation (Lewis, 2005). Fear rose in the livestock grazing communities, and Western State representatives attacked the Roosevelt administration's position on increasing the size of the national forests. During his second term, Congress passed an agriculture appropriations bill with a rider that eliminated Presidential authority to set land aside (nullifying the Forest Reserve Act). The night before the bill passed into law, Pinchot and Roosevelt worked together to circumscribe lands as national forests and grasslands, which totaled over 80 million acres. These forests have been called the "midnight forests" ever since (Robbins, 1975).

[3] Removal of all the trees in a stand of timber.

Americans were fighting over grazing rights. Enraged stockmen in the West convened the Denver Public Lands Convention in 1907, where participants attacked what they called "the federal land grab" and "Czar Pinchot," whom they held accountable for what they perceived as a denial of their right to graze on public land (Lewis, 2005). On the third day of the conference, Pinchot stood before the convention to speak. He did not confront people by telling them they were wrong. Instead, he talked to them about why he felt that conservation was critical and how it would actually be the thing that will ultimately save grazing and their profession (Robbins, 1975).

Gifford Pinchot had a much different view of conservation than did some more ardent preservationists (Steen, 2004). Pinchot summed up the purpose of the Forest Service by writing, "to provide the greatest amount of good for the greatest amount of people in the long run." Preservationists like John Muir believed that the land should be set aside and preserved and that all use should be restricted to recreation. Their paths crossed over the proposed Hetch Hetchy Dam in the scenic Yosemite Valley area of California (Lewis, 2005). In 1913, the City of San Francisco had proposed that a dam be built in Hetch Hetchy Valley, which would supply much-needed water to the city. A group known as "preservationists," led by John Muir, was staunchly opposed to the building of this dam. They thought building a dam would destroy the natural beauty unique to this area. Gifford Pinchot led the "conservationists," who believed that a dam was necessary to support the people of San Francisco and advocated for its construction (Lewis, 2005; Steen, 2004). This was the first time an environmental issue had national interest, and almost every major newspaper in the country followed the story.

Pinchot argued that large private companies should not have control over natural resources, like water. These resources, he reasoned, belonged to the people and should come from the people's land (Lewis, 2005). Muir was quite ardent that the dam should not be built in an area as pristine as Hetch Hetchy. His feeling was spiritual, and he said of the valley, "Hetch Hetchy Valley is far from being a plain, common, rock-bound meadow, as many who have not seen it seem to suppose; it is a grand landscape garden, one of nature's rarest and most precious mountain temples" (Steen, 2004). Conservationists won the argument over Hetch Hetchy, validating Pinchot's view that the United States people would not have endorsed pure preservation.

Common Good Shifts to War on Waste

The Montana fires of 1910 were called "the big blow-up" because they killed 85 people and consumed three million acres in just two days. Towns were evacuated, and trains raced over burning trestles just before they burned. At the time, the Forest Service had 400 rangers in the field (Lewis, 2005). With timber as the major resource to be protected and managed, the Forest Service concluded that fire seemed to be an unnecessary waste of resources. Borrowing from the FBI's number-one most-wanted campaign, the Forest Service declared, "Fire is public enemy number one."

The major index of Forest Service success was rapidly becoming the organization's ability to prevent waste by suppressing wildfires. This not only represented a new definition of common good, but it also mandated a huge investment in infrastructure, roads, lookout towers, firefighters, tools, and innovation (Lewis, 2005).

Rangers would go to saloons to hire manpower for the fireline. The fireline personnel did not receive any specific training to extinguish flames or to build fireline. Lookouts, on the other hand, were a recognized specialty, which required unique abilities and training (Lewis, 2005). It was difficult to find people qualified for this work. In 1913, Assistant Forest Ranger M. H. McCarthy on the Klamath National Forest had three applicants for one lookout position. He described the applicants to his forest supervisor in this way, "The first is a drunk; the second has poor eyesight; and the third is no gentleman." McCarthy then hired Hallie Morse Dagget, who became the first female forest lookout in a time before women could vote (Lewis, 2005).

Ferdinand Silcox was the second in command of the Forest Service during the Montana big blow-up of 1910 and argued successfully that the fires of 1910 were fully preventable (Pyne, 2004). "All we needed was more men, better communication, more roads, and more equipment." As a result in 1935 Silcox established the so-called 10 a.m. policy, which decreed that every fire should be suppressed by 10 a.m. the day following its initial report. Other federal land management agencies quickly followed suit and joined the campaign to eliminate fire from the landscape. (Pyne, 2004; Forest Service, 1957). The full suppression policy relied on what was being called the "can-do"[4] attitude, which was a label both critics and supporters used in reference to the Forest Service (Saveland, 1998).

The high esteem in which the Forest Service was held was not limited to the public but carried over to Congress. Its rapport with Congress was rewarded by generous budgets. In return, the Forest Service fostered a can-do attitude. It would provide Congress with what it wanted (Sedjo, 1998).

This language may have been translated into a commitment to fight fire aggressively and ultimately to put people in harm's way to achieve goals. In 1994, the can-do attitude would be cited as a direct cause of the 14 firefighter fatalities on Storm King Mountain[5] in Colorado (Forest Service, 1994).

The wasting of wild game was handled in much the same way as other recognized resource losses, even if this kind of waste seems natural by today's standards (Lewis, 2005). With a fervent belief in the ability to control outcomes and nature, practices were

[4] The Oxford Dictionary defines "can-do" as having or showing a determination or willingness to take action and achieve results.
[5] See South Canyon Fire incident information at http://www.wildfirelessons.net/orphans/viewincident/?DocumentKey=db8d7dbe-5f56-4b4b-bfe4-aec1a4e40b53.

put in place that reflected this rather simple view of the environment. In 1909, Aldo Leopold arrived in the southwest Arizona Territory as a new ranger and graduate of the Yale Forestry School (Lorbiecki, 1996). Leopold surveyed his forest and recognized that wild game was a principal value to be managed. He determined the definition of common good to be the creation of habitats suitable to the production of game for hunting (Lorbiecki, 1996).

Game losses to predatory species were considered just as wasteful as timber losses to fire. The value of the predator-prey relationship and the usefulness of fire on the landscape were not known or understood at that time. Working essentially off old wives' tales and traditions, Leopold formed the New Mexico Game Protective Association, which advocated the eradication of predators. Their platform was published in a newspaper Leopold created called the *Pine Cone*.

> The *Pine Cone,* July 1916: official bulletin of the New Mexico Game Protective Association, edited by Aldo Leopold
>
> **Our Platform**
>
> - We stand for vigorous and impartial enforcement of the game and fish laws.
> - We stand for federal control of migratory birds and prohibition of spring shooting.
> - We stand for co-operation with stockmen in a vigorous campaign against predatory animals.
> - We stand for an adequate system of Game Refuges.
> - We stand for such an increase in game and fish as will furnish legitimate sport for every citizen.
> - We are opposed in general to the public propagation in New Mexico of freight species as a substitute for Native American game.
> - We represent 1,000 members, each and every one pledged to observe the letter of the law and the spirit of good sportsmanship.
> - We are not in politics.
> - We stand beside every warden who does his duty.
> - We offer $50.00 reward for information leading to the arrest and conviction of any person killing antelope, mountain sheep, or ptarmigan.

Leopold was of his generation and time, when to kill a predator was expected. He recalled his personal transformation in his essay *Thinking Like a Mountain* and later captured in his book *Fierce Green Fire* when while leading a timber crew they spotted a group of wolves. “In those days we had never heard of passing up a chance to kill a wolf. In a second we were pumping lead into the pack.” They could see that they had shot the mother wolf.

> We reached the old wolf in time to watch a fierce green fire dying in her eyes. I realized then, and have known ever since, that there was something new to me in those eyes—something known only to her and to the mountain. I was young then and full of trigger itch; I thought that because fewer wolves meant more deer, that no wolves would mean hunter’s paradise. But after seeing the green fire die, I sensed that neither the wolf nor the mountain agreed with such a view (Leopold & Schwartz, 1987).

A few years later, Leopold began to understand that his job was more than just to manage the forest for lumber and animal harvest. For him the meaning of common good was forever changed to understanding the complexities of nature and how man lives with her (Lewis, 2005).

Challenge to the Status Quo

Before leaving the Forest Service, Leopold introduced the concept of wilderness areas, which are sections of forest set aside for the preservation of what he called "an original American landscape." This was a preservationist point of view that Muir would likely have supported (Lewis, 2005). In 1922, Leopold created *A Report on Proposed Wilderness Area, Name: the Gila Wilderness or Gila Hunting Ground,* the object of which was "To preserve at least one place in the southwest where pack trips shall be the dominant play." In this paper, and for much of his Forest Service career, he expressed the need to designate areas of the forest where there would be rules to limit access, prohibit automobiles, and eliminate roads. The Gila Wilderness was approved in 1924 and set the pattern for the National Wilderness Preservation System in place today (Steen, 2004).

The simultaneous social, economic, and natural disasters of the great depression; the stock market crash; and the dust bowl moved the Forest Service from basic conservation to a deeper social responsibility of sustainability (Lewis, 2005). Just as Pinchot's generation had been fixated on prevention of the depletion of timber reserves, this generation was moved by the environmental disaster of the dust bowl. This shifted the definition of common good as the creation of forests that could sustain productivity in terms of resources and recreation. The industrial revolution played a role in the interpretation of this policy, and foresters turned to manpower as a means to create pathways for sustainable productivity (Steen, 2004).

Pinchot, who had left the Forest Service and become the governor of Pennsylvania, threw his support behind Franklin Delano Roosevelt (FDR) in a successful bid for the Presidency. One of FDR's first initiatives was to create the Civilian Conservation Corps (CCC). The CCC provided much-needed manpower and helped the Forest Service to develop infrastructure on a much larger scale. For example, CCC crews cut a 600-mile-long fire-break in the Sierra Nevada Mountains of California and in the prairie states they planted 2,000 miles of trees as windbreaks called the "Shelter Belt" (Lewis, 2005) that reached from Texas to Minnesota. The chief of the Forest Service during this period was Ferdinand A. Silcox (1933-1939), who said, "This conservation army is rebuilding the national forests." CCC crews also formed the core of personnel available to fight fire (Steen, 2004).

Aldo Leopold also left the Forest Service and became a professor at the University of Wisconsin. His view of the world forever changed with the image of fierce green fire and the destruction of the land during the dust bowl, he became dedicated to understanding and advocating for the restoration of land and a new type of scientific forestry. He bought an old worn-out piece of land in Sand County, Wisconsin, and began an experiment in learning from the land. The worn-out land had been abused and exhausted like the lands affected in the dust bowl. He experimented on how to restore these abused acres of land, which he now owned and over which he had complete control (Lorbiecki, 1996). The Forest Service and the nation needed a common ethic of caring for the land, and Leopold

set out to discover it. He wrote, “A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. A thing is wrong when it tends otherwise” (Lorbiecki, 1996). For him the common good applied equally to land and the people’s use of it (Lewis, 2005).

Bob Marshall was an American forester and activist who, like Muir, had walked through much of the National Forest System land. It is reported that he would routinely hike 40 miles in a day. He became the first Forest Service director of recreation and became dedicated to the expansion and protection of the wilderness areas Leopold first advocated. Marshall and Leopold represented the new era of scientific foresters (Lewis, 2005). These were well-educated outdoorsmen who were dedicated to a new view of preservation and conservation. Concerned about the effect the CCC and FDR’s New Deal were having on the landscape, Marshall and Leopold created a group of like-minded authors, researchers, and foresters to form the Wilderness Society (Steen, 2004). Roads were opening public lands for recreation and improving access for firefighters, but the Wilderness Society expressed concern that these same roads were having an adverse effect on the land.

By the mid-1930s, some foresters supported by preservationists and the Wilderness Society began to argue that the land had not been improved through Forest Service management. Foresters from the southeast were beginning to demonstrate that fire had a place on the landscape, and Leopold’s writings were beginning to stir feelings of environmentalism in the public (Lorbiecki, 1996). However, there were hard lessons yet to learn about fire and how to fight it (Lewis, 2005).

Figure 1.1: An aerial view of the 1937 Blackwater Fire on the Shoshone National Forest in Wyoming.

The Blackwater Fire on the Shoshone National Forest in 1937 was an example of the full suppression policy that went terribly wrong. The fire was manned vigorously after detection, mainly with CCC firefighters, 15 of whom were trapped while building line ahead of the fire (Forest Service, 1937). The investigation attributed the cause of the fatalities to the inability to get additional firefighters on scene fast enough to be effective. The cause of the Blackwater fatalities was undoubtedly more complex than the simple counter-factual argument, “If more firefighters had been there sooner, the line construction would have been complete and the accident would not have happened” (Forest Service, 1957). The can-do attitude, the 10 a.m. rule, and full-suppression policy are artifacts of the culture of an organization that influenced the social construction of cause. This attribution of cause had the effect of placing emphasis on the development of ways to get firefighters to fires more rapidly, which ultimately gave rise to an innovation

called the smokejumper program, or aerial delivery of firefighters. In the same year, the *Ten Standard Firefighting Orders* and the *18 Situations that Shout Watch Out* (later called the *10 & 18*) were developed. The 10 & 18 will become part of a larger dialogue in this dissertation.

An Organization Shaped by Conditions

> Forestry cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and technology my flow to and from every worker in the field of forest fire control (Forest Service, 1937).

World War II saw an organizational response similar to the early years of the Forest Reserves (Lewis, 2005). Timber was once again a war resource that had to be conserved and protected. There were three principal threats: fires that began naturally; accidentally-ignited fires; and fires people intentionally lit as a form of sabotage (Lewis, 2005). Sabotage was a genuine concern. Japanese paper balloons had been found on the forests of the West. Enemy submarines had launched these paper balloons that carried incendiary devices to attack the timber reserves of the western states and to tie up valuable human resources to fight wildfires. The presence of these balloons were kept secret from the public until the end of the war (Webber, 1975); however, their presence likely further strengthened the resolve of the forest firefighting community toward full suppression.

Figure 1.2: A World War II-era Fire Prevention Poster.

Veterans returning from the World War II brought innovations learned in warfare, such as direct air support command and control theory and the importance of radio communications (Lewis, 2005). They also brought military terminology, approaches, and language to firefighting. The common good seemed to become more entrenched in what was becoming known as the "war on wildfire." In the early years of wildland firefighting, firefighters were not trained or qualified in any way (Steen, 2004). Returning veterans were unaccustomed to engaging an enemy without fully trained troops (Lewis, 2005). This was part of the influence that heightened the importance of training and

professionalization of the firefighting community. Firefighting actions demonstrated that there was a growing belief that the military model offered ways to avert casualties.

Clearly, if fatalities were not tolerated by the Forest Service, the organization had to invest in infrastructure, training, and equipment. The creation of hotshot crews was one innovation that resulted from this realization. These well-trained and equipped 20-person teams were considered elite firefighters.

Despite these efforts for positive change, fatality fires still occurred. By the middle of the 20th century, seven fires had killed ten or more firefighters each (Forest Service, 1957). The Forest Service called these "tragedy fires." The Forest Service mobilized modern science in the study and prediction of fire behavior and development of equipment (Lewis, 2005). Scientists applied physics and chemistry; better mobilization and organization techniques; and specialized training and improvements to safety equipment to the firefighting process (Steen, 2004). The Forest Service invested in innovations like helicopters and retardant tankers, and the organization espoused the desire to become "safe, effective and efficient!" (Forest Service, 2014b). Subjected to the cultural influences of the time, the field of scientific management[6] promised to improve efficiency, especially in terms of labor productivity (Steen, 2004). This influence was profound in the early development of the Forest Service and by 1950 scientific management, or *Taylorism* as it was called, dominated strategic thinking (Steen, 2004).

The fire community was subject to other cultural influences of the time and a major source of power was not employed. "There were no women on recreation crews and to think of woman fighting fire was laughable, no one even imagined that" (Susie Wood, Forest Service district clerk as cited in Lewis, 2005). This would not be the case much longer.

Figure 1.3: One of the first pictures of Smokey Bear after he was found on the Lincoln National Forest, New Mexico.

The Forest Service entreated the public to become involved in protecting the forests. The Smokey Bear campaign was created to warn against the dangers of wildland fire, and the world was told, "Only you can prevent forest fires!" The actual mascot, Little Smokey, was found on the Lincoln National Forest as a fire-burned cub, who then became a symbol of forest-fire prevention. At one point, Smokey was the most recognized character in the world.

[6] Taylorism was popularized and many organizations aligned work to improve efficiency.

By the 1960s, he had so much mail at the national zoo that he was given his own zip code (Steen, 2004).

The increase in the use of automobiles and suburban-community growth resulted in a housing boom, and more wood was needed. Private reserves had been logged extensively during the war, and that crop of new trees was too immature to harvest (Steen, 2004). Private industry turned to the Forest Service for access to the timber on public lands.

President Dwight Eisenhower demanded an increased output of lumber products, thus emphasizing the Forest Service's role as land manager (Lewis, 2005). The phrase, "timber is king," was heard throughout the organization, and production forestry became the dominant philosophy. The Forest Service became known in some circles as the Marine Corps of the civilian government because like the Marines, the Forest Service was a can-do organization (Lewis, 2005; Pyne, 2010a). With this increased demand for timber, the definition of the greatest good shifted again.

Clear-cutting became official Forest Service policy in the 1960s. Silviculturists[7] recognized that clear-cutting was the most effective and efficient way to regenerate forest products (Steen, 2004). Managing a forest for timber production alone required the regeneration of trees, and fast growing species were planted to ensure this goal was achieved (F. Dale Robertson, Forest Service Chief, 1987-1993).

New road access was needed, but this had a side effect. New roads for timber provided better access to people, who were experiencing recreational automotive travel in large numbers. This made the issue of clear-cutting a visible scar, and some people wanted land to be protected. The public had developed a love for the forests due in part to their accessibility, the strong Smokey advertising campaign, and the efforts of preservationist organizations like Muir's Sierra Club. People began to question how the forests were being managed, especially with regard to timber harvests (Lewis, 2005).

Awakening

Both conservation and preservation organizations started to become more outspoken in their questioning of how the Forest Service was managing the land. The agency that was used to thinking of itself heroically was now being questioned by its former allies. One clear-cut on Lodgepole Creek on the Bitterroot National Forest was so terrible in appearance that it earned the name the "oh-my-god clear-cut." It was a visible scar on the land, made worse by the apparent waste of thousands of trees left to rot in plain view (Lewis, 2005). Most did not realize these trees were cut and left as a result of an insect infestation that had plagued the area years before.

[7] Foresters concerned with the cultivation of trees.

By 1964, the Forest Service was managing millions of acres as wilderness and millions more for multiple-use. President Lyndon Johnson signed the National Wilderness Act in the same year, establishing a national wilderness preservation system. John Muir followers and many Pinchot disciples had set aside wilderness lands, laying the groundwork for the development of the wilderness system (Sedjo, 1998). Gifford Pinchot's son, an ardent conservationist, denounced the Forest Service in his father's name. Conservationists had what they needed to make an appeal to public sensitivities. It appeared to them that the 1897 act seemed to rule out clear-cutting and that the Forest Service could be taken to court for the violation. The Forest Service lost the case, and the National Environmental Policy Act of 1970 (NEPA) was created, giving the public a voice in how federal public land is managed (Kaiser, 2006).

Specialists in ecology, biology, hydrology, and ecosystem management were incorporated into the Forest Service. Often called the *"ologists,"* they represented recognition on the part of the Forest Service that a variety of educational backgrounds were needed to manage forest diversity (Kaiser, 2006; Lewis, 2005). The definition of the greatest good shifted yet again. The Forest Service goal became and remains as follows: "The mission of the USDA Forest Service is to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations" (Forest Service, 2014).

Recognition that Complex Systems Cannot Be Controlled

When Mount Saint Helens erupted in May of 1980, the Forest Service was struggling to understand and implement environmental legislation created following Earth Day.[8] The devastation on the landscape, resulting from the eruption, helped raise a new question about the definition of the greatest good (Lewis, 2005). The Gifford Pinchot National Forest had been laid level and covered with ash, and people questioned whether the area should be studied or restored to what was considered normal. The agency's mindset had been entrenched in the thought that such a disturbance was simply destruction, a laying waste to the land and precious resources (Sedjo, 1998). As the assessment of the forest began, the Forest Service ologists discovered a lot of specific species had survived the eruption, and many were actually flourishing (Lewis, 2005).

The ologists also helped the organization to learn that interacting with complex systems using cause-and-effect models means always operating in a form of trial and error (Pyne, 2004). Always reacting as the expected effect is met with unexpected outcomes. Even the simple concept of fire prevention had an unforeseen cost, and Smokey went through a bit of a mid-life crisis (Lewis, 2005). The full-suppression policy and long-term fire prevention strategy were so effective that they resulted in increased fuel loading throughout the forest system (Saveland 1998, Pyne, 2010b). Fires became unstoppable, such as the 1988

[8] April 22 1970 marks what many consider the birth of the modern environmental movement.

Yellowstone fires. This situation led to a deeper understanding of the importance of fire on the landscape (Steen, 2004).

The model of waste was socially constructed over a period of nearly 100 years of resource management and timber production. It became evident to researchers that what had been thought of as waste, such as denuded landscapes, massive fire scars, and even volcanic eruptions may actually have a benefit (Pyne, 2010a). People began to question the mental model of waste, and a complexity model began emerge. Learning how a landscape recovers became a very important part of the Forest Service, and the science was changing to accommodate complexity (Pyne, 2004). The lessons Aldo Leopold had learned over a lifetime of inquiry mirrored what the Forest Service was beginning to understand and learn for itself over the period of a century.

Summary

Pride and professionalism continue in the Forest Service today. The United States currently has a system of 155 national forests, 20 national grasslands, and 222 research and experimental forests along with other special areas that cover more than 192 million acres of public land. The Forest Service has evolved into a 30,000-employee agency that manages the national forests for a number of multiple uses, including aquatic life, grazing, minerals, recreation, timber, water, wilderness, and wildlife. Over the last century, the Forest Service has initiated numerous innovative products and procedures and has led the country and the world in scientific forestry matters. The Forest Service journey is a fascinating story of people, places, politics, laws, and controversies.

Figure 1.4: USDA Forest Service gate lock.

The meaning of common or greatest good shifted several times since 1905. The first approach that may seem naïve now was a simple cause-and-effect model employed to manage product delivery from the forests. Pinchot wrote, “Conservation demands the welfare of this generation first and afterward the welfare of the generations to follow” (as cited in Lewis, 2005). The influence of the industrial and technical revolutions saw the development of technical improvements and organizational interventions that represented individual safeguards and organizational defenses (often in the form of rules, regulations, policy, and procedures). This period was marked by a definition of common good focused on efficiency coupled with barriers designed to allow people to go farther and to do more safely. The eruption of Mt. Saint Helens heightened awareness of a complexity that had been loosely central to Muir, Leopold, Marshall, and others. This was the concept that the Forest Service was the steward of a complex ecosystem that would not always respond as expected. A deeper more networked approach was needed to

both understand and manage the complex landscape and society's changing expectations.

Chapter 2: The Evolution of Accident Investigation

Introduction

> *Surely these men gave their lives in defense of this country, for without the strength of our forests, water and other natural resources, this Nation would not be a leader in the free world today." --Richard E. McArdle, Chief, Forest Service, regarding the Inaja[9] Fire (1956)*

There was no recorded Forest Service formal guidance regarding the process of investigation of incidents or accidents until 2001 when the first *Serious Accident Investigation Guide* (SAIG) was published. Accidents had been handled in a number of ways, from recognition of error on the part of those involved to the recognition of those same participants as heroes who were valiantly engaged in the war on wildfire.

Throughout the history of firefighting, the organization equated large loss of life with the greatest need for change. Each major event where multiple lives were lost initiated large organizational responses that resulted in changes to policy, procedures, protective equipment, and training. This chapter shows how the organizational response changed or evolved over nearly a century of operations and fatality-fire investigations. The supporting material for this chapter is Forest Service accident investigations, which are available from two main sources: The Wildland Fire Lessons Learned Web site and a privately maintained Web site called Always Remember.[10]

Sometime between 1910 and 1930 wildfires started earning names—of course they are assigned numbers for accounting purposes, but more important to agency culture, they are also given names. Some of these names represent key points in the organization's history and are tied to moments of reflection and/or action. These fires were commonly those involving large losses of life. As such they have meaning to firefighters and the Forest Service. The naming tradition links fires with specific organizational attempts to improve firefighter safety. For example, the Blackwater Fire pointed out the importance of rapid response and is credited for the development of the smokejumper program, and the Inaja Fire spurred the organization to adopt standard fire orders. Some names, like

[9] See Inaja Fire information at http://www.wlfalwaysremember.org/incident-lists/166-inaja-fire.html.
[10] Currently two primary sites archive information on wildland fire fatality reports and supplemental information: The Wildland Fire Lessons Learned Center (http://www.wildfirelessons.net/home) and WLF Always Remember (http://www.wlfalwaysremember.org). Always Remember seems to have the most complete records.

Esperanza,[11] Cramer,[12] and Thirtymile,[13] evoke a sense of distrust in the investigation process.

Societal construction of cause and attribution of blame associated with fatality accidents appears to be quite different from 1910 when compared to today. After 1957, a noticeable change in tone and in demand for causal attribution is apparent in Forest Service Investigation Reports. By the mid-1960s, written guidance reflected the need to detect mistakes as well as systemic weaknesses as shown in Forest Service letters of delegation to investigation teams. As the decade progressed, this guidance moved to error identification and ultimately to attempts to eradicate error consistent with mainstream accident-prevention methods (Amalberti, 2001). By 1994, investigations were focused on rule violations and admonishment of the violators (Forest Service, 1994). In 2001, the process evolved to a point where decisions perceived by the Thirtymile accident investigation team as errors were criminally prosecuted.

This chapter will explore evolving theories of investigation and safety that may have influenced the creation of definitions and the establishment of goals associated with accident investigations to explain how different approaches emerged. It will show how definitions and goals changed over the course of years and how this evolution of investigations may have led to the creation of the first SAIG.

Forest Service Investigations – The Emergence of Story without Judgment

One of the first coordinated firefights took place in Yellowstone National Park in 1886, when US Cavalry troops engaged over 60 fires in a military-style campaign, establishing fire as something to be fought (Pyne, 2010). As in war, at first the mission was to control the fires and prevent resource loss. In 1910, fires destroyed towns along with thousands of acres of trees, and 85 people lost their lives during a single firestorm in Idaho and Montana. The Forest Service gradually became more and more responsible for wildland fires that affected communities bordering Forest Service lands. Timber protective societies (some mandated by state law) also emerged as people adjacent to forests, and in many cases reliant upon the timber industry, voluntarily engaged in fighting wildland fires (Robbins, 1975).

Pyne (1996) described as a national mentality that fire was the “enemy” and that aggressive firefighting was “the moral equivalent of war”, which became known as the

[11] See the Esperanza Fire Accident Investigation Report at http://www.fire.ca.gov/fire_protection/downloads/esperanza_00_complete_final_draft_05_01_2007.pdf.
[12] See the Cramer Fire Report of Investigation at http://www.usda.gov/oig/webdocs/rptinvestigations.PDF.
[13] See the Thirtymile Fire Accident Investigation Report at http://www.fs.fed.us/t-d/lessons/documents/Thirtymile_Reports/Thirtymile-Final-Report-2.pdf.

"root metaphor" (p. 252). This established a standard approach grounded in aggressive firefighting as a war on fire and the language of fire mirrored combat operations. The reaction was clear: people would be put in harm's way to protect natural and man-made resources, and there would be accidents. For example, since 1994 there have been over 400 wildland firefighter fatalities (Always Remember, 2014). Calling into question a long standing espoused value, "No wildland fire situation, with the possible exception of threat to human survival, requires the exposure of firefighters to life-threatening situations" (NWCG, 1980).

The first fatality reference available on the Wildland Fire Lessons Learned Web site is a *History of the 1910 forest fires—Idaho and Western Montana,* written by Elers Koch. Koch was a forest supervisor during the big blowup of 1910. In this account, he provides a series of stories related to hard work and survival, often in the participant's own words. In his introduction he writes, "If history is not written, it is soon forgotten…This is not written for publication, but primarily as a record for the Forest Service, so that the story will not be lost" (Koch, 1910). In Forest Supervisor Koch's approach, it appeared that he understood the importance of story and did his best to present information without judgment of actions or decisions despite the loss of 85 people, 76 of whom were wildland firefighters.

Stories can provide insight with regard to what can be learned from an event. Human beings are the creatures who tell stories […] and those stories serve a function, namely to make meaning of our experience (Clark & Rossiter, 2008). The stories Koch presented were not sanitized to present a specific or singular perspective. They were often running narratives that included remarkable success and devastating failure. What was seemingly absent was a judgment of actions in terms like *right* and *wrong* or of people in terms of dominant metaphors such as *hero* or *villain*.

People familiar with day-to-day operations were allowed to view the information through their personal interpretive lens and derived their own lessons from others' experiences. This individual learning is exemplified in Koch's recounting of Ed Pulaski's story. Pulaski is a renowned figure in Forest Service history, with one of the principal wildland-fire hand tools used today named after him. Koch described him as "a man of most excellent judgment, conservative, thoroughly acquainted with the region, having prospected throughout the burned area during the last 25 years, and is considered by the old timers in the region as one of the best and safest men that could have been placed in charge of a crew of men" (1910). During the fires of 1910, Pulaski led 42 men into a mine tunnel to avoid the flame front, an innovation that is credited as having saved his crew. At no point in the narrative is the term hero used; instead, his knowledge and innovative approach are recognized.

> When he got about half way, however, he found he was cut off by new fires. At the sight of this, his men became panic stricken, but he assured them that he would still get them to a place of safety. Being thoroughly

> familiar with the region he knew of two prospect tunnels nearby, the shorter being about 50 feet in length and the longer about one hundred in length. Not being certain as to whether or not he could reach the largest and safest, by putting a wet gunny sack over his head, he penetrated the dense smoke to where he could see the largest tunnel, and finding it was safe he rushed back to his men and hurried them to the tunnel, getting them there just in time to get them inside before the fire reached them. The portion of his crew with him consisted of 42 men and two horses. He got all his men and horse inside the tunnel, with the exception of one man who had fallen a few hundred feet behind and was caught by the fire before he could reach the tunnel (Koch, 1910.)

The account is not analyzed or reduced; it does not favor a perspective of error for having been in the position to make this difficult choice, nor does it admonish Pulaski for his actions. Those judgments are left to the reader.

Forest Service Investigations – Concept of Local Rationality

The Blackwater Fire in Wyoming in 1937 involved the next major loss of life in wildland firefighting. Fifteen firefighters died when they were cut off by a rapidly advancing fire front. Chief Investigator David Godwin concluded that the leadership on the fire was "intelligent and protective of the men" (Forest Service, 1937). Godwin focused his attention on the arrival times of responding units and posed a counterfactual argument that if the additional responding units had arrived earlier the crew that was lost would not have been in a position to be cut off by the fire (Brauneis, 2002; Forest Service, 1937).

To his credit, Godwin recognized the inability of people to be fully aware of surroundings. "Had they known these things, and anticipated an afternoon wind, their action probably would have been different. But, weighing the known factors, Post and Clayton thought the job a normal undertaking and one not involving more than ordinary risk to men." Despite the counterfactual supposition, Godwin recognized the concept of *local rationality*. People's behavior in work situations can be considered as consistent with Newell's principle of rationality—i.e., practitioners use their knowledge to pursue their goals (Newell, 1982). Local rationality is described as "people are doing what makes sense given the situational indications, operational pressures, and organizational norms existing at the time" (Woods, Dekker, Cook, Johannesen, & Sarter, 2010). Godwin's summary gives insight into his perspective on the events:

> Regrettable as it is, it must be recognized that in man's control of forest fires some accidents will occur—just as in city fire protection—without fault or failure on the part of anyone. Here was brought about a peculiar combination of circumstances rare in forest-fire history. It is reassuring to know that such occurrences are infrequent. Not since 1910 have so many

> lives been lost on a single national forest fire, and fatalities from burning are very uncommon, although probably more than 100,000 men fight fires in the average year" (Forest Service, 1937).

This summary is reflective of the style of the period, and concepts of fault and failure are recognized and addressed rather than presupposed and judged.

Forest Service Investigations—Individual Actions in Context

The Rattlesnake Fire[14] occurred on the Mendocino National Forest in California on July 9, 1953 with the loss of 15 lives. The subsequent investigation was conducted as a review board, in the style common to military boards of review. The board evaluated the nature of fire strategy and tactics and what was called *generalship* and determined these were "in conformance with acceptable fire suppression principles" (Forest Service, 1953). The emphasis turned toward the knowledge of fire behavior: "…it is evident that here, as generally throughout the Service, there are technical aspects of fire behavior that are not fully understood." Report conclusion number two demonstrated that the team understood the complex nature of the fire-ground. "The organization, although perhaps not entirely in strict accordance with conventional standards, was well adapted to the requirements of the fire and functioned effectively" (Forest Service, 1953, p. 28). This conclusion may be a reflection of understanding the need to adapt in the face of the uncertainty that wildland fires commonly present.

A *reasonable-person* argument is offered in conclusion number 4 of the report. "The decision to burn out along the Alder Springs Road westward from the point of origin (Oleta Point) was a sound decision and one that an experienced fire control officer would be expected to make under the conditions prevailing at the time." West's Encyclopedia of American Law defines reasonable person as "a phrase frequently used in tort and criminal law to denote a hypothetical person in society who exercises average care, skill, and judgment in conduct and who serves as a comparative standard for determining liability." This approach does not consider hindsight bias, which is the inability of a person to judge the actions of another when the outcome is known (Fischhoff, 2007; Kahneman, 2012).

Dekker (2006) points to the problems with hindsight bias and the importance of recognizing local rationality or the perceptions of those involved in the incident, what Dekker (2006) would refer to as "the perspective from the inside of the tunnel" (p. 26). This is further reinforced in conclusion number 5: "Neither does the Board seriously question, under the circumstances that existed, the timing and intensity of the action taken" (Forest Service, 1953, p. 28).

[14] The Rattlesnake Fire report is included on the Always Remember Web site at http://wlfalwaysremember.org/incident-lists/481-rattlesnake-fire.html.

The board also recognized that people do not act to willingly expose people to undue risk, even when the result is a fatality accident. This was captured in the report summary:

> The Board's belief in the wisdom of the manning of the Missionary spot presumes the feasibility of doing so with full guarantee of safety to the fire crews involved. This is a value laden conclusion that begins with the basic assumption of innocence and that the people were acting in the best interest of all those involved. A presumption of good people doing the best that they could (Forest Service, 1953).

Chief McArdle's directive to the board reflects the danger inherent in the operation but does not ask the board to find a culprit.

> We all realize that fighting a forest fire is dangerous. It can't be a soft job. Despite the fact, or because of it, we must assure every precaution to guard the safety of those who take on this tough assignment. Human life must never knowingly or carelessly be subordinated to other values (Forest Service, 1953).

Although the language in the last sentence suggests the possibility of carelessness, the board is never told to look for it. This would change within the next 15 years.

In November of 1956 the Inaja Fire took the lives of 11 wildland firefighters (Forest Service, 1957). The Inaja Forest Fire Disaster Report presented a story-based narrative; as shown in figure 2.1., context is placed around decisions and actions (see figure 2.1).

Conclusions

- A. Fire Behavior. The disastrous flare-up of the Inaja fire was caused by a critical combination of highly flammable fuels, steep topography, and adverse weather. The lull in the fire before and at the time of arrival of the night crews created a false sense of security, even though existing conditions of fuel, topography, and weather were critical.
- B. Crew location in canyon. The men were taken down the line into the canyon owing to a lack of information to show possible danger from the fire in the canyon below. The contributing factors were:
- a. Absence of specific information on the fire status in San Diego Canyon available for the briefing at the base camp, due to poor conditions for aerial reconnaissance.
- b. Emphasis placed on the danger of the burning-out fire rather than on the main fire in the canyon below, when the day division boss briefed the night overhead personnel.
- c. Quiet appearance of the fire as viewed from the rim.
- d. The night overhead personnel had not seen the terrain in daylight.
- e. Lack of detailed scouting of the canyon on sector G during the day.
- f. Absence of contact with the bosses of the division across the canyon who had a different vantage point for viewing the situation.
- C. Trail location. The location of the fire trail on the specific ridge where it was built instead of the spur ridge up the canyon was questionable. The previous behavior of the fire and the position above and alongside a precipitous chimney made the chosen location hazardous.
- D. Burning-out. Sound firefighting principles call for burning out the intervening fuels between the control line and the fire edge. The effect of the burning-out fire on the behavior of the main fire and of the planned escape routes is a vital factor influencing decisions on when, where, and how to burn out, and where to place men. Fire behavior is not well enough understood to firmly establish the possible effect of the burning out fire in sucking the main fire rapidly up the chimney at the site of the disaster. Other factors would have permitted the explosive run without the presence of the burning-out fire. Furthermore, the burning-out fire did not cut off the escape route.
- E. Lookout. The crew cutting line into the canyon received warning to come out when a crew boss on the upper part of the line saw the fire heating up at a point below the men. It is uncertain in the Inaja fire disaster that a specifically designated lookout would have given warning any sooner. However, it is vital that a lookout be designated when crews are in a potentially dangerous location.
- F. Water. Exhausting the water supply from the tanker at the time of the flare-up did not cause or contribute to the tragedy. The flames that raced up the canyon slope were of such height and were extended so far in advance of the burning fuel, that water available from one or several ground tankers would not have had a material effect.
- G. Personnel. The leaders on the Inaja fire were capable and experienced. They were trained in accordance with recognized Forest Service standards. There is, however, need for more intensive fire behavior training for key fire supervisory personnel.

Figure 2.1: Conclusion section from the Inaja Forest Fire Disaster Report

A pattern was beginning to emerge concerning how the reports were structured, particularly in regard to the order in which major components of the reports were presented.[15] However, when faced with the challenge of understanding what occurred and making recommendations, the assigned team still had to develop their own criteria. The result of their effort appears to take the stance of building context around the actions and decisions rather than the assignment of blame or ascription of cause.

This style dominated the organization's response to accidents and incidents until the 1960s when it was replaced with a more mechanically oriented approach, which simply listed failures and/or errors. This shift appears to be a gradual movement toward the identification of absences, errors, or failures and a drift away from context. The long-term result was that findings of individual error became formal statements of cause (Leape & Berwick, 2005).

Forest Service Investigations – The Search for Accountability

Twelve firefighters died during the Loop Fire[16] in California in 1966. Victims ranged in age from 18 to 26. The letter delegating the investigation team from Forest Service Chief Edward P. Cliff to the deputy chief (dated November 2, 1966) made clear the search was less about the story than about cause:

> We want facts – what happened, how and why. Then we want those facts studied carefully and evaluated to formulate sound conclusions and recommendations—how could the final outcome, or any of the occurrences or situations leading up to it, have been avoided? What mistakes or weaknesses or oversights can be prevented in the future? You must follow every possible lead to determine how we can tighten up our safeguards to prevent a similar disaster in the future. (Forest Service, 1966).

The presumption of error is evident in this direction to the investigation team. Since there was a fatality, there had to be "mistakes or weaknesses or oversights" (Forest Service, 1966). This presumption is commonplace in many subsequent investigations, which ultimately led the organization to the search for causes that align with the identification

[15] By the 1960s a standard report format began to emerge and reports included (in order): Background Information; Topography; Vegetation and Fuels; Weather and Fire Behavior; Strategy and Tactics; Sequence of Events, and Maps. The archives only include excerpts of these reports, which are commonly eight pages of a larger report (in almost every case a total of 37 pages long). There are no conclusion sections or recommendations available in these records.

[16] See the Loop Fire Disaster Report at http://www.fireleadership.gov/toolbox/staffride/downloads/lsr1/lsr1_investigative_report.pdf.

of a culprit who could then be held accountable for the incident. This established a sense of urgency to find those responsible and to hold them accountable for their choices.

Perhaps the ultimate drift toward this accountability model was observed in a fatality fire in Washington State in 2001 when the organization identified errors on the part of a number of fire staff officers and the incident commander (IC). The Thirtymile Fire accident investigation resulted in the legal indictment of several staff officers. Prosecutors cited the accident investigation factual report as source material for these indictments and brought formal charges against firefighters. The IC received the largest number, 11 felony indictments, including four counts of manslaughter (one for each of the fallen firefighters). Ultimately the charges were reduced and he plead guilty to "making a false statement" to law enforcement authorities and was subsequently sentenced to three years of probation and 90 days of work release (Gabbert, 2013). The charges against the staff officers were dropped only after they had endured years of public embarrassment, blame, and scrutiny, which haunt them to this day (Personal interview with the former district fire management officer).

The Thirtymile report spurred what many have referred to as a knee-jerk reaction that went all the way up to the highest level of the federal government. Influenced by the coverage; investigation-team press releases posted during the investigation; public outcry over the loss of young firefighters, and the numerous causal findings (simply listed without any context) in the report, Public Law 107-203 was passed. The law includes the following language:

> In the case of each fatality of an officer or employee of the Forest Service that occurs due to wildfire entrapment or burn-over, the Inspector General of the Department of Agriculture shall conduct an investigation of the fatality. The investigation shall not rely on, and shall be completely independent of, any investigation of the fatality that is conducted by the Forest Service (Congress, 2002).

Within the agency the effect was perhaps best summarized by Bill Gabbert in *Wildfire Today* magazine. "This had a chilling effect on firefighters who are required to make split-second decisions that later may be second guessed by a jury with no clue of what it is like to be faced with a life or death situation on a rapidly spreading wildfire" (Gabbert, 2013).

During an interview with the Office of Inspector General, agent in charge of Forest Service cases he said, "The law does not serve us well. My agents complain that they are bringing cases to the AG (attorney general) that they would normally disregard." All cases brought to the AG as a result of this law have been dismissed prior to trial (Forest Service,[17] 2008, July 25; Office of Inspector General, 2004). The effect of the Thirtymile investigation on

[17] See the Accident Investigation Report: Dutch Creek Incident at http://www.wlfalwaysremember.org/images/incidents/documents/2008-07-25-palmer-dutchcrk-final.pdf.

Forest Service field personnel was silence, and stories about errors, mistakes, or even successes stopped flowing.

Until the gradual shift toward accountability occurred, firefighters were expected to learn through story. The stories included adaptations that succeeded as well as those that failed, and the basic assumption was that good people were caught in a bad situation (Rasmussen, Nixon, & Warner, 1990). The organization shifted from one that had focused on ways to help good people learn to deal with the challenges of wildland fire operations to one that correspondingly attempted to provide systemic and physical barriers to help front-line personnel. Over time, adaptations were converted to errors and violations. Ultimately, the early efforts to assist and support decisions and actions would be used as a measure of compliance with rules, and people would be blamed for their own deaths under the guise of transparency and accountability.

Why Would Well-intended People Do This? Why Did This Make Sense?

In the late 1960s, mechanical failure was cited in more than 80 percent of the accidents investigated by the NTSB (Hollnagel, 2004). Mechanical accident models were the predominant analysis mode, and they fit the predominant investigation type being conducted. Mechanical investigations rely on the discovery of cause in broken parts or components. In these investigations, a thorough search is conduced to find what many called “the golden BB,” referring to the part that failed, which was believed to have caused the accident. Technical analysis was credited with significantly reducing accident rates by trending these failures and developing use and inspection intervals and design and manufacturing improvements to reduce the specific failure mode(s) (Hollnagel, 2004) (see figure 2.2).

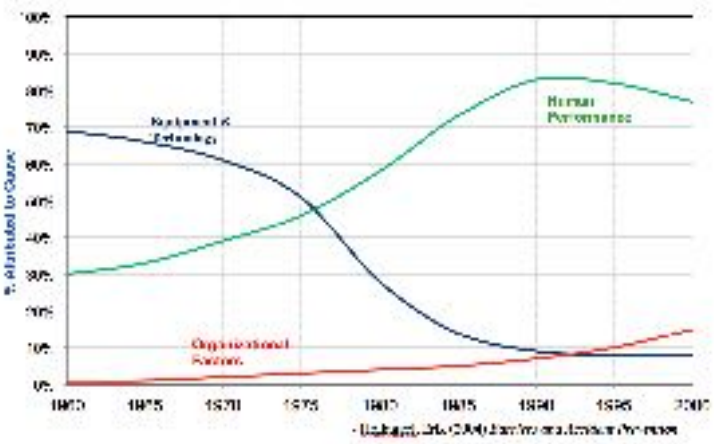

Figure 2.2: Trends in attributed accident causes (2004).

By the mid-1970s, the technical approach to accident investigation was dominant; however, there was a noticeable change in the attributed causes of accidents. “Personnel

factors," accidents as they were called, started to rise, and by 1976 they began to dominate the statistics. An NTSB safety study published in October 2001 listed personnel factors as the cause of 85 percent of all fixed-wing aircraft accidents. Yet there was no shift in the analysis philosophy. Simple cause-and-effect models, successfully used in mechanical-failure analysis, were applied directly or in a slightly modified form to all analysis aspects. Many of these were based on the tools that worked for the investigation of mechanical failures, such as statistics, trends, classification, and root-cause analysis (Hollnagel, 2004).

Mechanical investigation models rely on reducing the whole into parts that can be more easily understood or analyzed.

> Most accident reporting systems are designed and employed by engineers and front-line operators with limited background in human factors. As a result, these systems have been effective at identifying engineering and mechanical failures, whereas the human factors component of these reporting systems remains generally narrow in scope (Shappell &Wiegmann, 1997).

The reduction or disassociation of components in order to facilitate the analysis can inadvertently obscure the network of relationships between those components in favor of a linear model of relationships. H. W. Heinrich's domino model of accident causality describes five dominos, each representing system components that fall and affect the next, the removal of any one of which would result in the accident being avoided (Heinrich, H. W. as cited in Shappell & Wiegmann, 1997). This suggests that intervention should be focused on the identification of the failed domino or layer of defense so as to interrupt the causal chain.

The sequential model, represented by a chain of events, is a construction of the event based on known outcome and actions rather than an understanding of the participants' view based on what they knew about the environment (Dekker, 2002). Firefighting is a poor fit for sequential models, mainly because fire can be broken down into its chemical components (heat, fuel, and oxygen), reducing fire to a simple chemical process that is shaped by its physical environment (Pyne, 2010a). Fire is rarely seen as a biological phenomenon. Society handles fire very differently than other natural disasters, and firefighting is a subset of fire.

In the case of mechanical failure, the linear relationships exist. For example, if an engine is operated without oil, friction among components will ultimately cause them to exceed their metallurgical tolerances, and the engine will predictably fail. When a system is adaptive, the direct relationship between one component failing and resulting in system failure is non-linear, and relationship of the components to each other is more accurately represented as a web or matrix. Failures in this type of system can be more accurately described as a concatenation of conditions unique to the specific incident (Morin, 2008).

Mechanical-analysis methods work well to assess aircraft factors and technical-component failure because machines are predictable, and failures can follow clear paths. These paths can be replicated in laboratory or testing conditions (Rasmussen, 1997), and they can exhibit sequences that are repeatable and predictable. This information can ultimately be used to develop predictions based on expected trends.

The application of these same techniques proved to be less useful in human-related mishaps because people do not respond like machines. For example, no two people respond to the same conditions in exactly the same way (Flyvbjerg, 2001). In fact, it is unlikely that the same person exposed to the same conditions more than once will respond the same way. “People learn and behaviors change as a result of learning” (Dreyfus & Dreyfus, 1986). In retrospect, the causal conclusions drawn by these reports are too simple and lack the depth needed to address complex system adaptations (Hollnagel, 2002; Rasmussen et al., 1990).

Accident models based on mechanical prediction, trending, and cause-and-effect brought the language associated with mechanical failure. People and their actions were viewed as though they were “defects in the system” (Reason, 1990a). Sidney Dekker also pointed out this fallacy when he challenged the *bad-apple* theory. He sarcastically wrote, “Complex systems would be fine, were it not for the erratic behavior of some unreliable people” (Dekker, 2006). The conclusions drawn using this approach had a predictable effect on public perception and the level of trust workers expressed with regard to investigations. Reports and the public started listing human error as causal and even began blaming the dead for their own demise (Forest Service, 2010; Forest Service, 2004; Forest Service, 2001).

The mitigation strategy used by mechanical investigations singled out broken components that needed to be corrected or fixed (Dekker, 2006; Lundberg, Rollenhagen, & Hollnagel, 2009), which leads to blame. The search for broken components extended to people and was exacerbated by language where agentive descriptions led investigators to attribute more blame and request higher penalties than non-agentive descriptions. This is an example of how linguistic framing can influence judgments (Fausey & Boroditsky, 2010). Event participants can be viewed as guilty until proven innocent. Organizational management and leadership, taking their lead from language and a mechanical structure, easily supported conclusions that fit the correct-and-fix model and demanded simple hierarchical accountability (Forest Service, 2004; Forest Service, 2001; Whitlock, 2001).

They often missed opportunities to recognize that systemic boundaries and pressures created through social, economic, and structural conditions were shaping actions and decisions (Forest Service, 2008; Rasmussen, 1997). These lessons would be learned over the next seven years of accident investigation as will be represented in this dissertation’s case studies.

Summary

This chapter bridges the history of the Forest Service with that of accident investigation. In many ways it is a parallel story to the larger Forest Service story, described in chapter 1. It shows how the Forest Service evolved from prescriptive methodology that could do little else but identify culprits and blame them for their own death to the recognition that accidents can occur without the need for blame.

The Forest Service had been influenced by Scientific Management and applied it liberally to land management (Sheen, 2004). Professional Forester's became problem solvers and problems were determined to be definable, understandable and solvable. This could be seen as a value judgment, especially in accident investigations, where the absence of success was considered to be failure and individuals were held to account for their actions and decisions. This had two profound effects: First, it eliminated the ability to learn by reducing the event to an individual failure. Second, it made the workforce distrustful of the organization and, therefore, less willing to provide information.

This chapter is designed to show how the policy of accident investigation evolved from a place of understanding context, in the early 1950s and 1960s, to a fixation on solving tame problems. The influences of external agencies and scientific practices are explored, to show that this evolution was not done out of malice, rather, it was the result of influences that were common during the 1970s and 1980s. One key aspect of the chapter is the exposé that this movement toward cause-effect relationships and mechanical (scientific) analysis removed context from actions and decisions.

Chapter 3: The Serious Accident Investigation Guide—Pressure to Standardize the Investigation Process

You have your way. I have my way. As for the right way, the correct way, and the only way, it does not exist. --Friedrich Nietzsche

Introduction

This chapter explores the way that the Forest Service began to react to internal and external pressures to explain accidents and incidents, which led to the development of the Serious Accident Investigation Guide (SAIG). It illustrates the common language and processes advocated by the accident investigation community and the limited academic sources included in the SAIG.

The chapter begins by showing that the process of investigation was not meeting the needs of the organization and that numerous reports had content that detracted from the desired goal of accident prevention. The SAIG, first developed in 2001 and later revised in 2003 and 2005, is described in enough detail for the reader to understand the goals and desired products the guide espouses. There is an attempt to understand that different audiences will benefit from different information and this is addressed by creating two reports, an Accident Investigation Report that is released to the public and a Management Evaluation Report, which is designed for internal leadership only. This gives rise to the belief that there is a secret report withheld from the field of practice, which adds to growing distrust in the system.

Through a series of checklists, the SAIG guides the reduction of complex interactions into definable bites that can be digested into cause-effect narratives that are considered to be factual. The language of the SAIG and the recommendation that judgmental terms and phrases are used in the report are discussed in detail and the process can be seen as a vehicle that inspires the construction of cause and blame. Chapter three begins to challenge the use of language, as well as the investigative process, itself, by asking if it is possible to create a factual report based on the accounts of individuals who were close to the incident or accident.

System Demands for Structure

The 1980 taskforce report to interagency leadership was inspired by the loss of 15 firefighters in 1929. The taskforce reviewed tragedy accidents that had occurred in

wildland firefighting operations. One of the major recommendations was the creation of an organized approach to accident investigation. This recommendation was based on a perceived need for an investigation process that was centered on prevention alone. The taskforce believed that the existing process was attempting to answer to a number of competing goals (National Wildfire Coordinating Group, 1980). This effort ultimately resulted in the creation of the interagency *Serious Accident Investigation Guide* (SAIG) in 2001 (see figure 3.1).

Reviewing the fire-related fatal and near fatal accident reports compiled for this study, one gets a different impression of the purpose for which these investigations were conducted, and of the uses for which these reports were intended. Purposes other than accident prevention seem to influence the information gathering process and the finished report. Some of these collateral purposes appear to be:

a. Line of duty determinations for injured or killed persons

b. Protection of employee or survivor benefits

c. Protection of government interests - from a claims standpoint

d. Determination of private party liability

e. Law enforcement aspects of man-caused fires

f. Justification of: management's fire suppression policies, actions on particular fires, and money spent on suppression

Figure 3:1: Excerpt from the 1980 NWCG Task Force Report.

The *SAIG* is essentially a series of checklists designed to help investigators in the creation of a management evaluation report, an accident investigation report, and a safety action plan (known in the Department of Interior[18] as an accident prevention action plan). The safety action plan is a vehicle by which recommendations are assigned and tracked. Final reports are presented to an accident review board for approval. This board is commonly made up of Forest Service senior executive service employees,[19] program managers, and directors (different for the Department of the Interior).

[18] DOI – The Department of the Interior supports the Bureau of Land Management (BLM), US Fish and Wildlife Service (USFWS), National Parks Service (NPS) and Bureau of Indian Affairs (BIA), each of which have land management and firefighting responsibilities.

[19] Senior executive service (SES) members serve in the key positions just below top Presidential appointees as a major link between these appointees and the rest of the federal workforce. They operate and oversee nearly every government activity in approximately 75 federal agencies.

The Serious Accident Investigation Guide (SAIG)

The first formal interagency attempt to standardize an approach to accident investigation was the *2001 Serious Accident Investigation Guide* (Whitlock, 2001). "This guide is designed to be used by investigation teams who are assigned to conduct a Chief's Level investigation" (Whitlock, 2001). This type of investigation is typically initiated when a fatality or injury requiring significant hospitalization has occurred; this criterion is consistent with Occupational Safety and Health Administration (OSHA) recording criteria (OSHA, 1970). As the name implies, this process is to be used on accidents that are considered to be serious. This concept is consistent with folklore regarding accident causality that suggests the bigger the consequence, the bigger the problem that caused it. This approach leads to the need for intense scrutiny of the more serious events. Additionally, large-loss events attract more attention and as a result, may demand more accountability from external sources.

Organizations like OSHA and the NTSB left more than a small impression on the SAI process. The opening paragraph of the 2001 SAIG begins with a phrase that mirrors OSHA's General Duty Clause[20] and highlights the expectation of control over the natural environment, which is a common belief in mechanical and "urban built" environmental models (Saveland, 1998). "Supervisors and managers at all organizational levels are responsible for ensuring employee safety and for providing a workplace that is free from recognized hazards" (Whitlock, 2001). The Occupational Safety and Health Act became law in 1970, and this clause has been an OSHA cornerstone since then. There is an interesting albeit unintentional conflict established when the SAIG uses the act language: The Forest Service and the other land management agencies require that people engage with known hazards in the work environment, and each agency actually pays firefighters a hazard-pay differential to engage in hazards like fighting wildland fires.

The SAIG is divided into nine chapters (not including the glossary and abbreviations sections). Each chapter is designed to be followed sequentially, in checklist fashion (see figure 3.2). Most references to the SAIG will be to the 2005 SAIG. This latter edition was in use during the period covering all four case studies used in this dissertation. In the event that an earlier SAIG is relevant to the discussion, the text will reflect the edition being referenced.

[20] OSHA Act of 1970, Section 5 "Duties," General Duty Clause, "Each employer -- (1) shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees" (29 USC 654).

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Figure 3.2: Table of Contents, 2005 Serious Accident Investigation Guide

The first paragraph of the 2005 SAIG addresses supervisors and managers as responsible for ensuring employee safety. There is an implicit, not-so-subtle, support of the search for "latent organizational failures" common to the epidemiologic model (Maurino, Reason, Johnston, & Lee, 1998; Reason & Hobbs, 2003; Shappell & Wiegmann, 1997).

> Since no one can foresee all the possible scenarios of disaster, it is therefore inevitable that some defensive weaknesses will be present from the very beginnings of the systems productive life, or will develop unnoticed—or at least uncorrected – during its subsequent operation (Reason, 1997).

This approach does little to recognize the role or the importance of creation of safety by workers as they face situations daily. Another key assumption inherent in this declaration is that leadership creates safety through rules, regulations, policies, and procedures and if people would just follow the rules, everyone would be safe (Dekker, 2002).

The next line of the 2001 SAIG, repeated in the 2005 SAIG, establishes a base for understanding how actions and decisions are to be addressed. "The causes of most accidents or incidents are the result of failures to observe established policies, procedures, and controls" (Whitlock & Wolf, 2005). This approach is deeply rooted in the illusion of cause-consequence equivalence or the assumption that really bad consequences can only be the result of really bad actions or decisions, most frequently judged as errors (Dekker, 2002).

The inadequacy of individual actions and the efficacy of such actions are addressed in the third line of the 2005 guide: "All too often, accident investigations reveal existing hazards that were not adequately addressed" (Whitlock & Wolf, 2005, p. 2). To fulfill this challenge, the investigator must ignore local rationality and assume that the operator was deficient and that deficiency equates to the absent or inadequate behavior. It also assumes that the operator was able to notice the conditions that contributed to the incident—conditions which become extremely clear after an incident has occurred—which is an apparent reflection of hindsight bias (Fischhoff, 2007) inherent in the SAI process.

The fourth line of the 2001 SAIG addresses hazards and hazardous practices. This line of instruction suggests that the organization did not address the hazard or that the individuals were engaged in a hazardous practice that should be corrected. In a sense it is the culmination of the previous three lines and reads, "Hazards or hazardous practices must be corrected to prevent accidents and incidents." This lays the groundwork for recommendations designed to correct and fix the broken person, thus eliminating the hazardous practices. Hazard correction is especially vague and may refer to systemic hazards, which would be a positive alternative approach.

When the guide was re-written in 2005, this paragraph was changed to read as follows:

> Supervisors and managers as all organizational levels are responsible for identifying and abating hazards, incorporating safe operating procedures into each of our daily tasks, and refusing to accept unnecessary risk. The causes of most accidents or incidents are a result of failures to observe established policies, procedures, and controls. All too often, accident investigations reveal existing hazards that were not adequately addressed (Whitlock & Wolf, 2005, p.2).

When this approach was applied to actual incidents, the full impact of this guidance and its language became apparent to the firefighting community. The reports generated using this process listed "findings and causal factors" in sections of reports that pointed to individual failure and deficiency. Causal factors often presented judgment of actions that were dissociated from any context that would facilitate understanding why these actions might have made sense at the time (see figure 3.3).

Causal Factors from the Cramer Fire Accident Investigation

1. Management Oversight was inadequate.
2. The IC did not adequately perform his duties to execute safe and effective suppression operations.
3. The IC's attention was diverted to issues other than the Cramer Fire.
4. There was a failure to comply with policy.
5. There was a failure to recognize and adjust strategy and tactics when initial fire suppression efforts failed.
6. There was a failure to accurately assess the fire situation, hazards, and risks on the Cramer Fire.
7. There was inadequate integration of the H-2 operation into the Cramer operation.
8. There was a delay in formulating and execution a plan to retrieve the rappellers for H-2.
9. The rappellers were caught in a burnover.

Figure 3.3: Causal Factors from the Cramer Fire Fatality Report

A letter of delegation to the investigation team leader and chief investigator normally initiated the SAI. A typical letter included direction to the team from the chief of the Forest Service regarding her/his specific intent and on occasion, the investigation method the team should use. For example, the Thirtymile accident investigation letter of delegation directed the team to do the following:

> 7. Through a thorough analysis of accident sequence, human factors, and environmental factors determine:
> Direct causal factor(s) of fatalities;
> Contributing factor(s) surrounding the accident (Forest Service, 2001).

This re-enforced the SAIG concept that cause is something that can be discovered in complex social environments. It also supported concepts common to investigation theory of the 1970s of a causal sequence or chain of events. The belief in the existence of accident causal chains resulted in investigations that focused on the identification and

removal of the weakest link. Ultimately this contributed to the bad-apple theory. If bad apples can be identified and removed, the safety of the system will be restored (Dekker, 2006).

The belief in causal relationships, linear models, agentive language, and the ability of an organization to predict and prevent incidents resulted in an approach that sought specific answers to specific questions; all unintentionally introduced biases into the investigation process (Vesel, 2012). The language used in posing questions as well as the questions themselves can influence investigators to look in specific ways and in specific places for specific things (Hollnagel, 2008). In mechanical-failure analysis, this works, mainly due to the ability to develop objective empirical data supported by laboratory analysis (Wood & Sweginnis, 1995). Objective quantitative data is rare in social contexts that are much more relational than directly attributable. Facts in a social context are constructed (Gergen, 2009).

It is important to note that the SAIG is attempting to lead investigators through an analysis of more than the human contribution (Whitlock & Wolf, 2005). The cause-effect relationship may be applicable to most mechanical failures, for example, and in that context can be an important prevention tool. The tension arises from the fact that very few, if any, accidents are unrelated to human contribution and the application of a cause-effect model on social interactions and human decisions rarely results in more than a judgment of actions as errors (Dekker, 2006; Hollnagel, 2009b).

By 1997, Reason built on the earlier concept of in-depth defenses that are breached and barriers that have inherent weaknesses or holes. The *Swiss-cheese model* (SCM)[21] emerges as a key metaphor for this concept and finding and fixing holes becomes the goal of major accident investigation processes (Wiegmann, Rich, & Shappell, 2000). The model becomes a tool to identify where to apply additional barriers to bolster defenses and to contain the energy of an accident (see figure 3.4).

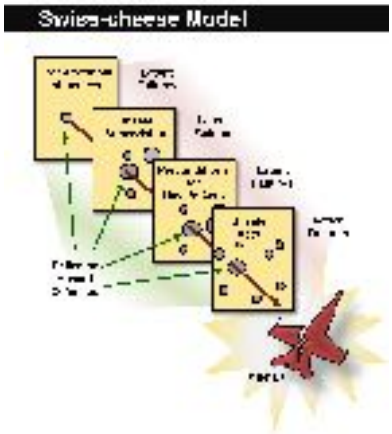

Figure 3.4: Swiss-cheese model within accident investigation processes.

[21] This model metaphorically uses the concept of Swiss cheese to represent systemic layers of defense; the layers each have holes and the holes represent what Reason called *latent conditions*. This metaphor emerged as other researchers were experimenting with ways to describe Reason's concept of an epidemiologic approach to accident investigation. James Reason did not call his model Swiss cheese; however, this label was at some point attached to this model. Today, the term Swiss-cheese model is most commonly linked to Reason (Reason, Hollnagel, & Paries, 2006). This model has also been referred to as the *energy to be contained* or the *epidemiologic model* (Dekker 2007; Reason, 1980).

The SAIG has a section devoted to the human factors analysis and classification system (HFACS), which is an attempt to identify the human causes of an accident in order to assist the accident investigation team in targeting training and prevention efforts (Shappell & Wiegmann, 1997). HFACS taxonomy uses SCM to determine four levels of failure:

- Unsafe acts subdivided into error or violation.
- Pre-conditions for unsafe acts subdivided into environmental factors, condition of operators, and personnel factors.
- Unsafe supervision subdivided into inadequate supervision, plan inappropriate, failure to correct known problems, and supervisory violations.
- Organizational influences, which guides the user to find failures in resource management, organizational climate, or operational processes.

The intent of this product seemed genuine; however, the language was found to be agent-oriented, and "agentive descriptions of events invite more blame and more severe punishment than do non-agentive descriptions" (Fausey & Boroditsky, 2010). This approach seemingly dismissed prevention efforts that were focused on the system rather than individuals (Reason & Wagenaar in Rasmussen et al., 1990).

Internal factors that influenced the SAIG Taskforce Reports

By 2001, the Forest Service developed a long history of responses to adverse outcome events. These responses primarily focused attention on plugging holes in the system and recommended the development of many of the rules, regulations, policies, procedures, and physical barriers currently in use during wildland firefighting operations (Forest Service, 1957; Forest Service, 1967; and National Wildfire Coordinating Group, 1980). Physical barriers include fire shelters, boots, and other personal protective equipment (PPE).[22] Many recommendations came as a result of special taskforces or boards that specifically looked at the lessons learned from a number of incidents rather than from single incidents (Forest Service, 1957; Forest Service, 1967; and National Wildfire Coordinating Group, 1980). One excellent example of this was the development of a research arm of the Forest Service established to understand fire behavior and fire weather, which then developed courseware for the firefighting community.

The first Forest Service fire task force (Forest Service, 1957) reviewed 16 tragedy fires from 1936 to 1957 in which 79 men lost their lives. This report compiled a list of 11 factors common to many but not all of the fires (Forest Service, 1957). The report's major

[22] That equipment and clothing required to mitigate the risk of injury from or exposure to hazardous conditions encountered during the performance of duty. PPE includes but is not limited to: fire resistant clothing, hard hat, flight helmets, shroud, goggles, gloves, respirators, hearing protection, chainsaw chaps, and shelter.

recommendations resulted in an investment in fire-behavior analysis and training, as well as the development of the *Ten Standard Firefighting Orders.*[23] The recommendation read, "The use of a form of Standard Orders starting immediately would be a long step in the direction of assuring attention to the fundamentals" (Forest Service, 1957). The *Ten Standard Firefighting Orders* resulted from interaction with the US Marine Corps and US Army who fought fire alongside Forest Service personnel. This relationship resulted in numerous opportunities to share information and processes (Steen, 1976) (see figure 3.5).

4. SUGGESTED DRAFT OF "STANDARD FIREFIGHTING ORDERS"

STANDARD FIREFIGHTING ORDERS

1. FIRE WEATHER. Keep informed of fire weather conditions and predictions.
2. INSTRUCTIONS. Know exactly what my instructions are and follow them at all times.
3. RIGHT THINGS FIRST. Identify the key points of my assignment and take action in order of priority.
4. ESCAPE PLAN. Have an escape plan in mind and direct subordinates in event of a blow-up.
5. SCOUTING. Thoroughly scout the fire areas for which I am responsible.
6. COMMUNICATION. Establish and maintain regular communication with adjoining forces, subordinates, and superior officers.
7. ALERTNESS. Quickly recognize changed conditions and immediately revise plans to handle.
8. LOOKOUT. Post a lookout for every possibly dangerous situation.
9. DISCIPLINE. Establish and maintain control of all men under my supervision and at all times know where they are and what they are doing.
10. SUPERVISION. Be sure men I commit to any fire job have clear instructions and adequate overhead.

Figure 3.5: First ten Recommended Standard Firefighting Orders.

A decade later the 1967 taskforce created a report titled, *Fire Safety Review Team: A plan to further reduce the chances of men being burned while fighting fires*. This team evaluated 27 tragedy fires, 13 of which resulted in a "loss of 42 lives by burning." It also examined the "fire safety progress made since 1957." The report's conclusions resulted in recommendations regarding the development of rules for downhill line construction; improved communications; improved fire scouting criteria; a recommendation that all Forest Service regions adhere to "service-wide principles of organization" (an attempt to align nomenclature); a recommendation to equip personnel with fire shelters; fire protective clothing; an emphasis on pre-attack planning; and the continuation of "an aggressive fire behavior training program" (Forest Service, 1967).

By 1980 the National Wildfire Coordination Group (NWCG) had been formed with representatives from each land management agency that engaged in wildland firefighting operations:

[23] Standard Orders were common in military organizations as a way to ensure that minimum standards were met during missions.

Department of Agriculture – US Forest Service

Department of the Interior – Bureau of Indian Affairs, Bureau of Land Management, National Park Service, and US Fish and Wildlife Service

This interagency group provided each agency with an equal voice in firefighting operations, guidance creation, and incident accident investigation processes. NWCG conducted a taskforce review of *Fatal/Near-Fatal Wildland Fire Accidents*. This report for the first time contained a section titled "Human Behavior." This report language differs considerably from that of the previous two taskforce reports. The NWCG report recommended the standardization of the interagency approach to accident investigation (human behavior was not mentioned in this section). The report included the "Purpose of Preparing Reports; Uniformity, Quality, and Availability of Reports; and Objectives of Fire Reviews" (National Wildfire Coordinating Group, 1980, p. 10).

The 1980 report also quoted a description of the purpose of accident investigations, borrowed from the US Energy Research and Development Administration's (ERDA)[24] Accident/Incident Investigation Manual:

> The primary purpose of an accident investigation is to prevent similar occurrences and thus improve the safety of ERDA operations. The emphasis should be on discovering all cause-effect relationships from which practical corrective remedial actions can be derived. The intent is not to place blame, for all people err, but to determine how responsibilities may be clarified and supported and errors reduced…The purposes do not include: enforcement proceedings, liability determination, or controlled research—all of which require supplementary or separate investigations (National Wildfire Coordinating Group, 1980, p. 10).

The ERDA approach appeared to be designed to avoid placing blame; however, the cause-effect relationship and the belief in the ability to correct and fix deficiencies were still apparent in its guidance.

Of particular importance to this dissertation is that the 1980 NWCG report indicated that accident reports had been used for purposes other than prevention and that this was not considered acceptable (National Wildfire Coordinating Group, 1980).

The report (1980) inquired with advocacy:

[24] President Nixon called for a Department of Energy and Natural Resources, and also asked for two additional agencies to replace the existing Atomic Energy Commission. The Energy Research and Development Administration was created in 1974 to develop fossil fuels, nuclear power, and potential new forms of energy, while the five-member organization of the Atomic Energy Commission, plus its licensing and regulatory functions, would be transferred to a separate and renamed Nuclear Energy Commission.

> Can fire management realistically expect frank and open discussion of the accident circumstances, e.g. management failure, employee error, etc., when the collateral uses of this information are know the witnesses, investigators, and management? Does the influence of these other purposes have a sanitizing effect on the report? (National Wildfire Coordinating Group, 1980)

Although the 1980 report considered the adverse effect that including multiple purposes in accident investigations might have on the willingness of people to provide information, it did not consider the effect of identifying error and failure. In the next paragraph, the 1980 report said the following:

> Personnel providing statements and/or eyewitness accounts are aware of the many uses to which their information may be put. Concerns such as the protection of a fellow employee, etc., may tend to reduce the accuracy of the information provided. Even if such concerns are not valid, this perception will restrict the information flow (p. 11).

This quote recognized the importance of the way the report might be perceived on the part of personnel who could provide accounts to investigation teams. The effect of these perceptions is further supported by the 1980 Taskforce Report, which refers to the quality of near-miss information:

> For comparison, contrast a *near-miss* report to [that of] the report of a fatality. With no loss of life or major property damage, the influence of collateral investigation purposes on the final report is much less. Witnesses are normally more willing to be open and frank, management does not feel paranoid about releasing all pertinent information, and a much more accurate and useful report results. (National Wildfire Coordinating Group, 1980, p. 11)

Aside from being a strong argument for the importance of studying near-miss situations, the potential for bias and reluctance to provide information to fatality investigations, as a result of perceptions, is clearly indicated.

The 1980 report is the first recorded declaration of the need to standardize the approach to accident/incident investigation reports. The focus at that time was directed on the accident-report format, scope limitations, and to a lesser degree the investigation process itself. A single-page form was recommended for all data collection from incidents regardless of the severity of the outcome. This recommendation explained that data should be collected *objectively*. The board also established criteria for what it thought was missing from reports due to the multiple goals; this list included questions they believed each report should address (National Wildfire Coordinating Group, 1980, p. 12):

- What were the dangers to life and property during the fire?
- What were the suppression/management options?
- What actions were employed and why?
- Did the chosen actions turn out advantageously from the standpoint of:
- Protection of life and property
- Safety of fire personnel
- Cost effectiveness

These questions suggest alternative purposes that seem inconsistent with the ERDA description of the purpose of accident investigations: for example, cost effectiveness.

Major Accident – Major Change, Storm King Mountain

In 1994 outside the city of Glenwood Springs, Colorado, 14 firefighters were trapped and burned to death trying to out run a rapidly advancing fire. The investigation team cited the failure to follow the Ten Standard Firefighting Orders and the can-do attitude of the firefighters. This was the same *can-do* attitude that had been a point of pride in previous generations of Forest Service personnel. The Ten Standard Firefighting Orders had, by this time, been enhanced with the 18 Situations that Shout Watch-out (the 10 & 18). Following the accident the Chief of the Forest Service proclaimed the following about the 10 & 18: “We don't bend ‘em and we don't break ‘em” (Interagency, 1994).

The 10 & 18 had evolved from guidance to a metric for the evaluation of the firefighter’s compliance with rules, regulations, policies, and procedures. This would become a trademark of the SAIG and subsequent investigations completed using the guide.

However, there was dissention in the ranks; one of the subject-matter experts on the Storm King investigation team, Dr. Ted Putnam, refused to sign the report. Instead he insisted on the importance of understanding the incident from the perspective of human factors. His efforts resulted in the first Human Factors Conference and several internal Forest Service publications. In 1995 Putnam recognized the importance of understanding *why* the event occurred.

> There’s no question individuals must be held accountable for their performance. But the fire community must begin determining at psychological and social levels why failures occur. The goal should not be to fix blame. Rather, it should be to give people a better understanding of how stress, fear, and panic combine to erode rational thinking and how to counter this process. Over the years, we’ve made substantial progress in modeling and understanding the external factors in wildland fire suppression and too little in improving thinking, leadership, and crew interactions (Weick, 1995).

This was a major effort to move the organization toward a different type of investigative process and there were some effects, noticeable in the next edition of the SAIG. A section called *Human Factors Accident and Incident Analysis* (Whitlock & Wolf, 2005) was added. This section, discussed earlier, is fashioned after HFACS. It is designed to identify an accident's human causes and to provide a tool to support the investigation process in targeting training and prevention efforts (Shappell & Wiegmann, 1997). Putnam's approach was based on the work of Karl Weick, which differs significantly in approach to HFACS. Weick advocates a model centered on sensemaking.

Summary

Prior to the Panther Investigation, the standing belief was that reports represented facts collected during the investigative process. As such, the reports were considered factual accounts. Frequently the reports were single-perspective narratives that either averaged accounts of participants that disagreed or that only told perspectives supporting the plausible theory that the team chose to support. This was not intentional on the investigators' parts; they are trained to produce factual reports and to create solutions to identified problem(s). The guiding premise, or social construction, is that because there was an accident there has to be a problem. Mechanical failures respond well to this approach; however, the analysis of human-related actions and decisions does not.

Facts, narratives, and conclusions are often the result of imagined cause-effect relationships constructed from a realist perspective. When cause-effect relationships exist, as in most mechanical failures, this approach creates an accurate, empirical assessment of the event, which can be tested and verified in laboratory settings. The theoretical assumptions, biases, and values common to the natural sciences, color and construct what we take to be the fact (Gergen, 2009, Gergen et. al., 2004; Flyvbjerg, 2001). However, when this same approach is applied to social actions common to all human interactions, the results may only represent a single explanation. The search for evidence will be influenced by the accident theories, the language used to explain them, and the team's philosophical approach. What results is a socially constructed, yet plausible explanation of the event from the single perspective of the investigation team (Woods et al., 2010).

There is greater potential for collateral damage through the creation of a report that is structured around fact and cites actions as causal. This damage is most often felt by the people closest to the decisions and actions. This is called the creation of "second victims:" people who are traumatized by the investigation and/or its judgments (Dekker, 2011a). "In daily life, many of our categories lead to untold suffering. Consider the distress and death that have resulted from such phrases as: He is to blame […] They are evil" (Gergen, 2009). This represents a way of describing the world and explaining actions and decisions with a language of blame based on the assumption that a cause-effect relationship existed. A common theme in such reports uses a counterfactual argument, i.e., the

participants could have recognized the relationship between action and outcome; therefore, they should have avoided the outcome (Dekker, 2002).

> The SAI is an investigation-oriented process introduced in 2001. Despite improvement efforts, use of this product failed to change annual Forest Service fatality rates that have remained essentially unchanged for 40 years. Over that period, the Forest Service work-related fatality rate has averaged approximately 6.5 on-duty employees per year. This tragic statistic is evidence that our previous post-accident processes, including the SAI, have been inadequate in capturing the learning needed to reduce, much less prevent, such serious incidents (Forest Service, 2014).

There were many reasons that the process of accident investigation grew to serve many purposes. Some of these may have been the result of decreasing budgets and the perceived need to do more with less. The SAI process is still designed to capture information for claims against the government; protection of the government; determination of liability; and the determination of line-of-duty death. These are important items that must be handled after an accident; however, they also introduce goal conflicts when they are combined in a single safety investigation. This information is unquestionably needed in our modern litigious society; however, the search for cause and the myriad of conflicting goals ultimately contributed to the lack of faith in the SAIG process and subsequent challenges to its use.

Chapter 4: The Norcross Case Study

Introduction

The Norcross Case Study addresses the challenges I faced as the Chief Accident Investigator, while I tried to implement the SAIG. It begins with a description of the event and a synopsis of the report. Most importantly, it exposes the challenges associated with the reductionist model espoused by the SAIG. The concept of complex adaptive systems is introduced, in both the chapter and the investigation, but at this point it is poorly understood. What is recognized is the need for an approach that is open to understanding the human contribution to accidents, rather than judging human actions as adequate, erroneous or, in the worst case, as violations.

Two major conflicts are introduced in the Norcross case study: First, the importance of context and the apparent unimportance of cause. Second, the recognition that it was impossible for us, as an investigation team, to fully comply with the SAIG. To begin with, we recognized that there was no possible way for us to resolve all the interactions at Norcross into a list of causal factors. Our desire to understand why it made sense for those involved in the accident to do what they did influenced us to ask very different questions. Finally we recognized that to accomplish the goal of the SAIG and provide complete answers, we would have to construct, or fabricate them.

Event Summary[25]

On July 23, 2007, an accident occurred in a remote area of northern California on a fire that was winding down. Crews were doing what is referred to as “mop-up,” which is where hand crews search the edge of the fire for any embers that might grow into larger fires. This activity can even involve sifting through soil with bare hands.

The crew supervisor ordered water blivets (bags filled with 1,000 pounds of water) to be delivered to a location near the fire. Crew leaders want the best for their people and will often try to get water so that crewmembers can do this work more effectively. The dispatch system complied and sent a Bell 205++ helicopter. The mission was not uncommon, and the aircraft and pilot were both *carded* (qualified and certified) for the mission.

[25] The following executive summary is based on The 2007 Norcross Fatality Serious Accident Investigation Report, field notes, and personal interviews.

Day One

The division group supervisor (DIVS) was a very charismatic leader with the best intention of serving his crews. He was visiting and talking about options with the crew leader and noticed that the crew leader was using a lightweight, brightly colored flagging to direct helicopters to critical areas of the fireline that required air support. This kind of flagging is very effective for ground personnel when marking a trail, but it is difficult to see from the air. The DIVS knew that a heavier marker called a panel would be more visible from the helicopter and left one on the ground so the crew leader could use it the next day to mark the spot where the blivets of water should be placed to best support the crew (see figure 4.1).

Figure 4.1: Panel (40” X 9”) as observed two days after the Norcross accident.

Day Two

The incident helicopter arrived over the panel and began an approach to drop off the blivets. There was a large sugar pine off the right side of the helicopter and the marshaller, who was on the ground talking with the pilot (via radio), pointed out the hazardous tree to the pilot, who acknowledged its location. The helicopter lowered the blivets to the ground and the hitcher, whose job is to detach the load from the long-line, moved in. The load was unhooked and the helicopter flew away just as this type of operation had been done many times before; type of mission is often completed without ground personnel being present. The firefighters filled their bladder bags with water and started toward the fireline.

This was normal work for almost all of those involved in the incident. Moments before the helicopter lowered the blivets, two first-year firefighters were walking down to the drop zone to get water when they saw the helicopter approach. They noticed the large sugar pine and became concerned about the potential for danger, as the tree looked very close to the helicopter from their perspective—too close, they reported later to the investigation team. They chose to run back uphill to a place that seemed safer. They later stated feeling somewhat embarrassed when nothing bad happened. After a few minutes they emerged without saying a word and walked over to the blivets to fill their bladder bags.

Operations were normal, or so it seemed. The crew used the water rather quickly and called for another load to be sent up the next day. It was a long walk to the vehicles and then a long drive to base camp. As they were walking out, a couple of crewmembers started talking about bringing a video camera to take film of operations the next day,

especially the aviation operations. They talked in small groups, but never as a crew, and nothing about the day really stood out in these conversations. After all, the day was a success; nothing bad had happened.

Day Three

The drive and hike to the fire took hours, but the crew was there in time to meet the aircraft and get its second load of blivets. Crew members waited a short distance from the drop zone so they could once again fill their bladder bags with water and get to work. The spot they chose gave them all a clear view of the site where the helicopter would approach and lower the load. In order to gain experience, a different marshaller and hitcher were selected to work with the helicopter pilot. They were both qualified for this duty. The marshaller had watched the drop the previous day and was concerned about the proximity to trees. He radioed back to the DIVS to ask the helicopter to put on more line to ensure there was greater separation from the trees. DIVS relayed the information to the base and the reply was that the helicopter had an added 50 feet of line and was airborne on its way to the site.

The helicopter pilot approached the same way as he had the day before. The only differences were that today the pilot would have to hold position while the empty blivets were attached to the long-line (so they could be taken back to the helibase to be reused) and that one of the crewmembers on the ground was videotaping the event.

As the aircraft approached, the marshaller tried to establish radio contact with the pilot but could not get on the frequency because another aircraft was using it. The helicopter kept coming, getting closer with each second. The marshaller started to get nervous, as he thought there would be no way he could give the countdown to touchdown for the pilot. This is done so the pilot will have confirmation of when the load hits the ground. Plus, the marshaller wanted to say something about that big sugar pine that had been talked about the day before. He knew the spot was tight. Just in time to start the count down, Ten…nine…eight (feet to go)—but not in time to discuss the tree—the frequency opened up, and the marshaller started the count.

The helicopter descended, and the blivets were lowered to the ground (the video shows the approach of the helicopter; the long-line with blivets attached; and even the pilot, bent over looking at the load in the right-side window). To most observers everything was just as it had been the day before (the video shows the aircraft in a hover and then it starts drifting slowly toward the sugar pine). The impact with the tree is dramatic. The ground crew started to run almost immediately, and the helicopter turned radically downhill away from the tree before crashing and burning. The helicopter's single occupant died of blunt-force trauma.

The Investigation Process

The accident investigation was formally promulgated under the NTSB. The NTSB investigator in charge transferred the field investigation to the Forest Service. Forest Service Director of Occupational Safety and Health Hank Kashdan convened a serious accident investigation team (SAIT) to investigate the incident, and I was assigned as the chief investigator. 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 ergonomics from the University of Southern California.

The NTSB directed the team to answer the question, "Was this accident mechanical, or was it human-caused?" This question was consistent with formal investigation training, the Serious Accident Investigation Guide (SAIG), and the NTSB's expressed desire as the regulator to whom the investigation team reported. At the time the question seemed so natural it was not challenged. The team devoted time to answering the mechanical question first, and the engine was sent to the manufacturer along with a videotape of the actual incident for analysis.

The search for cause was central to the focus and intent of the Norcross investigation. The general flow of interviews and collection of information was pointed toward answering the key question of causality. The prevailing methodology was to identify lapses, weaknesses, absences, and deficiencies in the existing system so that they could be filled or mediated by the addition of some type of barrier or correction.

The 2005 SAIG called for a similar explanation of cause: "A causal factor is any behavior, omission, or deficiency that if corrected, eliminated, or avoided probably would have prevented the accident." In addition the SAIG instructs investigators to write causes using the most agentive language: "Developing causal factors—Write causal factors in the active voice, clearly identifying the actor(s) and causal action, along with any necessary explanation. For example: Active voice–The vehicle operator did not use wheel chocks as required by policy. Passive voice–No wheel chocks were used by the vehicle operator (Whitlock & Wolf, 2005).

The separation of human from mechanical cause and the search for a root cause was also supported by Forest Service summary reports and conclusions. For example, in the annual accident summary report for 2007, the existing Forest Service position regarding human caused accidents was summarized as follows:

> Human vs. Mechanical – Human cause when a human error was the causal factor made by the flight crew. Mechanical cause – when there is a mechanical failure that causes the accident; however, in almost all mechanical accidents, human errors are determined to be the root cause.

> For example, a bolt breaks and causes an accident, but the bolt was not the correct bolt (Forest Service, 2007).

This model or approach does not require that any action or decision be placed in context. The Norcross team was not satisfied with this approach and felt an urgent need to know why. In the example above, “Why was the wrong bolt selected or in use?” There are usually a myriad of supporting conditions that created a situation where that selection, action, or decision made sense to the person involved at the time. This formed the need for the Norcross SAIT to deviate from the normal type of report.

The Norcross investigation dutifully researched the mechanical aspects of the incident and determined that there was no mechanical malfunction that contributed to the event. This information was reported to the NTSB along with the initial conclusions regarding radio congestion. The NTSB was content with an explanation that included the failures in the system identified by the Norcross SAIT:

> The National Transportation Safety Board determines the probable cause(s) of this accident to be: the pilot's failure to maintain clearance with the trees during a long-line operation. Contributing factors were the Forest Service's inadequate communication between crews, failure to properly assess the safety of the intended drop zone, reduced visibility to the right side of the helicopter, and the trees (National Transportation Safety Board, 2008).

The influence of Isaac Newton can be seen in the cause-effect relationships described in both reports (National Transportation Safety Board, 2008). The separation between human and machine into discreet, separable components is consistent with this societal influence and perpetuated by a belief that an independence exists that investigators can probe, and as long as they have the right tools and tenacity, they can objectively determine cause by simply reducing the problem into component parts (Dekker, 2002).

The SAIG states that components should be separated into human, environmental, and mechanical categories. This is another indication that supports the desire to separate components from each other rather than consider how components interact to create outcomes. This concept is called reductionism (Dekker, 2002). This approach is consistent with linear cause-effect models, which suggest that components can be viewed in isolation and that analysis of the parts in isolation to provide the story needed to correct and fix the problems inherent in the system (Reason, 2000; Shappell & Wiegmann, 1997). This approach also advocates that cause is something to be simply discovered and the more objective the approach, the more likely the investigation is to determine cause (Dekker, 2002; Dekker, 2011a; Hollnagel, 2002).

Shifts in Process or Analysis from the SAIG

There were a number of shifts in the approach to investigation beginning with a fundamental shift in the initial premise of an *investigation*. These were followed by changes to the report structure and to the way data (or findings) were presented.

Procedural Shifts

Once the SAIT determined that the incident was not the result of mechanical failure, the SAIG statement that "the causes of most accidents or incidents are a result of failures to observe established policies, procedures, and controls" (Whitlock & Wolf, 2005) needed to be addressed. By this reasoning, once the team determined that there was no mechanical failure, the only cause available was human error. The team could identify a number of problems in the system, all of which could be considered causal, but none of which stood alone as a cause. There seemed to be an amalgamation of related conditions that supported the outcome.

As a result the team created a list of conditions that set the stage for human error. This was an early recognition that human error does not stand alone as cause for an incident. 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 action or the outcome. The team did not understand at the time that this was the beginning of understanding complexity and the relationships that have to be in place for any outcome to result—even an accident.

The Norcross SAIT began to understand the context that surrounded each decision or action. The resulting fundamental shift in approach was a concurrence that challenged the status quo: "If something bad happened, then someone had to have made a mistake" (Department of Interior, 2003). This statement suggests cause is attributable to the mistake or error identified by the team given the authority to make such determinations or judgments.

In the SAIT chief investigator's opinion, the NTSB causal statement lacked context. The Norcross SAIT was unaware of the early history of Forest Service investigations (1950s and 1960s) and did not know that placing actions in context had been common practice. The team used the Swiss-cheese approach but added a short narrative that ended up being quite similar in language to the early Forest Service investigation reports. The final Norcross report did cite "human error" as causal; however, it devoted an entire section to contextualization of the error (see figure 4.2).

The 2005 SAIG states the Human Factors section of the report should be placed in the appendix. This direction avoids the identification of the relationships between human, environmental, and mechanical contributions to the unfolding event, as well as a

perpetuation of the belief that data can be reduced and better understood by looking at isolated components. The main body of the Norcross report included a section called Human Factors Management Evaluation. Including the Human Factors section in the main body of the Norcross report was contrary to SAIG guidance.

B. Latent Conditions which set the stage for human error

- 1. There is no system in place to ensure that drop zones are cross-checked to ensure that site selection meets minimum standards (formal or informal) for safe operation.
- 2. Acceptance of placement of panel without question or verification, despite recognition of exposure to the aerial hazard.
- 3. Ground crew's assumption that the pilot would be the "final authority" in the site "selection" process, as a final barrier to prevent use of a hazardous drop site. The intent of the pilot being the final authority was to provide the pilot with the authority to refuse any mission based on comfort level or perception of unacceptable risk. The crew's use of this policy assumed that the pilot is more directly involved in approval of the site. The difference appears subtle, however this interpretation has resulted in crews selecting sub-standard sites with an understanding that if the site is not acceptable the pilot will refuse it. The pilot must retain the right to refuse a site, but should not be expected to perform the site evaluation for the ground firefighter.
- 4. No systematic review of exposure to hazard(s), or risk(s) by personnel was conducted at the helibase upon completion of missions - IHOG risk matrix was not used, due to its cumbersome and vague nature.
- 5. No direct communication between crew and pilot before or after AAR, thus limiting the ability of the crew to convey concerns regarding the proximity of the trees to the drop zone.
- 6. Briefing guides do not adequately consider aviation operations or aviation safety.
- 7. No mechanism is currently in place to ensure that the most qualified pilots are placed with most qualified personnel in confined areas or complex situations.
- 8. Safety duties are not specifically assigned to individuals and there are no discussions regarding safety concerns, roles or responsibilities.
- 9. The discussion of safety concerns was prevalent at lower levels of the fire organization. These concerns were not communicated beyond peer level and were not solicited by senior members of the organization. Many high reliability organizations use a "all to Go one to say No" policy for situations like this. This concept suggests that if all the members of a group are not satisfied with the operation, then that operation will be halted and evaluated to the satisfaction of all members of the team. This empowers all the members of the team and ensures that safety concerns are consistently discussed when they are observed.
- 10. The radio communications system in use in wildland fire suppression is complex and therefore prone to error. Normal operations require that several

Figure 4.2: Excerpt from the Norcross Fatality Investigation Report

The influence of Reason's concepts of accident investigation and causality is evident in the report section called *Latent Conditions, which set the stage for human error*. Latent conditions are the inevitable *resident pathogens* within the system. They arise from decisions made by designers, builders, procedure writers, and top-level management. Such decisions may be seen as mistakes in hindsight. All strategic decisions have the potential for introducing pathogens into the system. Latent conditions have two kinds of adverse effects. They can translate into error, by provoking conditions within the local workplace (e.g., time pressure, understaffing, inadequate equipment, fatigue, and inexperience). They can also create long lasting holes or weaknesses in the defenses (e.g., untrustworthy alarms and indicators, unworkable procedures, design and construction deficiencies, etc.). Latent conditions, as the term suggests, may lie dormant within the system for many years before they combine with active failures and local triggers to create an accident opportunity. Unlike active failures, whose specific forms are often hard to foresee, latent conditions can be identified and remedied before an adverse event occurs. Understanding this concept leads to proactive rather than reactive risk management (Reason, 1990).

The concept of latent conditions supports the view that holes or weaknesses in systemic defenses are there to be discovered and fixed. This report was largely based on this concept and listed findings consistent with what is termed the *Swiss-Cheese Model* (SCM). The recommendations are tied to findings as directed by the SAIG, and the influence of SCM can be seen in many of the findings listed in the Norcross Fatality Investigation Report (see figure 4.3).

The Norcross investigation team differed in another major way. A university professor was commissioned to assist in the field review of information and the creation of the final report. There is no indication that this had ever been done before in a Forest Service serious accident investigation and there is nothing in the SAIG to suggest the solicitation of external support. The training associated with the SAI process is quite clear that only the SAIT should be allowed to view the information gathered during the process. Najmedin Meshkati, a personal friend of James Reason, assisted in data collection and analysis of information. Meshkati has a long history of major accident investigations, such as Three Mile Island, Chernobyl, etc.

Excerpt of Findings Section of the Norcross Fatality Investigation Report

Finding #1: Site Evaluation

- a. Site evaluation was never performed (Causal).
- b. No supervisory oversight was performed to ensure that the selected site met established criteria (A 219 - External Load Training).
- c. Pilot in proper position to perform longline operations was unable to maintain visual contact with obstacles on the right side of the aircraft.

Finding #2: Site Selection

- a. The pilot was not involved in site selection. Instead it was assumed that the pilot would evaluate and/or reject the site if he felt the site was unsafe (witness statements) (Causal).
- b. There is a reliance on the pilot to be the final authority in site "selection" (witness statements).
- c. The pilot was not asked to evaluate the site and accepted a marginal site with known hazards (Causal).
- d. The length of longline used was not adequate to maintain clearance from obstacles at the drop zone (Causal).

Finding #3: Ground Crew – Pilot Communication

- a. Crew did not consistently communicate hazards to the pilot that reflected risks involved with this site which did not meet (go-no go) criteria (Causal).
- b. The crew requested a longer line for use on the accident day, as a result of the concerns from the previous day's mission. The reason for this request was never identified and the request was not made in a timely manner.
- c. The crew expected the pilot to fully assess the drop zone. This expectation was assumed by the crew to be a standard operating practice. The pilot was fixated on delivery and failed to fully evaluate the drop zone (Causal).

Finding #4: Operational Leadership/Guidance

- a. Several members of the crew internally questioned the safety of the drop zone, yet this information was never shared with overhead during the After Action Review (AAR) or tailgate safety briefings (Causal).
- b. The Division Safety Officer, Division Supervisor, and Crew Superintendent did not specifically discuss the aircraft use or operations with the crews during the "After Action Reviews" or at any other time (Causal).
- c. The Incident Response Pocket Guide (IRPG) is specific with regard to ground firefighting operations. However, aviation safety is not directly addressed in the After Action Review section of the IRPG.

Finding #5: Safety Roles and Responsibilities

- a. Roles and responsibilities were not specifically assigned to individuals who held critical safety related duties (Causal)
- b. Crew members assumed safety related positions without assignment by supervisory personnel. These duties were assumed on a voluntary basis.
- c. Division Safety Officer Trainee assumed roles and responsibilities based on previous experience as DIVS and did not fully support the DIVS with regard to assignment as Safety Trainee. This assumption of duty reduced or limited the supervisors input on priority of operations, lessons learned and safety observations (SOFR Safety Officer Line Qualifications and currency).

- d. Crew training and qualification for long-line operations were not current.

Figure 4.3: Excerpt of Findings Section of the Norcross Fatality Investigation Report

The SAIG recommends a taxonomic classification of error and latent conditions, which is analogous to a list of holes in the Swiss cheese. The list was derived from the Human

Factors Analysis and Classification System developed by Shappell & Wiegmann (1997). The SAIG version, called Exhibit 2-2, Human Factors Accident and Incident Analysis, is oriented toward finding fault with the humans involved in the incident and has little demonstrated benefit. One fire subject-matter expert relayed his experience.

> I tried to use the Human Factors Checklist [exhibit 2-2]; in fact, I was told to do so by the Chief Investigator. It was terrible. All I could find was how people failed and how the system was messed up. I felt sick and knew what would happen if we used it (Regional safety officer assigned to an investigation).

His assessment was that it could only result in blaming people for the accident (Interview with regional safety officer).

Analytical Shifts

The Norcross investigation did not use Exhibit 2-2, the Human Factors Accident and Incident Analysis. Instead errors, weaknesses, and actions were identified and then placed in context to the extent possible. The human-factor aspects of the incident were related to the environment and pressures felt by the crews and personnel involved. The concept of the systemic support of error was introduced to show how system pressures can influence the individuals involved in an incident. In Norcross the SAIT listed pressures associated with a particular action. An excerpt from the Norcross Fatality Investigation Report follows:

> It was determined that the drop-zone site was not properly evaluated. Discovery of why this critical issue had not been properly addressed became the focal point of the investigation. The investigation revealed that the drop-zone selection was made as a result of communication errors, which stemmed exclusively from organizational wellness and human-factor issues (p. 29).

The taxonomic classification was replaced with a Contributing Factors section of the report, which added additional context to the decisions and actions (see figure 4.4).

Excerpt from Contributing Factors section of the Norcross Fatality Investigation Report

Contributing Factors

Site Selection versus Site Refusal:

The site selection was performed before the pilot had the opportunity to see or evaluate the drop zone. The pilot observed the site for the first time while making an approach with a fully loaded long-line. Thus, the burden of site refusal was placed on the pilot at a critical phase of the operation. This pilot was put in the difficult situation of how best to support the "customer" (ground personnel). Regardless of how willing ground personnel were to relocate the site, the pilot would have needed to decline the location, before relocation would have occurred. Disapproval of a site has a negative connotation and would have resulted in the crew having to travel further to an area where support could be safely received.

Restriction to Visibility:

Pilot was operating an FAA approved Supplemental Type Certificated Helicopter, which permitted him to fly from the left seat. This position allows the pilot to view the ground and the long-line operations while leaning to the left, facilitating the pilot's ability to control the collective. This configuration, however, significantly reduces the pilot's ability to observe and monitor the presence of hazards on the right side of the aircraft. The visibility of hazards on the right side of the aircraft is further obstructed by aircraft structure, passenger seats and the passenger seat headrests.

This flight was conducted in an area of confined space with hazards on the right side of the aircraft—a quadrant of the aircraft that the pilot had little or no ability to observe. The pilot had no ability to see the hazard on the right side of the aircraft while in the proper position for a longline operation.

Pilot in the same type of aircraft demonstrating the proper position for longline operations (Left). View from the left seat of the helicopter, over the pilot's right shoulder and out the right rear window, taken from a fully upright position (Right).

Figure 4.4 Excerpt from Contributing Factors section of the Norcross Fatality Investigation Report.

Summary - Lessons Learned

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 openness in the organization around accident investigation that had not existed for decades. Norcross went beyond what had become traditional accident investigation process by including context and human factors in the main body of the report and senior leadership in the Forest Service was in agreement. This openness supported the concept that an accident could happen even when no one did anything wrong. One member of the Norcross Accident Review Board recounted:

> *This was the first time I was asked to sit on an ARB. I came to DC not having seen the report, but loaded for bear to condemn the SAIG. I recall getting to my hotel room, receiving a copy of the report, reading it that night, and thinking, "holy crap, they didn't follow the SAIG!" I was pleasantly surprised when the ARB had no problems with blessing a report that didn't follow the SAIG. The door was indeed opened.*

The work of James Reason factored heavily into the Norcross investigation data collection, assessment, and analysis. Reason's Swiss-cheese model dominated thinking and approaches to incident and accident reviews. Finding the active failures and latent conditions were commonplace and this supported devising ways to place more barriers in place or to plug holes in the Swiss cheese. This method looks at risk in a very unique way—as energy to be contained. Problematically, there is little understanding of the relationship between barriers and people.

Barriers do two basic things: they either prevent the accident from occurring or they mitigate the accident results. Barriers have been effective methods to deal with high-risk environments. National highway safety statistics support this conclusion; America has not had a substantive change in highway fatalities since the nation started keeping records. The number has hovered around 35,000 per year despite the marked increase in the number of drivers and miles driven each year (see figure 4.5).

Figure 4.5: Comparison of annual deaths and vehicle miles driven (taken from Wikipedia and verified against national highway safety data).

Despite the increase in miles traveled, the number of fatalities has consistently declined. There have been major changes to automotive and highway design (barriers) that prevent accidents or mitigate the results. This means that there has to be room for this type of approach in any accident analysis. Looking at the SCM as a sinister or undesirable product is counter to the espoused goal of any investigation, which should be that open inquiry leads to prevention.

Norcross was, however, the first indicator that the barrier approach was not enough and served as the beginning of the development of a process that included diverse, often misunderstood, and poorly valued methods of viewing the human contribution to work and incidents.

Norcross also served to inform the organization that there were other ways to view incidents and that the investigative process might need to be reviewed. In the Norcross summary section is a recommendation that the serious accident investigation process be modernized:

> The team therefore recommends that the Serious Accident Investigation Guide be re-written both in format and in content. Checklists are adequate to ensure that sequential processes are followed while operating complex systems or machines; however, they limit the ability of investigators to quantify the complex nature of human failure. Furthermore, the classification of error does not encourage a robust discussion or thorough evaluation of Human Factors. The failure to fully assess the human factors results in an inability to develop appropriate recommendations and thus limits our ability to prevent reoccurrence of the observed failures. We believe that in order to instill a safety culture in our organization, analysis and discussion of Human Factors must be prominent in our accident

> investigation process and subsequent Management Evaluations (National Transportation Safety Board, 2008, p. 30).

Norcross introduced the concept of complexity to the Forest Service through this passage and graphically in the depiction of the communications system in place at Norcross during the second blivet delivery (see figure 4.6).

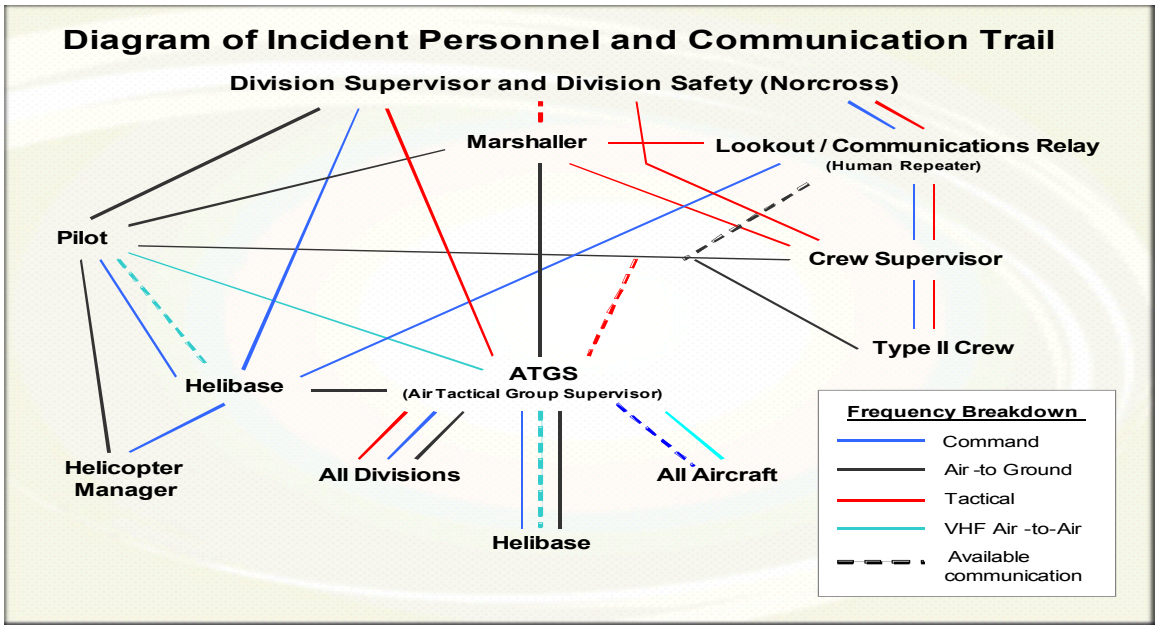

Figure 4.6: Diagram of communication pathways from the Norcross Fatality Investigation Report.

This representation, while simple by many of today's standards, was the first time that the challenges associated with basic and critical communications were depicted in a way that demonstrated the competitive nature of frequency allocation and use. At any given time an air-tactical (lead-plane) pilot will have to listen and respond to as many as six different frequencies. Ground fire leaders have expressed the same problem. One recently stated, "When things started getting hectic, I would turn the radios off one by one until I could think clearly again." The graphic was designed to highlight the challenges associated with the current communication system, but it went a step farther. It put in view a system connectedness—interaction and relationships—that had not been viewed in such a way prior to this. It also led to the development of the Decision Factors and Complexity Diagram used in the Panther investigation as well as the sticky-note technique, which was used to highlight connections between data points on a whiteboard to show relationships.

Chapter 5: The Panther Case Study

Introduction

On July 26, 2008, a highly skilled firefighter died while assessing a fast-growing fire on the Klamath National Forest in northern California. This fire was named Panther because of its proximity to Panther Creek.[26] The purpose of this chapter is to show how the Panther fatality investigation (Panther) influenced the Forest Service investigative process. The chapter begins with an overview of basic fire terminology to help readers understand the report language, which is followed by a summary of the Panther Fire Entrapment Report narrative. An overview of the investigative process used sets the stage for an exploration of ways that the approach taken in the investigation challenged the traditional accident investigative process. The result was the development of a different report style. The chapter concludes with Forest Service leadership's reactions to the report.

The fatality on the Panther Fire was my first ground fatality investigation as a Chief Investigator. This chapter explores the emerging need for greater understanding of the relationships between information, language, conditions, facts and perceptions and how this made simple explanations impossible. The Panther event could not point to a single error or error chain. The conditions people felt or perceived were instead viewed as a web of interconnected factors that influenced decisions and actions. Key decisions were not judged as right or wrong, instead we worked to understand why the actions and decisions made sense to those involved. There were no bad actors; just people doing the best that they could with the knowledge they had available. The approach we took was consistent with Dekker's New View of human error (2006). No actor or set of actions could be pointed to as bad, unless the outcome was known; this challenged the idea that error is a fact waiting to be discovered, if the investigator just tries hard enough (Dekker, 2006).

Two key concepts were introduced in this case study: First, the stage was set for understanding the role of the report as a learning tool for a wider variety of audiences, which challenged the common practice of developing a single report to serve multiple audiences. Second, my ignorance of ground firefighting culture and operations allowed me to ask questions about the culture of firefighting that were largely assumed by most investigators with ground fire experience. This allowed me to innocently challenge assumptions through open dialogue with my subject-matter experts. The success of this approach ultimately led to the inclusion of more subject matter experts and the concept of focus groups.

[26] Fires that escape containment during initial attack or fires that are not contained by the first units dispatched without significant reinforcement are given names. The names are often based on local landforms (rivers, creeks, peaks, etc.).

As the serious accident investigation team (SAIT) chief investigator, Panther helped me understand how conditions could influence people in different ways. I determined that factors did not cause events, actions, or decisions; instead these conditions exerted varying degrees of influence. As a result conditions may be present and perceived in several ways, each representing different perspectives of those involved. The perception of conditions results in actions or decisions. This represents an individual construction of reality that challenges most investigative models that demand the creation of a factual report.

As the SAIT began to understand the relationships between information, language, conditions, facts, and perceptions, simple explanations became impossible. Although eight knowledgeable people were involved in the investigative process, two of us were left at the end to make sense of what had happened and to create a report. We felt that simply following the Serious Accident Investigation Guide (SAIG) would be unfair to those involved. We discovered five significant aspects of the SAIG had to be modified or abandoned as a result of what we learned:

- The basic assumptions of the investigative process (discussed in chapter 3).
- Causal factors, common to traditional reports, which did not support understanding the event from the perspective of those involved. As a result, causes had to be replaced with conditions that influenced decisions and actions.
- The SAIG-recommended linear presentation of information or reductionist categorization did not convey important relationships or interactions between conditions that influenced the actions and decisions.
- The realization that we could not attribute error without making judgments or assumptions about people's actions that could easily lead to cause forced us to once again abandon the language of causality.
- Language influences were found to be important in two ways: first, how language developed in a small team and the effect that had on a newcomer's ability to understand key messages; and second, the SAIG-recommended report language was recognized as biased.

Basic Fire Terminology and Operations

The Forest Service developed the Incident Command System (ICS)[27] to coordinate the deployment and facilitate coordinated operation of units responding to wildland fires. The approach allows for the integration of facilities, equipment, personnel, procedures,

[27] ICS is, "A standardized on scene emergency management concept specifically designed to allow its user(s) to adopt an integrated organizational structure equal to the complexity and demands of single or multiple incidents without being hindered by jurisdictional boundaries" (National Wildfire Coordinating Group (NWCG) Glossary, http://www.nwcg.gov/pms/pubs/glossary/i.htm).

and communications operating within a common organizational structure and establishes common processes for planning and managing resources, regardless of the type or origin of the units responding. The lowest response level is called Type 5, and the system grades up to the highest response level, called Type 1. This classification system is based on fire complexity, number of responding units, and fire behavior. Leadership qualifications required to manage each of these levels of classification are commensurate with the fire's assessed complexity.[28] Type 1 team members are, therefore, among the most qualified and experienced fire personnel.

For the purposes of understanding the Panther report it is important to know about flanks or the sides of the fire and how that name formally changes to divisions when the fire size and complexity increases. Figure 5.1 illustrates the parts of the wildland fire and introduces the concept of flanks along with other key fire components such as head, finger, and spot fire. This language is commonly used for initial attack (or first response to a wildland fire) (see figure 5.1).

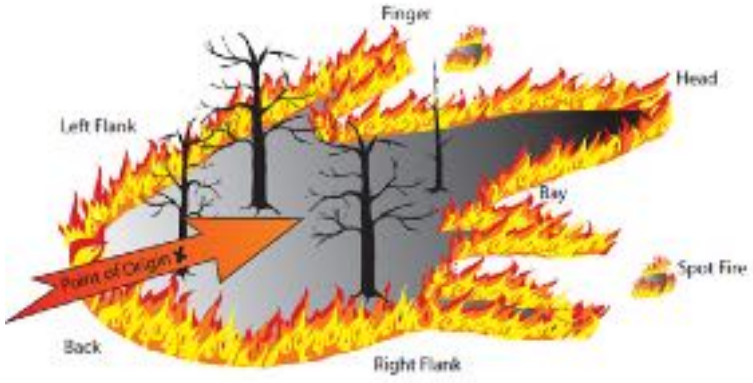

Figure 5.1: Parts of a wildland fire.

If the fire escapes initial attack, as it did at Panther, a higher-level organization will be ordered and fire suppression efforts will often be separated into divisions. Division leaders are called division group supervisors (DIVS). Geographic areas for which a DIV is responsible are marked on fire maps with the symbol)((see figure 5.2).

Synopsis of the Panther Narrative[29]

The Panther fire was located and scouted on July 23, 2008. Initial attempts to contain this fire were made by a Type 4 incident command organization (this effort is called initial

[28] Complexity is determined by the IC using a checklist that identifies "Incident Complexity Indicators" which can include: the fire location, threat to life or property, political sensitivity, weather, etc.

[29] This is an adaptation of the narrative section of the 2008 Panther Fire Entrapment Report, field notes and personal interviews are included and the text has been altered to improve readability.

attack). Due to an increase in fire size and the fact that it was not controlled in the first operational period,[30] it was transitioned to a Type 3 incident (the next higher incident-command level).

By the evening of July 25, the Type 3 incident commander (IC), who was a trainee under the supervision of a qualified Type 3 IC, identified the need for additional oversight and recommended that the fire be elevated to a Type 2 incident command organization. This decision was again based on continued increase in fire complexity (see figure 5.2). The district fire management officer agreed that an increase in overhead (leadership and support) was needed and recommended that the fire be incorporated into a nearby Type 1 fire complex (Siskiyou Fire Complex). The transition was coordinated and scheduled to take place the following day.

The Siskiyou Fire Complex Type 1 organization wanted to get an *eyes-on* evaluation of the fire of which they were about to assume control. Two division group supervisors (DIVS 1&2) representing the incoming Type 1 organization arrived at the Panther Fire. Their assignment from the Siskiyou Complex branch director was to scout the fire and develop a plan to include Panther in the Siskiyou Complex on the following day.

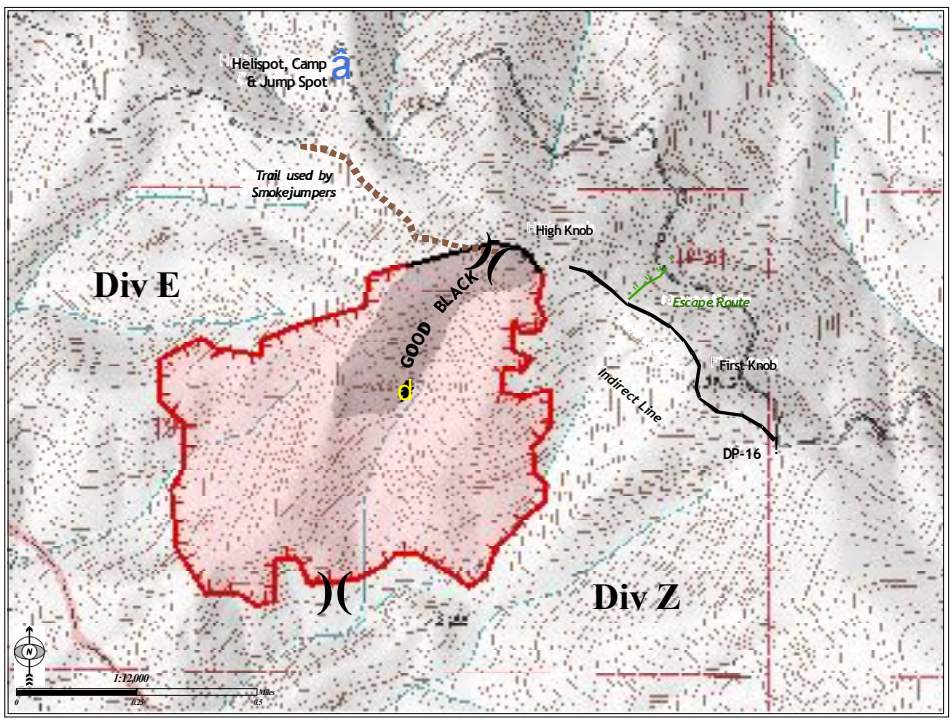

Figure 5.2: A map shows Division Z and Division E and the relationship of the high knob to the good black. Uncontained fireline is depicted in red with hash marks; the symbol)(indicates division breaks. The escape route from the saddle is depicted in light green.

[30] The period of time scheduled for execution of a given set of tactical actions as specified in the Incident Action Plan. Operational Periods can be of various lengths, although usually not over 24 hours.

Figure 5.3: Example of typical fuel along the P-line from the DP-16 to the saddle. This photo was taken of actual fuels along part of the ridge.

Upon arrival at the fire, DIVS 1&2 received a briefing from the Type 3 incident commander (ICT3) and the ICT3 trainee (ICT3T). They explained the limited successes on Panther and the problems encountered, including the rather dense fuels on the fire ground (see figure 5.3). The ICT3T explained that the crews were not engaged on the fireline at the moment because of a weather forecast that indicated the possibility of increased fire behavior associated with the collapse of an inversion over the fire. Following this briefing, DIVS 1&2 scouted the road system in the fire area before they returned to the initial briefing area. By the time they returned to the briefing location, crews were reengaged on the fireline. DIVS 1&2 parked their vehicle and began reconnaissance of the line where the initial attack crews were working. While scouting the line, they made initial contact with both assigned crews.

The ICT3 and ICT Trainee were confronting a logistics issue at another location and were unaware that DIVS 1&2 had left the road and were on the fireline.

The Type 3 organization (crews and leadership) had been together since the first day of initial attack of the fire. During that period of time, they had developed phrases that, although in common use on the fireline, had unique meaning and importance to them. One key phrase was, “The column is breaking through the inversion.” This phrase commonly meant that weather conditions were changing that could result in an expected increase in fire behavior; however, to the crews who had been on the Panther fire for days, it also meant that personnel should withdraw from the fire line as soon as possible. For DIVS 1&2 this phrase did not have the import that it did among the leadership and crew who had been on the fire for the last three days.

During their reconnaissance of the fireline, DIVS 1&2 could hear one of the lookouts make this announcement on the fire frequency (which was known to be available to the DIVS). While its meaning was clear to most of those involved with the incident, it was not clear to DIVS 1&2, who did not take the immediate action to leave the fireline.

The Panther Fire made a major run and rapidly overtook the ridgeline where DIVS 1&2 were standing. They attempted to escape but found their escape routes cut off and then

elected to deploy their fire shelters. DIVS 2 reconsidered before getting fully inside the shelter and chose, instead, to evade the advancing fire by escaping downhill through heavy, unburned fuels.

The following section is copied directly from the Panther report and represents information provided to the accident investigation team through interviews with participants engaged in firefighting operations on Panther (it is presented in the font used in the actual report):

> The T2IA lookout made another call to the IHC crew at approximately 1430 hours reporting "increased fire behavior and that the column was breaking through the inversion." This information was a clear indication to the personnel assigned to Panther Fire of increasing fire activity and the need to disengage. It also was a reflection of what the crews had been concerned about during the morning briefing. Crew's supervisors then made the determination to withdraw from the fire line. DIVS 2 stated during his post-accident interview, he heard the radio transmissions, but did not perceive them to be warnings. From his perspective there was no reason to discontinue their reconnaissance.
>
> Upon hearing the transmissions from the lookout, the Trainee made radio contact with DIVS 1 and asked his position. DIVS 1 reported that he and DIVS 2 were on the indirect line close to the IHC crew in the saddle. This came as a surprise to the Trainee and ICT3, as they assumed DIVS 1&2 were only going to perform a reconnaissance of the 14N05 road.
>
> Meanwhile, the Supt. verified the report of increased fire activity. He determined the report was correct. He also heard the radio transmission between DIVS 1 and the Trainee stating they were with his crew. The Supt. radioed his crew that fire activity had increased below their position and the crew was to prepare to disengage.
>
> At approximately 1500 hours, DIVS 1&2 met the Supt. in the saddle. The Supt. was pulling his crew together and directing them to leave the indirect line, move down the escape route to the 14N05 road and then back to DP-16. DIVS 1&2 heard the Supt. brief his crew about the fire activity. DIVS 2 asked how far it was to the black (Division Break, high knob). The Supt. replied "Two to three-hundred yards through a thick piece of ground." DIVS 2 then stated, "We are going to go to the next knob, to the black, to the safety zone there." DIVS 1&2 then departed the saddle heading west. (IHC crew Superintendent's and DIVS 2 statements). The Supt. "…walked along [the] ridge to the east to look for opportunities to pick up the fire after it slopped the ridge."
>
> As the Supt. returned to the saddle he looked for DIVS 1&2, then followed his crew down the escape route to DP-16. In his statement the Supt. indicated the fire hit the ridge between 1510 and 1515 hours. "The fire hit the ridge all across the ridgeline [from] a half mile west of DP-16 to the west [of the saddle] another 200 yards against the hard black just short of the 3971 elevation knob" (Division Break). He also stated, "I witnessed extreme fire behavior with flame lengths exceeding 100 feet".
>
> Having never been west of the saddle, DIVS 1&2 could only estimate the time needed to reach the safety zone at the Division Break. When DIVS 1&2 recognized that fire conditions had changed and their position was in jeopardy, DIVS 2 asked DIVS 1 "Up or down?"
>
> DIVS 1 responded, "Down". They proceeded briskly, back down the indirect line toward the saddle and the escape route they saw the IHC use to get to the road. DIVS 1 radioed to the Trainee, "We are getting out of harm's way."

By the time they reached a point where they could see the saddle, the fire was already well established and their escape route was cut off. They then reversed direction again and started back up the indirect line heading toward the Division Break.

[see figure 5.4 for locations of DIVS 1&2 as they were cutoff and the approximate escape route for DIVS 2.]

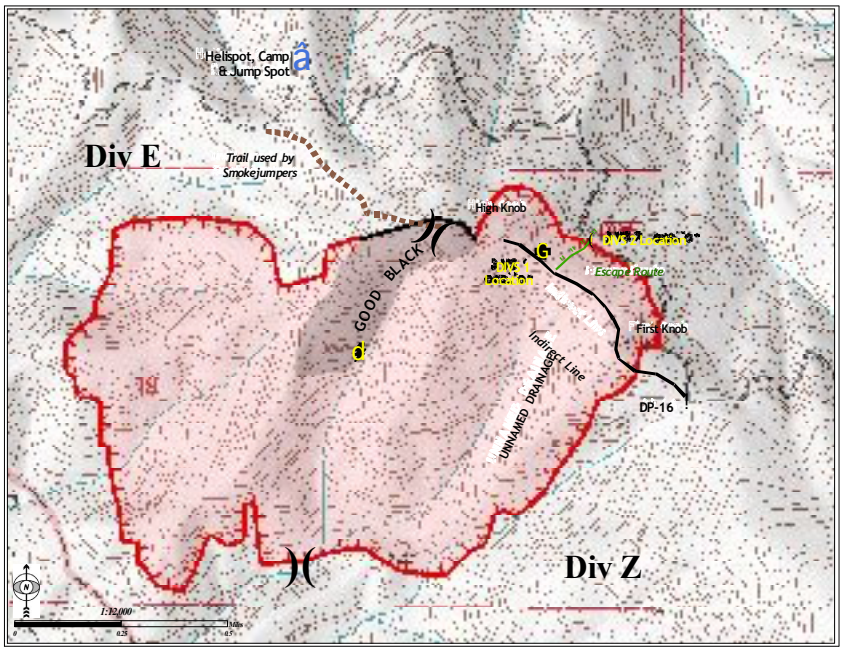

Figure 5.4: Locations of DIVS 1 and DIVS 2 after the crown-fire run.

DIVS 1 was in the lead at this time and saw a small opening in the brush. He led DIVS 2 into the opening and stated "We need to deploy! We need to deploy!" DIVS 1&2 discarded their packs and started to deploy their fire shelters. (DIVS 2 statement)

DIVS 1&2 raked the ground to prepare the site for deployment. While shaking his fire shelter open, DIVS 2 took another look around and determined, based on his assessment of the fire behavior and the fuels surrounding the site, he felt a shelter could not survive. He immediately said, "We need to go down the hill! The shelters won't work here! We need to go down the hill! We won't survive with deployment!" Finally he said, "Follow me! I am going down the hill!" DIVS 1 did not respond. DIVS 2 balled up his shelter under his arm and ran down the hill. DIVS 1 had deployed his shelter and did not follow [see Figure 5.3].

DIVS 2's escape was difficult due to very heavy brush and the steep slope. He stated that there were times that he could not touch the ground; instead he was suspended by the heavy brush. As he made his escape, he had to navigate around spot fires between the deployment site and the 14N05 road below.

The Trainee drove down the 14N05 road as the fire made its run through the saddle. He was watching to see if the fire was going to spot across the road and compromise the escape of the firefighters. The Trainee was aware that the DIVS 1&2 had been on the fire line and was concerned about their exact location. As the Trainee drove past the established escape route at 1520 hours, he encountered DIVS 2 on the road.

> Struck by the unexpected location of DIVS 2, he angrily expressed his discontent. Then DIVS 2 told him "We have bigger problems, [DIVS 1, name withheld] is deployed on the ridge." As they were proceeding back to DP-16, they looked for DIVS 1 on the road hoping to find him.

Although DIVS 1 had fully deployed his new generation fire shelter, the intense heat of the fire and its residence time exceeded the fire-shelter capability. The deceased firefighter was recovered on July 27, 2008. DIVS 2, who chose to escape the advancing fire, successfully escaped to a road below the ridgeline. The route he took had not been previously identified and was a steep north slope typified by extremely heavy fuels.

The Investigation Process

Upon notification of the fatality, the Forest Service appointed a team to investigate the accident. I was appointed as chief investigator and rapidly assembled a team consistent with SAIG guidance.

To this point my background, experience, and education with regard to accident investigation had been limited to aviation accidents. My Forest Service operational experience was as a lead plane pilot,[31] and I had very limited knowledge of the ground firefighting culture. Key individuals emerged as critical to assist me in comprehending fire language and culture, which was necessary for me to understand the event. Perhaps the most significant was Jay Kurth, who had been a hotshot crew superintendent and had an extensive ground-fire background. Jimmy Reaves was a senior leader in the Forest Service assigned to lead a Forest Service Research Station, and his fire background was limited; however, he did represent the Washington Office to whom we reported. Reaves facilitated discussions and ensured that we did not stray too far off track.

The team attempted to use the methods recommended in the SAIG, but it was quickly realized that these methods did not fully or fairly represent the individuals involved in the incident. Each of the two DIVS had made the same decisions or had performed essentially the same actions, until they separated at the shelter deployment site. The traditional procedure of finding cause, especially tied to error or violation, did not seem to fit the accounts we were beginning to accumulate.

The team had lengthy discussions on the topic of error and the SAIG recommendation to find cause. The investigation team could not determine the existence of a specific error, as no normative standard existed for deployment and this critical decision was, by intent, left to each individual firefighter. We found that each of the DIVS had acted in accordance with the most current information and guidance available and within their leader's intent

[31] Lead-Plane - Aircraft with specially trained pilots used to make trial runs over the target area to check wind, smoke conditions, topography and to lead air tankers to targets and supervise their drops. Lead-Planes provide coordination of aerial resources over the fire and often engage directly with ground firefighters via radio.

to complete their assigned scouting mission, so there was no violation. Each DIVS had experience commensurate with the assigned position, yet, in the end, each chose radically different paths. These paths were consistent with rules, regulations, policy, and procedures—none of which could guarantee safety in the wildfire environment—and none of them could be considered erroneous based on the outcome.

Another major departure from procedure occurred when the fallen firefighter's widow asked to meet the investigation team. Reaves consented, and the two of us met with the widow. This meeting was heartfelt and deeply moving. She asked us to be certain that her husband did not die in vain. This became an overriding goal for Reaves, Kurth, and me as the report was developed.

There were also conceptual shifts in the investigative process. Early in the investigation, the team identified a number of conditions that seemed to influence decisions and actions (Groth & Mosleh, 2012). These conditions by themselves were not causal; however, they appeared to be networked in that they affected each other in ways that seemed to unpredictably increase their effects. These interconnections were not equal between the people who had been exposed to them. I determined that the same stimulus or conditions did not always have the same effect and this questioned the cause-effect relationship.

The team recognized that the action or decision to remain in the shelter vs. run downhill was ultimately based on individual heuristics, not some corporate rule or process. No rule, policy, or best-practice could anticipate the entirety of variable conditions that firefighters face in their daily work environment. The team faced an ethical challenge; following SAIG guidance and traditional analysis would demand that an error be exposed and reported. But error could not be clearly defined, as there was no normative standard for comparison and there was no clearly right answer or response that firefighters could be expected to follow. We had to fail to follow policy or procedure by not adhering to the SAIG.

Conditions that Influenced Decisions and Actions

The team unanimously agreed that an in-depth emphasis on the analysis of human factors was required to represent the information we were discovering and that this analysis was necessary for us to be able to propose recommendations that would be meaningful to safety and the Forest Service culture. We agreed, "The premise of any successful human factors analysis is the fact that people do not set out to make mistakes" (Forest Service, 2008). We then began to explore the analytic tools that were available to us either through training, experience or written guidance.

The team looked at sequence of events modeling. Problems arose during this exploration as we began to recognize that attempts to improve safety based on event sequences

were dependent on a recurrence of the events in the same sequence (like an assembly line). Each path in Panther seemed to be shaped by relationships between conditions that seemed unique to the incident. The team also recognized that any changes to the sequence or chain of events could result in completely different outcomes. The potential for such recurrence seemed too remote to be valuable to long-term prevention, so this approach was abandoned.

We then examined traditional views of human factors, the focus of which is on human limitations and the ability, or inability, of humans to process signals or perform functions. Frequently this results in a judgment of actions, based in part on individual and group biases (Wickens, Mavor, & McGee, 1997) stresses or physical limitations (Moray, 2005). This area of research mainly focuses on the design of equipment and devices to fit the human body, as well as the cognitive ability of the human component (Meister, 1991; Meister & Farr, 1967). The International Standard (ISO) 6385, *Ergonomic Principles in the Design of Work Systems,* defines ergonomics as the "scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles and methods to design in order to optimize human well-being and overall system performance" (ISO 6385). The team determined that this definition did not fit the situation we faced.

The human factors analysis created for the Panther report did not follow the recommended HFACS model. Instead, we modified the process to remove (as much as possible) the presumption of failure and developed a unique set of categories and associations. This approach presented the conditions surrounding the accident in five broad categories, which reflected my military experience and the paramilitary culture of wildland firefighting: Command, Control, Management, Communication and Personnel (see figure 5.5).

The following discussion defines the relationship between the operational structures and conditions that existed and set the stage for the accident. These conditions are often removed both in time and space from where the action took place. Incidents unfold in terms of events in perceived time, as opposed to a chronological manner. The people involved in the incidents predicated their decisions on their perception of those events. For this reason, it is very difficult to imagine the thoughts they must have had or the complexity that they understood at any given time. This report does not presume to tell the reader what those thoughts might have been rather, it indicates the complex nature of the environment in which they were operating. The analysis examines the story in segments, as told from the perspectives of the participants, to facilitate understanding of the background conditions. Those segments are:

- Command
- Control
- Management
- Communication
- Personnel

Figure 5.5: Excerpt from the Human Factors Analysis Section of the Panther Fire Entrapment Report.

The team identified the system constraints as related to command, control, management, communication, and personnel. The investigation process began to populate these categories with listed examples of the conditions observed or known to be in place that may have affected decisions and actions. Examples of the conditions by category follow:

Command

Condition 1: Management did not provide strategic guidance to the ICT3 and ICT3 trainee. This resulted in no clear articulation of goals for an extended attack strategy. The primary guidance provided to the ICT4 who became the ICT3 trainee was simply, "Keep the fire as small as possible" and "Do your best" (Panther investigation interviews).

Condition 2: The existing decision support tools for strategic analysis and assessment are not considered to be useful by many mid-level fire commanders.

Control

Condition 1: DIVS 1&2 were highly experienced; however, they were not formally assigned or directly under the control of any of the responsible Panther fire leadership. Their mission was external to the incident action plan (IAP). Chain of command and responsibility were not clearly articulated in a formal transition process. DIVS 1&2 truly were newcomers to the fire and operating outside the existing incident command structure.

Condition 2: One purpose for scouting a wildfire is to gain information regarding the distances between escape routes and safety zones. Because DIVS 1&2 had not been on the fire earlier, they did not have a sense of how far they were from the safety zone at the high-knob division break.

Management

Condition 1: The ICT3 position retained responsibility for all command functions because there is no requirement to establish additional command-staff support. In contrast to this way of doing business, the Forest Service does not support duties external to fire duties for ICT3 positions, as they are perceived as a distraction to critical duties; however, the retention of collateral command functions is not excluded by any policy. This leaves the ICT3 in a position of needing to juggle competing demands as the fire increases in complexity.[32]

[32] Most accidents occur during the transition between Type 3 and Type 2 incidents.

Communications

Condition 1: There is a system-wide absence of standard communication or phraseology in wildland firefighting that can potentially lead to miscommunication of safety critical information. This absence is especially evident during transitions. Assumptions, impressions, and expectations replace factual and realistic verification, which results in a lack of understanding of significant critical safety communications or actions.

Personnel

Condition 1: Assumptions and expectations replaced verification, which resulted in a lack of understanding of significant critical safety communications. Examples of assumptive behavior included the following:

- Crews assumed that DIVS 1&2 did not require additional warning.
- DIVS assumed that warnings would be clear.
- The IC assumed that DIVS would not go on the line.
- DIVS assumed if crews were re-engaging it was safe to go on the line.
- DIVS expected they would be able to recognize danger and react appropriately on their own.
- The IC assumed that DIVS would leave the saddle with the crew.
- If there is a question and there is no response, the perception is that the position is supported or that communication is understood (no challenge/response).
- All firefighters have a universal understanding of fire terms.
- All firefighters are assumed to have an understanding of all fuel types, associated fire behavior, and operational effectiveness.

Condition 2: Personnel qualifications and work/rest histories were evaluated and no discrepancies were found.

Condition 3: Risk-assessment tools that would have highlighted awareness of specific hazards were not available. As a result individuals were placed in a position where decisions had to be made with less and less time available.

Each of these conditions was expanded in the report to provide support for the assertion that they influenced the decisions and/or actions of the principal event participants. The effort provided context for those decisions and actions, which the team agreed was more valuable than blame or causal attribution.[33]

[33] The SAIG insists on the development of causes and the identification of error. When these two things are coupled, the common result is an attribution of blame associated with the individual who acted or made a decision. The team viewed error as an effect, not a cause, and avoided this approach.

Departure from Linear Presentation and Categorization of Data

The approach listing conditions by command, control, management, communication, and personnel was still a categorization that separated conditions from each other and did not fully facilitate a discussion of the relationships between these factors. As the fields were populated, duplication of conditions under each of the categories emerged. This duplication suggested a non-linear relationship between conditions existed and provide a rudimentary understanding of complex systems and the human role in those systems.

We explored ways to understand how the conditions influenced or shaped the decisions and actions made by the participants (this concept was important to the creation of the 2014 Forest Service Learning Review guide). However, we were still trying to fit this information into a model.

We began to move farther from the HFACS model by re-naming factors as conditions. Conditions represented the many aspects of the human-system interaction rather than a list of causes or causal factors. Conditions were also recognized to be situational with real-time influence on decisions and actions unique to the incident. Thus they affected human performance but not necessarily in a way that could be replicated.

We wrote individual conditions on post-it-notes and placed them on a wall. Each of the conditions was considered with regard its relationship to other notes, and a large interconnected web emerged. We were then challenged with how this could be presented in a format that could be understood. The map was simplified using a word program to create an image. Our simple depiction was included in the report. What emerged was a network of conditions that was converted into a complexity diagram (see figure 5.6).

This was an experiment designed to resolve the numerous relationships of conditions that influenced actions and decisions. The depiction was designed to avoid the oversimplification associated with reductionist methods that simply create separate lists of causal and contributing factors. Complexity theory suggests that the value of the system is more than the sum of its parts; instead there is a non-linear influence of one component to another that can be unpredictable (Byrne, 1998; Cilliers, 2005; Morin, 2008; Page, 2009). This diagram was an attempt to map those relationships. We only understood that a relationship between components existed, but we had no way to measure the value of the interactions. As a result, we created a simple table to represent a partial map of the interactions between conditions.

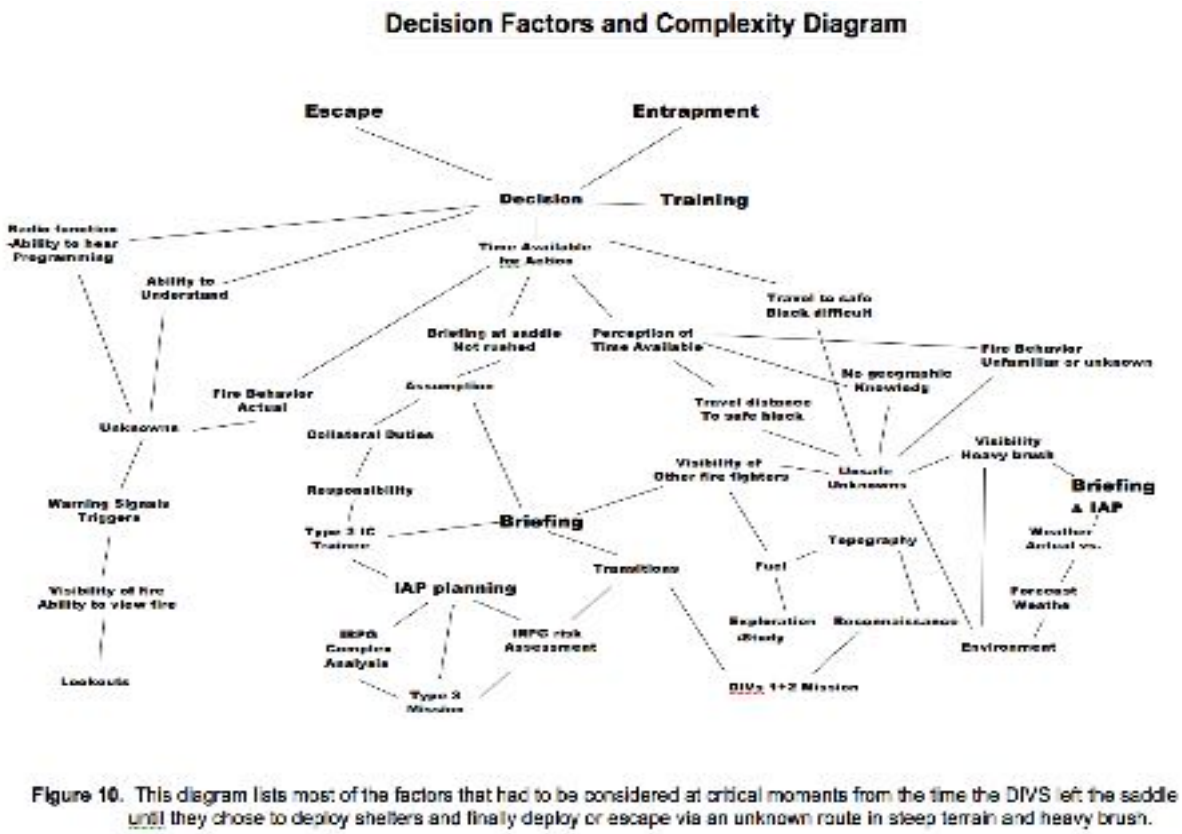

Figure 10. This diagram lists most of the factors that had to be considered at critical moments from the time the DIVS left the saddle until they chose to deploy shelters and finally deploy or escape via an unknown route in steep terrain and heavy brush.

Figure 5.6: Complexity Diagram from the Panther Fire Entrapment Report (Labeled "Figure 10" in the original Panther Fatality Investigation report).

The Fallacy of Error and Causality

> *Human behavior in any work system is shaped by objectives and constraints which must be respected by the actors for work performance to be successful. --Jens Rasmussen, 1997*

The team avoided traditional models of human factors analysis and the judgment or classification of error.

> The Panther Fire accident did not depend upon the failure of a machine or a mechanical component. It was not a function of the technical limitations of some form of apparatus or automation. Instead, it was a function of systems interactions, decisions, assumptions exclusively related to human factors (Forest Service, 2008, July 26).

One clear example of this could be seen in the critical decision to stay at the deployment site or to leave and run down the mountain. If, in hindsight, the label of error is applied, then it could apply to the individual who stayed (because he died). However, at the

moment the decision was made, no one knew what the outcome would be. DIVS 2 decided in a rapid analytic or perhaps intuitive assessment that he would run. So he balled up his shelter and began to run downhill from the advancing fire, which by this time was erupting around him. He was hung up in low brush to the degree that he could not touch the ground with his feet. He wriggled free and made his way to the road and survived. This may not make him *right*; it may be that he was just lucky. Thus a judgment concerning action is predicated on outcome and not action.

The Panther SAIT tried to avoid direct causal attribution of decisions to causes. To make this point the potential for luck was introduced during team discussions (see figure 5.7). The question asked in the team discussion was, "Is there any way of distinguishing 'good' from 'bad' decision processes when intuition and luck both play a critical role?"

	Good Outcome	**Bad Outcome**
"Good" Decision Process (function of analysis & intuition)	What you expect	Unlucky
"Bad" Decision Process	Lucky	Deserving

Figure 5.7: Outcome as a function of luck and decision-making.

For these reasons, discussions based on error seemed counter-productive to the team and to learning from the event. It became more important for the team to show how conditions, individual perceptions, and pressures influenced decisions and actions. We began to believe that understanding conditions might be a pathway to learning from events and labels such as error or cause could be distractions to readers.

Language

Agentive Language

While the team was focused on the importance of conditions in shaping actions/decisions, a shift in language occurred as we recognized conditions to be influential rather than causal. One condition that we explored dealt with the original Type 3 team's use of language. We wondered why there was no standard way to explicitly communicate danger as there is in aviation. We recognized that language developed on the incident was unique enough to be ambiguous to newcomers. This realization sensitized us to the importance of language and freed us to explore the language we would use in the Panther report, as well as the language used on the fire.

I had been considering the effect of basic terms on judgment and blame. In Norcross this realization made me avoid the use of blame. Panther added error to that list and began a greater scrutiny of how phrases shape associations of guilt, blame, and even culture. We are all part of world of influence, and we can easily ascribe cause to event outcomes. In some cases we may do so to alleviate tension we might have about doing something we feel might be dangerous. For example, if we wanted to fly an airplane, we might want to believe that a crash resulted from the actions of someone less equipped than we are to perform the same task. This belief could restore the belief that the system would be safe were it not for the actions of a few careless, complacent people—these are, of course, words we would not use to describe ourselves, implying that our world is safe and does not require review or change. I came to believe that using judgmental or subjective language (like complacency or even error) would inhibit learning and should therefore be avoided.

Research has shown that English is an agentive language that often requires an agent to be associated with an action. Fausey and Boroditsky use the example, "She broke the vase," [English speaker] agentive, verses "The vase broke," [Spanish speaker] non-agentive (2010). Assigning a causal agent to an action may create a link that makes us believe that the person caused the incident unintentionally, thus introducing bias into the report. Describing the same event in an unintended causal way in an accident report may damage the participants in a number of ways. This realization was instrumental in the team's decision to omit the word *cause* from the report.

The report introduced the concept of providing information to readers in a non-judgmental format that did not draw conclusions and instead assumed that the readers would reflect and use their own values and expertise to learn from the event. Agentive language did not fit this model and because the team felt that agentive or judgmental language would inhibit learning, every effort was made to recognize and remove this language from the report.

The Report

Findings and recommendations were delivered in the order the SAIG required (human, mechanical, and environmental). However, the exact format was avoided—the criteria for *establishing findings* were not adhered to in the traditional way. The most significant of these was, "Each finding is an essential step in the accident sequence, but each finding is not necessarily the cause of the accident. Do not include any more information in each finding than is necessary to explain the event occurrence" (Whitlock & Wood, 2005). In previous reports this guidance resulted in lists of findings absent context. The team believed that following this guidance isolated findings from each other and removed the context from actions and decisions that were critical to understanding the event.

To illustrate connections between conditions and actions, the team elected to summarize some of the key connections identified in the complexity diagram. We created a graphic image of a scale, which demonstrated the need for participants to balance the influences of conditions[34] as a trade-off between competing influences. This was a very rudimentary comparison.

Some traditional SAIG-recommended methods remained in the process and were reflected in the report. For example, recommendations were presented as per the SAIG and supported by findings in accordance with the SAIG.

Structurally, the report did not follow the SAIG pattern. A foreword was added that outlined the methods and theory used to prepare the report. The human factors section now held a central role in the report,[35] which was organized around the *conditions that supported decisions and actions*. An expanded narrative was included in the appendix to provide greater detail should a subsequent study be initiated.

The report also included human, equipment, and environmental findings and another section called findings of significance. Findings of significance were not considered causal (as the SAIG recommended); rather the report stated that these findings "could be argued to have bearing on the outcome" and were "significant enough to bring to the attention of leadership" (Forest Service, 2008, July 26). This section was expressly designed to meet leadership's need for information.[36.] It contained recommendations specific to the organizational response and the improvement of accident prevention tools (Forest Service, 2008, July 26).

Summary – Learning from Panther

Organizational Learning

> *"Whenever we are certain about what is real, we seal ourselves from other possibilities" (Gergen, 2009, p. 161).*

The Panther investigation challenged the concept of error as being a fact available for discovery. This was a major step in Forest Service accident investigation process improvement. This report opened a dialogue that resulted in organizational leadership recognizing that error is most often constructed and its identification is rarely of benefit, especially if it is simply tied to blame or listed without context. The accident review board

[34] In 2009 Professor Erik Hollnagel published a book called *The ETTO Principle: Efficiency-Thoroughness Trade-off*, explaining this balancing trade-off in detail.
[35] The Human Factors section was thus placed in the main body of the report rather than in the Appendix.
[36] Without realizing it, this was an initial recognition of the different needs of the fire community and leadership. This realization would ultimately result in the creation of multiple learning products, each specifically designed for a target audience.

recognized the power of allowing readers to draw their own conclusions from the narrative and human factors analysis, commensurate with the tone of the report.

The organization was already skeptical of correct-and-fix recommendations common to previous investigations and subsequent recommendations. Most of these called for additional guidance and/or regulation, creating manuals and direction that were cumbersome to read, access, and maintain. The Panther report opened a leadership dialogue that was centered on understanding and managing conditions instead of correcting behaviors. Previous leadership training had strengthened the importance of dialogue, which created an opportunity for this new approach to accident analysis to resonate with Forest Service leaders.

Within the Panther incident, actions and decisions were recognized as the products of conditions extant in the system. The context of actions became more critical than the actions themselves in terms of understanding the event and developing preventative strategies. In this way, the need for prediction was also revealed as a construction. Socrates, regarded by some as the founder of theorization, argued that for a theory to be universal, it must apply in all places and at all times (Flyvbjerg, 2001). Actions and decisions made during one event can result in success while the same decisions or actions made under another set of conditions could be catastrophic. “The same adaptations that result in success also result in failures” (Dekker, 2010).

Following Panther, there was a recommendation to “formally charter a group within the Forest Service to develop a human factors and systems analysis guide which will be incorporated into all further accident investigations guidance or direction” (Panther Investigation approved recommendations).[37]

Personal Learning

I have striven not to laugh at human actions, not to weep at them, not to hate them, but to understand them. --Baruch Spinoza, Tractus Politicus, 1676.

At the time the Panther report was to be released, accident reports still remained a vehicle for potential claims against the government. There were concerns about giving the family too much information, which could then be used in liability claims against the government. Ultimately, the organization began to understand the value of being open with the family and allowing time to reflect prior to releasing the report publicly. This is now a standard practice, and no reports are released before the family has had the

[37] This recommendation was largely forgotten by the organization, in the years following the accident. However, it was always in the forefront of my mind. Ultimately, with the assistance of a transformational leader within the USFS, John Phipps, I was able to leverage it into an entire incident response protocol, called the Learning Review, which will be discussed later in this dissertation.

opportunity to review and comment concerning the content. Senior leaders and close family friends now conduct this process, rather than the chief investigator.

The Panther experience was remarkably powerful to me. I had to understand the value of honest inquiry in the need to be in a place of asking, not knowing. With my aviation background, the ground-fire environment was eye-opening in its complexity and absence of technology. The most powerful event for me was meeting with the deceased's family to show them the Panther report. The first of these meetings took place while we were gathering information when the widow asked to meet with me. I was ushered into the forest supervisor's office where the widow was sitting on the couch. I was honestly able to tell her that her husband did nothing wrong and that I would do everything in my power to ensure that he did not die in vain. She seemed relieved—I was a wreck. Almost a year later, we completed the report and for the first time, I agreed to work on my birthday. I traveled to Spokane, Washington to speak to the state fire chiefs and sat down with the widow to go through the report line-by-line. She was thoughtful and seemed pleased that the report was so different than the traditional ones she had seen. I let her know that this effort had initiated a shift in the way the Forest Service approached accident investigation. Her husband had not died in vain.

Panther was the first investigation where the investigators met with the family of the victim, both during and after the creation of the report. These meetings took place prior to the report's official release and afforded the family the opportunity to ask questions and to express any concerns they had regarding content. This became a pivotal learning moment for all involved. For the organization, it ultimately represented a goodwill gesture; yet, I had to convince the director of the office of safety and occupational health (OSOH) that there was value in holding such a meeting.

My ignorance of the ground-fire culture allowed me to ask questions in a very different way. The team saw my questions as honest inquiry coming from someone who genuinely wanted to know. Defensiveness, common to people who feel as though they are under scrutiny, was not apparent to me. A relationship developed between the team and me that facilitated this open dialogue. I often prefaced questions with "Here comes another obvious question," and Kurth took time to explain the situation from a ground-firefighter's perspective. The report reflected this in terms of event explanations designed for average readers. More importantly, I recognized firsthand the importance of inquiry and dialogue to learning.

Chapter 6: The Importance of Sensemaking Communities to Accident Prevention

Introduction

Accident prevention requires that people learn by giving meaning to the experience of others. They do this by seeking to understand how actions and decisions made sense to those directly involved in the incident (Dekker, 2002; Weick & Sutcliffe, 2007). This post-incident sensemaking by the general community of workers is critical to the development of accident prevention strategies and modalities. The assessment of interactive, interrelated, diverse, and adaptive conditions that influenced people and their capacity to make decisions and/or make sense of information in the moment ("soft data") is often overlooked by technical or factual reports, which rely on hard data. This chapter shows how a sensemaking community's consideration of both hard and soft data can best support prevention strategy development.

This chapter first explores what is meant by the term sensemaking and how it applies to accident investigations or reviews. Then it shows how people outside the recognized authority made sense of a specific accident and created meaningful recommendations through inquiry, dialogue, and relationships. The chapter summarizes the effect this realization had on the Forest Service and the agency's Learning Review process.

Sensemaking

Most definitions of sensemaking refer to how people make sense of environmental conditions in the moment. Starbuck and Milliken (1988) assert "sensemaking refers to comprehending, understanding, explaining, attributing, extrapolating and predicting." Jeong and Brower (2008) propose that practitioner sensemaking develops through the three stages of noticing, interpretation, and action, which vary as a function of the ecological, institutional, and social relational contexts in which they are constructed" (2008).

Taylor and Van Every expand on this definition:

> Sensemaking involves turning circumstances into a situation that is comprehended explicitly in words and that serves as a springboard for action. Circumstances are the flowing stream. A situation is what is caught on the mesh of a sieve. And the predicates and relations are the words,

> categories, and descriptions that serve as a springboard to action. We are able to make sense when we seem to capture continuous experience in discontinuous concepts, when actions and comments fit into a finite number of types, and when experiences are edited in the interest of collaboration. When we organize we tend to magnify these constraints, they enlarge the number of unnoticed interdependencies and shrink our already limited concepts, which means that these malleable constraints are what we should keep our eyes on (2000).

Maitlis (2005) describes sensemaking as "the process through which people work to understand issues and events that are novel, ambiguous, confusing, or in some way violate expectations." When people encounter ambiguity or uncertainty, it is natural to give meaning to what they perceive by using cues to create a plausible account in order to "make sense" of what occurred (Weick, Sutcliffe, & Obstfeld, 1999; Weick, 1993).

From this collage of definitions, common themes emerge; Sensemaking is the process by which people work to understand issues and events that are novel, ambiguous, confusing, or in some way outside our expectations. Sensemaking is both an individual and a collective or group activity that is context dependent. Individuals engage in sensemaking to understand an unfolding event; however, it is in some sense also retroactive, in that the process involves people building meaning based on observed circumstances that they perceive to be true. Sensemaking involves situational awareness, but is more encompassing and comprises: how we become aware of what is happening around us (changing conditions), our capability to build connections between changing conditions; differentiate 'signal' from 'noise'; use our memories, expertise, emotions and reflection to analyze, create relative frames of reference, and create a plausible (shared) narratives or meaning. The application of the concept of sensemaking therefore, applies to incident or accident review in at least two ways. First, incident analysts can examine the conditions extant during the event and develop an understanding of the influence or role of circumstances in how people directly involved made sense of an unfolding event. Second, organizations or groups can make sense of an event for the purpose of creating a plausible account from which to learn.

Trying to understand how the incident could have made sense to those who faced the decisions and actions in the moment is important in terms of building context and understanding of the event and actions of those involved. "When sensemaking is regarded as unfolding between individuals, inter-subjective meaning is constructed through a more mutually co-constituted process, as members jointly engage with an issue and build their understanding of it together" (Maitlis & Christianson, 2014).

The case that follows illustrates the way that the NTSB and the community of practice each made sense of a commercial aircraft crash.

The Crash of Colgan Air Flight 3407

At 10:17 p.m. on February 12, 2009, Colgan Air Flight 3407 crashed in a suburb of Buffalo, New York. Colgan Air was a small commuter airline operating on the east coast of the United States. The accident that killed 49 people including 44 passengers received national attention. Initial information from major news networks indicated that the aircraft had crashed into a suburban area while on approach to the Buffalo-Niagara airport.

This case study will draw upon the NTSB report that resulted from the crash's thorough investigation.

> Within minutes of the crash, the NTSB was notified and the next morning they launched a Go-Team to the site. The team included NTSB investigators and representatives from the:
>
> - Federal Aviation Administration (FAA)
> - Air Line Pilots Association
> - National Air Traffic Controllers Association
> - United Steelworkers Union (representing the flight attendants)
> - Transportation Safety Board of Canada
> - Air Accidents Investigation Branch of the United Kingdom
>
> In addition to the parties, other organizations participated in the investigation—more than 60 in total—including Transport Canada, Bombardier, Pratt & Whitney Canada, Dowty Propellers, as well as representatives from state agencies, area-wide county and city offices, emergency responders, police departments, service organizations, and many others (Hersman, 2009).

The NTSB team began a study of the incident that took nearly one year to complete.[38.] The result was a detailed 299-page factual report; a visual reconstruction of the crash; and a formal public board meeting to discuss the findings. The NTSB also made recommendations to the regulator, the Federal Aviation Administration (FAA), regarding how this accident could have been prevented[39] (Fielding, Lo, & Yang, 2011).

The NTSB's ensuing study filled in many details of the flight, company operations, pilot condition, airworthiness information, and in short, was complete and consistent with

[38] The NTSB Final Report was released February 2nd 2010.
[39] The traditional response, in such cases, is that the FAA reviews, accepts and rejects recommendations. Accepted recommendations are written into law in the Federal Aviation Regulations or in guidance in the Airman's Information Manual.

NTSB policy and direction. The report described the causal and contributing factors to the accident as follows:

> The National Transportation Safety Board determines that the probable cause of this accident was the captain's inappropriate response to the activation of the stick shaker,[40] which led to an aerodynamic stall from which the airplane did not recover. Contributing to the accident were (1) the flight crew's failure to monitor airspeed in relation to the rising position of the low-speed cue, (2) the flight crew's failure to adhere to sterile cockpit procedures, (3) the captain's failure to effectively manage the flight, and (4) Colgan Air's inadequate procedures for airspeed selection and management during approaches in icing conditions (National Transportation Safety Board, 2010).

The report made no causal connection to fatigue, despite a detailed account of the pilot's actions for a period of 72 hours preceding the accident. An example of this detail can be seen in this excerpt of the final NTSB Report:

> On February 12, 2009, the captain was scheduled to begin a 3-day trip. At 0310, the captain logged into the CrewTrac system. While the captain was logged into the system, he acknowledged a revision to that day's trip schedule. The captain logged into the CrewTrac system again at 0726. Two flight crewmembers, who reported at 0655 for a flight that departed at 0754, saw the captain in the crew room. Another first officer, who reported to EWR at 0525 for a 0632 flight and returned to EWR at 0956, saw the captain asleep in the crew room during the morning. Between 1012 and 1058, the captain made and received telephone calls. A flight attendant, who reported to EWR at 1130 for an 1153 flight, stated that she saw the captain eating lunch.
> The EWR regional chief pilot stated that the captain had offered to do office work and was inserting revisions into airplane manuals between 1200 and 1400.30. During this time, the captain made a telephone call to his wife, which lasted a few minutes.
> The captain's specific activities during the remainder of the afternoon are not known, but he was observed in the crew room watching television and talking with other company pilots. He logged into the CrewTrac system at 1421 and 1658, made telephone calls at 1624, 1801, 1915, and 1930,31 and received a call at 1649 (National Transportation Safety Board, 2010).

Fatigue was not listed as causal; however, there was dissention on this issue. The official report includes a notation from Chairman Deborah Hersman in which she makes a correlation between the effects of alcohol use and fatigue. She points out that fatigue has

[40] Stick Shaker is a mechanical device that is attached to the control yoke or "stick" that sends a vibration to the stick to warn the pilot that the aircraft systems indicate an aerodynamic stall condition is imminent.

many of the same symptoms as alcohol, but its identification is limited, as there is no empirical test to determine the level of fatigue. "There is no comparable chemical test for identifying the presence of fatigue as there is for identifying the presence of drugs or alcohol; hence, it is often difficult to conclude unequivocally that fatigue was a causal or contributing factor in an accident" (National Transportation Safety Board, 2010; Notation 0890A Chairman Hersman, Concurring). Hersman's notation came as a result of her request that "fatigue be added as a causal factor," which was over turned by the other board members, Sumwalt and Hart (National Transportation Safety Board, 2010).

The sensemaking conducted by the NTSB during the nearly year-long investigation is reduced to a list of causal factors:[41]

- The captain's inappropriate response to the activation of the stick shaker.
- The flight crew's failure to monitor airspeed in relation to the rising position of the low-speed cue.
- The flight crew's failure to adhere to sterile cockpit procedures.
- The captain's failure to effectively manage the flight.
- Colgan Air's inadequate procedures for airspeed selection and management during approaches in icing conditions (National Transportation Safety Board, 2010).

This list presents factual causes absent of the context that would allow others to make sense of these conclusions. This list and the associated recommendations were not enough to satisfy the people who were affected by the crash.

Community Reaction to the Colgan Air Incident

The NTSB is a world-recognized accident-prevention organization and considered to be the "gold standard for accident investigation and recommendations" (Sumwalt, 2010) and yet its report did not satisfy the larger community's need to make sense of what had happened.

In the years following this investigation a community of victim's families, safety specialists, academics, and commuter airline professionals convened to make sense of the event in a different way. Through dialogue and tenacity, they were able to propose meaningful recommendations for prevention to the FAA that were ultimately included in regulation and guidance. The emergence of this community ultimately changed regulation and monitoring of fatigue.

[41] NTSB recommendations, based on the causal factors, are designed to prevent reoccurrence and directed to the FAA for consideration, approval and implementation.

The community set out to discover what the report did not say: how this incident could have happened. The community wanted to know, "Why did the captain respond to the stick shaker the way he did?" Absent in the probable cause statement was anything that explained how this could have happened or why the actions described in the report might have made sense to the individuals at the time (Young & Obrien, 2010).

Community members looked to the narrative of their collective experience and knowledge and coupled this with the factual NTSB report and multimedia animation. They began their own sensemaking journey. News articles, op-eds, movies, blogs, and dialogues emerged, as aviation professionals and laypersons worked together to make sense of the incident.

The grassroots group grew as they added experts from safety and academic communities. New perspectives were explored, and as a result relationships between perspectives and *facts* were recognized. All of this led to increased understanding of the event. There was no systemic guidance in this process—it evolved naturally as information, multiple perspectives, and interconnections were discovered and discussed (Young & Obrien, 2010).

Stories regarding the pilot's quality of rest emerged and the relationship between fatigue and actions became relevant, just as Chairman Hersman had suggested. This relationship was not built through accepted, factually constructed, quantifiable evidence; rather it was *soft*, inferential, and practical. The community and families knew it was common practice be up early and to catch naps in pilot lounges. To a large degree this was thought to be unavoidable, due to schedules and low pay (Johansen, 2014). From personal experience pilots in the group could place this information in context so that others could understand the potential effect a sleep deficit could have on cognitive ability and behavior.

The NTSB is organized around a philosophy that seeks to find causal relationships and establish controls, often in the form of barriers. This structural approach results in a series of explanations of what occurred and unintentionally avoids how the incident occurred or why it made sense to the people involved. This represents a form of technical sensemaking that seems to undervalue the social aspect of sensemaking.

Despite listing "fatigue" for two decades on the NTSB's *Most Wanted List for Safety Concerns*, it seemed the agency was prevented by their own process from addressing it in the report (NTSB Public Hearing; (Young & Obrien, 2010). It took community sensemaking and public outcry to get the regulators to focus on fatigue. This group of end-users, pilots, writers, reporters, and aviation specialists were able to explore their knowledge and experience with regard to conditions that induced fatigue. They did not bind themselves to a particular way of looking at information, which enabled them to assess their sense of what was happening in the industry.

The community reaction gathered enough attention that Frontline News joined with the Public Broadcasting Service to create a documentary called *Flying Cheap*, which was entirely focused on the Colgan Air event. This documentary recognized the importance of the community created by the cooperation between the families of those involved in the crash and commuter airline pilots. Other media outlets also recognized this important breakthrough. “Thanks to the efforts of the grassroots advocacy group Families of Continental Flight 3407, FAA has set substantially higher industry standards across the board” (Johansen, 2014).

Colgan Air Incident Lessons

Investigations are a form of sensemaking in that they give meaning to the experience of others. The Colgan Air story teaches that sensemaking continues well beyond the release of a formal report. This case shows three specific qualities of sensemaking that can inform investigation approaches and give value to sensemaking: Sensemaking does not stop when the report is completed; the report is only one part of the sensemaking process; and the community has the potential to develop and deliver innovations.

This case shows that sensemaking is beyond the control of the agency or organization responsible for the investigation. Once the report was released, the community rallied to find answers that satisfied their needs. This process engaged a variety of people who continued making sense of the event and operated outside the control of any process or organization. This showed that sensemaking can be an independent and emergent process that adds to understanding an event.

A report, regardless of how thorough or well presented, is only one part of a body of sensemaking and can only partially describe the event. In this case the report became the starting point of further interpretation or sensemaking. What emerged was a free form of analysis, which was able to take advantage of both soft and hard data (Young & Obrien, 2010).

The community that self-organized following the Colgan Air Crash was not bound by process or bureaucratic responsibilities. They could access and interpret information from any source that they felt was useful or noteworthy, including their own knowledge and experience. This is not intended to say that structured responses are better than free-formed ones; rather it highlights the importance of including multiple perspectives in learning and in system improvement and innovation.

The Colgan Air case represents the importance of post-incident sensemaking. The learning that results is a function of individual needs, knowledge, experience, and heuristics. This is often beyond the control of agencies or organizations and implies that a new sensemaking form that I call “public sensemaking” can be a vehicle for the development of knowledge and innovation.

Forest Service Implications

The Colgan Air incident became an important case study for the Forest Service, as it helped leaders understand that sensemaking does not end when a report is published. The community will continue to talk about an incident until receiving a satisfactory answer. The agency does not have control of the learning that takes place but may well be in a position to take advantage of what the community can offer. This also demonstrates the importance of multiple perspectives in analyzing incidents and accidents and ultimately led the Forest Service to adopt the focus-group concept as an analytical tool.

Understanding the role of community sensemaking in the aftermath of Colgan Air triggered my own understanding of the importance of involving subject-matter expertise in the investigation process. This allowed me to help Forest Service senior leadership to understand that the people closest to the work can play a valuable role in making sense of an accident and in developing prevention strategies. This principal finding resulted in the inclusion of focus groups in the information gathering and sensemaking phases of the Learning Review process. The Colgan Air case also helped the agency understand the importance of informing victims' families during the investigation process; at some point leaders may recognize that families have an important story to tell as well.

As a result of this case, the Forest Service applied sensemaking concepts during the Saddleback Learning Review and the Yarnell Hill Investigation in a very different way—to understand why actions and decisions made sense to those involved. What emerged may be a new form of sensemaking not accounted for in the comprehensive list of *Forms of Sensemaking* (Maitlis & Christianson, 2014). This new form of sensemaking occurs when readers and/or practitioners make sense of information and add to that information with personal experience to create meaning or significance that goes beyond the original information. By adding multiple perspectives and levels of expertise new information is derived through the interactions of these sensemaking communities with each other and any number of additional sources of information. I call this *immersive sensemaking*.

In the two cases where this approach was used, additional information about the system, culture, or common operating conditions were discovered. These were relevant to understanding the conditions that supported decisions and actions of those directly involved in the incident. The following chapters will demonstrate how the Forest Service has included immersive sensemaking in its learning-review process.

Chapter 7: Learning from Error

Introduction

This chapter challenges models that suggest that error can be objectively determined and controlled. It explores some positive aspects of error, including using error as a catalyst for learning from events rather than simply judging actions and decisions and labeling them as errors. Adaptation is recognized as a method of managing the unexpected (Weick, 2007) and as a way to work in complex systems (Page, 2009; Morin, 2008). The same adaptations that result in success can also result in failure. This chapter addresses the way that error is socially constructed and often based on outcome, alone. It also challenges assumptions of cause, based on this kind of judgment. The chapter concludes with how these realizations applied to the creation of practices included in the Learning Review Guide.

The emphasis of this chapter is to show that both the accident investigation community of practice and the academic community have wrestled with the categorization and elimination of error, without success. Several academic models are introduced that demonstrate non-linear relationships that exist between risk and success (Adams, 1995). Hollnagel (2009a) is used to demonstrate the importance and role of context to understand goal conflicts in normal work environments.

Commonly Held Assumptions

Organizations commonly seek to identify accident causes in two broad categories: mechanical failure or human error (Dekker, 2014). This espoused goal dominates modern societal reactions and organizational responses. While seemingly benign to some, it embodies a particular set of assumptions about the role of humans in the system and infers that error can be both objectively determined and controlled.

The earliest efforts focused on the reliability of the human factor and the suppression of human error, specifically, the technique for human error rate prediction (Morel, Amalberti, & Chauvin, 2008). The total eradication of human error was quickly abandoned as an objective (being unrealistic from a simple theoretical viewpoint), and safety naturally evolved toward a more systemic perspective (Rasmussen, 1986; Reason, 1990a). In Rasmussen's (1986) footsteps, Hollnagel and Woods focused on the cooperative relationship of humans and machines and shifted focus to systemic risks as perceived through its interaction dynamics, rather than through the risk of failure of single components within the system—the machine on one hand, the human on the other (the concept of joint cognitive systems) (Hollnagel & Woods, 2005).

The category of human error is unclear and delineated largely in retrospect with the knowledge of hindsight. As the Colgan Air and Panther cases indicated, error has different meanings and is often perceived quite differently by field personnel and others outside the investigation. This observation is supported by research.

> From the outset, the definition of human error seems implicit. However, this area is subject to ambiguity. In industry usually, only errors having non-acceptable consequences (i.e., outside the field of safe operations, as defined by procedures, instructions and safety analyses) are labeled *errors*. On the other hand, psychologists define error as an erroneous act, whatever its consequences or the level at which it is detected and recovered (Amalberti, 2001).

The sensemaking that followed the Panther Investigation challenged the dominant assumptions about human error, many of which were espoused in the SAIG. However, the value of error and the ability to discuss it openly may have been the price paid for policies and investigations that focused on error for decades, which easily converted cause to blame (Dekker, 2002).

To evaluate the effect that the "war on error" (Kern & McKay, 2013) has had on the Forest Service, this chapter explores five key interpretations or fears regarding error:

- The questions raised by the Panther Investigation.
- The difference between adaptation and error.
- The challenges common to judgments of complacency and negligence.
- Challenges in our ability to recognize errors.
- Inhibitions on the part of our personnel to discuss errors that they did recognize.

The chapter conclusion will explore the importance of error recognition and dialogue as a way to learn from events and its importance to the development of a learning-focused organizational response to incidents and accidents.

Questions Raised by the Panther Incident

The Forest Service was drawn into a model of human and performance errors as the principal focus of accident investigation (Whitlock & Wolf, 2005). Actions that immediately preceded an accident were often judged to be errors and classified as *active failures* (Whitlock & Wolf, 2005; Reason, 1990). Human errors were defined as actions that had an immediate impact on the integrity of a system (Grabowski & Roberts, 1996). Panther supported a deeper view of error where accident inquires widened their scope to consider upstream influences on behavior. As Woods et al. point out, "Human error

should serve as the starting point for investigating how systems fail, not as a conclusion" (2010).

The conditions at the Panther fire evoked a different view of error. Two highly qualified individuals made the same decisions and took the same actions until the very last. Commonly the action or decision judged to be erroneous is the one that resulted in fatality or injury. However, in this case the best practice was to remain in the shelter (arguably the correct choice), which the survivor did not do. This realization moved the team to recognize that error was a label and not an observation or condition.

During the investigation, it became obvious to the team that a number of conditions influenced behaviors and decisions. The Panther report captured conditions that appeared ambiguous to the team. This list included but was not limited to the following:

- DIVS were not formally assigned or directly under the supervision of anyone on the fire.
- Crews re-engaged on the fireline (an indication that conditions had changed).
- Common wisdom on the forest was that shelter-deployment sites were uncommon, which was information unavailable to DIVS.
- The fireline crews did not act as though the conditions were volatile.
- The superintendent did not leave with his crew; he actually went toward the fire.
- Goals were in opposition: "Stay off the line" vs. "Scout the line and know what people are doing" (Panther Investigation Interview).

All of this incoming information was further compounded by communication that was complicated by terms with special significance to those who were part of the initial assignment to the fire and unfamiliar to the DIVS.

Panther pointed out that people ordinarily take actions appropriate to the meaning they ascribe to perceptions (Fujita & Hollnagel, 2004; Weick, 1995). These perceptions can be considered to be the conditions that influence behavior.

> It does not make much sense to think of an action, hence an action failure, without a context, and since the context often may be the 'error forcing condition' that leads to the failure, it seems reasonable to consider how the coveted 'error probability' can be determined directly from a characterization of the context (Fujita & Hollnagel, 2004).

Human performance is shaped by a number of influences, which can be seen as conditions. The conclusions drawn by the investigation team's experience with the Panther incident and subsequent research challenged simple cause-effect relationships and suggested that there were significant conditions that influenced decisions and

actions. This moved the team to avoid labeling actions and decisions as errors and shifted the goal of the investigative process.

Error or Adaptation?

Professor Jens Rasmussen studied industrial environments and concluded that in stable systems, "human errors can be studied as they relate to features of the system" (Rasmussen et al., 1990). He recognized two significant features of work environments: stable systems and flexible work environments (1990). Rasmussen further concluded that there is a need for adaptation in flexible systems.

> In modern, flexible and rapidly changing work conditions and socio-technical systems, other features are equally important, such as: (c) resource limitations that turn up in unpredicted situations and finally, (d) the influence of human learning and adaptation. In the present context, the relation between learning and adaptation and the concept of error appears to be important (1990).

The industrial, smooth, controllable, and predictable model does not appear to be applicable to complex adaptive systems (CAS), which routinely deliver uncertain or unpredicted situations. CAS are characterized by a number of agents or elements interacting in a dynamic, non-linear fashion (Anderson & McDaniel, 2000). Non-linear systems are recursive, defined in terms of connections and patterns of relationships among members where no one has complete understanding of everything taking place, and understanding is a function of interconnectedness and communication or sensemaking (Weick & McDaniel, 1989). Success depends on relationships and group sensemaking, which result in adaptations that meet situational demands (Paparone, Anderson, & McDaniel, 2008). For example, success or failure in wildland fire operations can depend on the quality of relationships between agency administrators and incident commanders, which are different than the relationships between incident commanders and crew leadership and can substantively affect the ability to communicate and adapt.

Date Created	Author(s)	Definition
2009	Rasmussen	Structuring the work processes by an individual in a flexible environment will be a self-organizing, evolutionary process, simply because an optimizing search is the only way in which the large number of degrees of freedom in a complex situation can be resolved.
2003	LePine	Reactive and non-scripted adjustments to a team's system of member roles that contribute to team effectiveness.
2006	Burke, Stagl, Salas, Pierce, and Kendall (in Salas, Rosen, Diaz-Granados, 2010)	The model of team adaptation consists of four process-oriented phases: (a) situation assessment, (b) plan formulation, (c) plan execution, and (d) team learning. Their model illustrates the series of phases that unfold over time and constitute the core processes (and emergent states) that underlie adaptive team performance.
2001	G. Klein & Pierce	Teams that are able to make the necessary modifications in order to meet new challenges.
1995	Smith & Hancock	Adaptation is the process by which an agent channels its knowledge and behavior to attain goals, tempered by the conditions and constraints imposed by the task environment… a dynamic concept that exists at the interface between the agent and its environment.

Figure 7.1: Definitions or Descriptions of Adaptability and Adaptation.

The term *adaptation* is not universally defined (see figure 7.1). Each of these definitions indicate that people will restructure work structure and create non-scripted adjustments that are purpose-driven, iterative, and the result of cognitive or behavioral actions carried out with the team's goals as the overarching priority. The adaptation can be seen as a product of sensemaking. Weick advocates sensemaking as the way to manage the unexpected (1995). No set of rules, regulations, policies, or procedures can anticipate every situation people face. People will be required to develop adaptations to meet unexpected challenges (Dekker, 2002).

Successful adaptations are frequently recognized as examples of superlative performance or thinking outside the box; however, when the same adaptations result in negative outcomes, they are judged to be errors. Both these judgments are based on an event outcome, which is unknown to the participants during the mission and therefore not a factor in their determination of action. These outcomes only become clear with the benefit of hindsight. Adaptation is necessary in CAS because the context of the unfolding incident and the conditions those involved observed and perceived shape decisions and actions that are not constant or predictable.

The application of normative standards is limited to that which can be predicted and defines the limits of *clear performance standards* that could be used to define error. This quality is not shared with CAS. The need for adaptive responses to manage the

unexpected gives them a unique place in this discussion because the same adaptations that result in success can also result in failure. This realization places an onus on investigators to consider whether a determination of error may be based on the outcome or subjective judgment.

The Challenges of Complacency Judgments

Consider this statement: "Workers are as safe as they need to be in order to get the job done." To some, this may seem to be heretical and to others, obvious. It is a key to understanding what Erik Hollnagel refers to as the "efficiency-thoroughness trade-off or ETTO" (Hollnagel, 2009a).

In this image (figure 7.1), the worker appears to be making a trade-off between safety and ensuring that the job is done well. She is standing on the top of a ladder and the top of a door in a stairwell. When asked about this, she said, "I felt perfectly safe; it was the only way I could reach this area." This indicates that the perception of safety varies from person to person and that personal and/or organizational completion standards can compete with what appears to be safe work practice. Certainly, OSHA would not allow this kind of behavior.

Figure 7:2: Worker doing what she felt was necessary and safe.

All too often these kinds of trade-offs are seen from the outside as a form of behavior that has to be curtailed or eliminated altogether. Following an accident, this type of action is frequently judged to be complacent or negligent. Adams (1995) says risk is an individual value and perception. The approach to risk can be seen as balancing behavior affected by the sense of reward; the potential severity (accident); the believed or perceived sense of probability (danger); and individual propensity to take risk (see figure 7.2). These perceptions, however, are not constant from one person to the next (Adams, 1995). Additionally, these perceptions change with exposure to risk and experience.

Figure 7.3: Adapted from (1995) depiction of balancing behavior.

As people become more experienced, they tend to reduce or normalize the risks associated with an activity. Typically when people begin a new activity with a component of risk, they are careful and cautious about their approach. When they continue doing that task for some time, they may begin taking shortcuts or finding more efficient ways to get the job done. Driving is an excellent example of this. New drivers tend to follow all the rules prescriptively, and some even drive below the speed limit. At some point in their development, they will begin to experiment and perhaps roll through a stop sign without stopping once they have assessed that the road is clear. They may even experiment with the limits of the road, the car, or both by exceeding the speed limit. Their original perception of risk has been normalized.

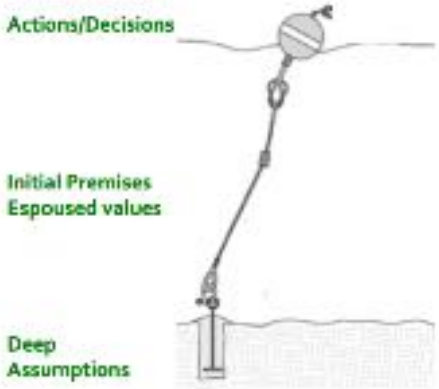

Figure 7.4: Adaptation of Schein's Cultural Model.

The action is an artifact of greater issues within the system. Labeling the action as complacent or negligent does not recognize the deeper cultural beliefs, espoused values, and assumptions (Schein, 2004). A buoy floating in the water (figure 7.4) is the only thing that can be seen from above the surface of the water. The buoy represents the artifact or action, and the deep assumptions (the anchor) hold it in place. The anchor line represents the beliefs and espoused values. The desire is often to change the behavior directly by

focusing on the worker. Metaphorically, it is like trying to move the buoy without moving the anchor.

Focusing on the artifact or action is a common practice in accident investigation reports. The SAIG defines a causal factor as "any behavior or omission or deficiency that started or sustained the accident occurrence" (Whitlock & Wolf, 2005). This focus commonly results in labeling the action as an example of complacent behavior. Complacency is used to describe several actions in the 2005 SAIG:

- Misjudgment of assignment risks.
- Failure to monitor assignment progress or conditions.
- Overreliance on automated systems.
- Misjudgment of mission risks.
- Failure to monitor flight progress or conditions.

The International Association of Fire Chiefs commissioned the development of the *Crew Resource Management (CRM) Manual for Firefighters*. This publication, now in its third edition, describes complacency as "a false sense of comfort that masks deficiencies and danger" (2002). It directly links this false sense of comfort with complacency: "We need to look to new venues to break the chain of complacency" (2002). The linear simplicity of the chain metaphor is striking, as it implies that complacency is tangible and observable, a fact to be discovered and eradicated. The concept of complacency has also been nominalized here—the original action verb, "to be complacent," has been turned into a noun with no need for action. The metaphor of "breaking the chain" with this noun now makes it seem like an easy, physical task to accomplish. What is absent from this approach are the driving conditions (deep assumptions and values) that supported the action. The definition, thereby, removes context from the action.

The International Civil Aviation Organization (ICAO) defines complacency:

> A state of reduced conscious attention caused by a sense of security and self-confidence. Behavior characteristics of complacency include overconfidence and boredom, both of which can significantly degrade performance" (ICAO, 2004).

This term is used to define a negative attribute of people in complex adaptive systems—in this case, civil aviation. Arguably, in a field where self-confidence is desired, how does anyone determine when people are overconfident, relaxed, or bored? These grey areas are open for interpretation and not factually or empirically determined. They are constructed half-truths at best.

The following is an excerpt from a serious accident investigation where the pilot lost his job for actions that were tied to complacency. "The pilot had extensive experience (3,000 hours make and model) and confidence in the aircraft and his ability to control it under

this circumstance indicating complacency and/or overconfidence" (Forest Service, 2010, December 14).
In this example, experience was equated with complacency or overconfidence. This item appeared as a causal finding with no explanation or context. It is doubtful that any experienced operator will equate his/her level of expertise with complacency.

The use of the term complacency can undermine the reader's ability to learn from the event. Its use can actually alienate the very readers the report creators most want to reach.

> When I read the Esperanza final report I was pissed. No one would do that. I could not believe the report, plus, I knew that it did not apply to me and my crew; we are not complacent about anything, especially when things are going to hell (Interview with a crew supervisor after the Esperanza fatality incident) (see figure 7.5).

Judgment and Risk Decision

- Acceptance of a high-risk situation or assignment.
- Misjudgment of assignment risks (complacency).
- Failure to monitor assignment progress or conditions (complacency).
- Use of incorrect task priorities.
- Intentional deviation from safe procedure (imprudence).

Intentional violation of standard operating procedure or regulation. Types:

- Violation of orders, regulations, standard operating procedures (SOP).
- Crew rest requirements.
- Inadequate training.
- Violated agency policy or contract.
- Failed to comply with agency manuals.
- Supervisor knowingly accepted unqualified crew.

Figure 7.5: Excerpt from the Findings section of the Esperanza Fire Accident Investigation Factual Report.

The use of this language and the judgment in hindsight of actions completely out of context does little more than make people less interested in the report or angry about the process used to create it.[42]

Error Recognition

Risks and mistakes may appear to have lesser value when associated with positive outcomes and may cause lost learning opportunities. For example, people may judge an outcome as positive and thus unintentionally reduce the importance of the mistakes or

[42] This anger resulted in a grassroots movement to create an alternative to accident investigation called the Facilitated Learning Analysis (FLA), which will be introduced later in this chapter.

the risks taken. This situation may be more common than realized and may contribute to an inflated belief in the safety of the system. In the *Roadrunner* cartoon with Wile E. Coyote, the coyote would run off a cliff and keep right on running; it was not until he looked down that he realized his error and began to fall. People are often like that coyote in that they do not recognize the error until actually seeing the peril.

A positive outcome influencing the recognition of error or success took place during a recent prescribed fire where things did not go exactly as planned. The outcome ultimately benefitted the organization, and the operation was considered successful. The fire management officer involved relayed the story and her concerns regarding the way the local fire organization and leadership reflected on the incident (see figure 7.5).

Later the person who shared the prescribed fire story (see figure 7.6) reflected on her impressions of the event. The following is the way that she captured the discussion we had regarding the story:

> For me, the murky depths lie in where we *succeed*. Watching an intentionally lit crown fire march across the landscape is a horribly uncomfortable position for me…For others I believe they felt it was a righteous moment. When we insert passion and ego there is no room for vulnerability and self-reflection. When we *succeed* our brains are saturating our bodies with endorphins all providing positive feedback to "Do that again!" Now that the heat of the moment has passed (excuse the pun), people are willing to admit that our after-action review right after the burn did not provide an environment with which we could honestly provide feedback on how to do things better. But, and this is a big *but*, the flag is still proudly being waved to forest and regional leadership that we have achieved a righteous and repeatable action. As you said, the critical moment lies in honest inquiry, and fostering that environment when there wasn't a near-miss or bad outcome is very difficult.

This story shows how outcome can influence highly experienced operator's ability to recognize error. In this case the positive outcome indicated that error did not occur. This example is one way that the concept of sensitivity to operations is undermined.[43] Instead of recognizing system fragility and the potential for the system to do harm, this became a success story. Such perceptions can potentially mask benefits of error detection, which can adversely affect both learning and situational awareness.

[43] Sensitivity to Operations is one of the five principles of High Reliability Organizing, introduced by Karl Weick in his book, *Managing the Unexpected* (Weick, 2007).

- I am struggling with the concept of luck and successful outcomes. Are we safe by design or are we just lucky it worked how we wanted it to?
- I have been on a few FLAs for escapes and it often strikes me listening to people wrestle with what happened….Inevitably someone always says, "Was this an unusual set of circumstances or have we just been lucky the past few times we have done this?"
- This burn was designed to "mimic" natural processes for the regeneration of Jack Pine for endangered Kirtland Warbler habitat. It's a big thing around here… we plant Jack Pine at 5,000-7,000 stems per acre after clear cutting and roller chopping an area … its expensive. There have (sic) been a lot of conversations regarding how this ecosystem existed with fire as a natural disturbance regime before man intervened. What surfaced were questions regarding the effectiveness of this approach, as it is quite dangerous.
- A group of us who have been researching and looking at things and wondering if the [historic] fires were intense surface fires for the most part, with isolated torching to open cones and thus regenerating the ecosystem in which the bird exists. But the person "pushing" this project through is a District Ranger, Type 2 IC, very TYPE A [personality] and has it in his mind the only way to regenerate these conditions is with crown fire.
- So that is a very abbreviated version of how I found myself last evening on an prescribed fire where we were intentionally trying to generate a small 35 acre crown fire. We had some ignition patterns established that were "designed" to break up the crown fire when it reached the edge of the project area. However, in this fuel type you can get spotting up to a mile away….
- The AAR last night was filled with the usual bravado when there is a group of firefighters who just got to play with 100' flame lengths and to some extent I was also kind of high off the situation too… deep inside I think the pyro in all of us was in awe of what we did. But there was a nagging voice that I am having trouble putting words too without looking like the Debbie Downer for the group…. We most certainly did NOT have control of that fire at one point in the ignitions. Is that ok on a prescribed burn? No one did anything really "heroic" … the project was set up in an area where the chance of it doing "serious" damage was low…. But I am NOT comfortable with the conversations I was hearing during the AAR… things like, "Now we have shown the world we can do this – we can do this other places." "That went perfect so we know our prescription was right"….

Figure 7.6: Recent prescribed fire story.[44]

[44] This story introduces language specific to fire – the following terms are defined to enhance readability of the story (definitions are obtained from the NWCG Glossary):
Torching - The burning of the foliage of a single tree or a small group of trees, from the bottom up.
Crown Fire - A fire that advances from top to top of trees or shrubs more or less independent of a surface fire. Crown fires are sometimes classed as running or dependent to distinguish the degree of independence from the surface fire.
Prescribed Fire - Any fire ignited by management actions to meet specific objectives. A written, approved prescribed fire plan must exist, and NEPA requirements (where applicable) must be met, prior to ignition.
Spotting - Behavior of a fire producing sparks or embers that are carried by the wind and which start new fires beyond the zone of direct ignition by the main fire.

The Relationship between Strength and Vulnerability

When organizational or societal reactions are perceived to be punitive, judgmental, or driven by liability, participants may be reluctant to share their accounts. Accident investigations that resulted in what Jennifer Ziegler called "blaming the dead" led to a fear of judgment and the ascription of blame (May, 2006). The community of practice in the Forest Service responded in two significant ways:

- The grassroots development of a local learning product called the facilitated learning analysis (FLA).
- The avoidance of open discussions about perceived errors.

The Facilitated Learning Analysis (FLA)

The FLA is designed to be a local discussion of a specific event that was a near-miss, surprise, or an injury accident. If the severity is not considered to have national attention, then the Forest Service uses a facilitated learning analysis (FLA) to explore what happened and to help those involved understand the incident and not blame themselves.

The FLA team creates an environment in which the participants can speak freely. This is done through dialogue and a series of agreements made between the event participants, leadership, and the team. The process overtly states that judgment is to be avoided with learning as the only goal. A contractual agreement between the FLA team and organizational leadership states, "The FLA will not be used for punitive action" (Forest Service, 2014c). The process includes efforts to ensure the stories reflect the perspectives of those involved, which ultimately become the basis for understanding and learning from the event. The FLA's protective nature cannot be understated; according to its developers, this is a direct response to the SAIG and the reports that blamed and shamed employees (Forest Service, 2014c).

Open Discussion of Errors

The pressures placed on Forest Service personnel as a result of years of punitive action and reports that blamed incident participants appear to have affected individual willingness to discuss error. This situation is exemplified in numerous accounts accumulated during this dissertation's development. One story captured the essence of the problem and offered some pathways to consider how a new organizational response should be shaped.

During a recent fire refresher training session, a senior firefighter told about a time he made a mistake as a division group supervisor (DIVS) that could have cost his division firefighters' lives. He prefaced the story by saying that it had happened years before and that he had never talked about it because he was ashamed.

He spiked-out[45] his division of four crews on a ridge above a smoldering fire.

> Our mission was to construct indirect line up on a major ridge in the wilderness area, prep it for burnout, and eventually burn out to establish a blackline.[46] The main fire was down in a major drainage bottom below us in what seemed like a long distance away (Firefighter's account).

The crews spent several days and nights working with seemingly little effect; all the while the fire smoldered below, held in check by an inversion.[47] One night, the inversion broke and the fire made a run, placing all the crews in jeopardy.

> "The main fire had finally come out of the canyon during the night, made a major uphill run towards our location, and spotted over the main ridge starting a spot fire below us. We now had fire on both sides of our ridge-top location—the main fire on one side and the spot fire on the other side, and us in the middle (Firefighter's account).

By luck, one firefighter was awake and noticed what was happening in time to warn the DIVS. During the DIVS fire-refresher presentation, he acknowledged the following:

> Not long after I had fallen asleep, I was abruptly awakened and told we were responding to a spot fire. The thought struck me of the mistake I made. I started beating myself up and asking myself, 'How could you have missed that? How could [I] have been so stupid?' It became clear to me then that I should have kept someone awake all night to act as a lookout in case something like this happened. I was very embarrassed for not having done that. I know that Fire Order #3 states: 'Base all actions on current and expected fire behavior,' and not: 'Base all actions on previous fire behavior.'
> I didn't see the potential for changing conditions ahead of time to anticipate the risk of what happened that night. By not doing so, I put myself and 60 other firefighters in danger. I didn't believe the fire would make an uphill run that night. I missed it. Fortunately, no one got hurt and we caught the spot fire. I made a mistake and got away with it (Firefighter's account).

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[45] Spike-out - Place the crew in a fire camp in close proximity to an ongoing fire to reduce travel time to and from a larger, more established fire camp.

[46] Preburning of fuels adjacent to a control line before igniting a prescribed burn. Blacklining is usually done in heavy fuels adjacent to a control line during periods of low fire danger to reduce heat on holding crews and lessen chances for spotting across control line. In fire suppression, a blackline denotes a condition where there is no unburned material between the fireline and the fire edge.

47 Inversion is an atmospheric phenomenon that represents a stable layer of air that is commonly associated with low fire activity while the inversion is in place.

When he was done with his presentation to the refresher training audience, all 300 participants rose to their feet and gave him a standing ovation. In his story, many of them said they could see themselves in what DIVS had done. When they heard the context that surrounded his actions, several of them said they could see adding this story to their understanding of fire.

In the weeks following his presentation, DIVS reflected and sent me this note:

> I had pretty much forgotten about this incident and my mistake over the 13 years since it happened, since fortunately no one got hurt and we recovered from it. However, preparing to tell it for these sessions brought back all the memories and feelings of guilt over this that I had gotten over and moved on from. I started judging myself again after dredging up a past mistake that I had forgotten about. It reminded me that we are often harder on ourselves than anyone else would be, even after 13 years. After deciding on which story to tell, I then began to worry about two aspects related to my sharing the story: 1. People would think I was stupid for the mistake I had made; 2. People would think that it really wasn't that big a deal and I was making much ado about nothing. Since I have worked in the Pacific Northwest Region (PNW) for over 30 years, and the three sessions where I would be sharing this story were all being held in the PNW, I knew there would be a number of folks in the audience whom I knew. I felt a little more pressure because of that since you don't want to embarrass yourself in front of people you know and will see again. I worried about what affect it would have on my reputation in the region after the three sessions were over.

Society avoids or even suppresses information about incidents that potentially place shame and blame on errors. Currently it takes heroic resolve to tell stories of error, mainly because this nation has socially created judgment of actions as a default response. One senior executive service leader in the Forest Service said, "Heroes, in this culture, are created in people who have the strength to tell their stories."

How We Address Error is an Important Part of the Organizational Response to Incidents

Learning has been argued to be important in accident prevention (Dekker, 2005; Hollnagel, 2002; McDaniel, 2007; Maurino et al., 1998; Weick & Sutcliffe, 2007). Accident and incident investigations and reviews struggle with how to address errors. Some investigations use error as the principal accident cause while other styles avoid the mention of error altogether to avert blame and alienation. The effect of these approaches is evident in the examples presented within this chapter. These examples indicate that

strategies to avoid error or to focus on error alone restrict the ability to learn from events.

Panther set the Forest Service on a course to evaluate error, and the agency learned that in order to leverage error into lessons learned, resources had to be dedicated to understanding error types and developing knowledge of the context in which errors occurred. Three specific areas of interest emerged: the difference between adaptation and error; the existence of inhibitions regarding the ability to recognize errors; and personnel's reluctance to openly discuss error. This led to understanding different ways that error has been applied.

Three potential applications of the term *error* emerged from this study. First, the reviewer, investigator, or individuals involved in the incident use error to describe behavior based on individual perceptions. One person's error is another person's adaptation. Second, there are times when error is normative when deviation from accepted practice, policy, or direction occurs. However, even this type of error must be placed in the context of the conditions that influenced the behavior in order to learn how to avoid reoccurrence. Third, the determination of error can be a judgment on the reviewer's part, and this approach can damage reporting and open discussion of errors.

Forest Service Application to the Learning Review Process

Recognizing the type of error is important; however, the key to learning from error may be by understanding the view of those involved in the incident (Dekker, 2006). Learning from an event calls for separating the triggering action from both cause and blame; the investigation must ensure that the context of the decisions are understood so that people outside the incident can understand how it appeared to those involved (Dekker, 2006). Prominent researchers in the field of accident investigation advocate that error is the starting point of the investigation (Reason, 1997; Dekker, 2006).

Learning about error is an opportunity to add to understanding what to do or not do. However, to manage the uncertain, people must enter into sensemaking dialogues centered on conditions and through these dialogues explore ways to improve the ability to recognize the system's potential to do harm. This is, in part, an attempt to recalibrate a form of drift where people normalize risks associated with common tasks. Adams (1995) builds a logical case for the natural tendency of people to minimize or reduce exposure when they detect hazards or risks in what they are doing. "Our behavior is guided by our anticipation. If we anticipate harm, we take avoiding action" (Adams, 1995). This represents a zero-cost option to learn from the mistakes of others and to recognize hazards and risks in the moment.

Understanding error also allows people to place the error in context and understand how others are dealing with errors that they perceive by asking, "What types of innovations or

work improvements are created when errors are detected?" This approach moves people to examine how the system fosters error and adaptation as well as how the workers create resilience in the work environment. Leaders can then understand more than how personnel are managing risk; they can also perceive how employees are recognizing risk. Leaders may then be able to leverage this knowledge into work improvements by sharing it with others.

From the organizational perspective, error can be used to understand the goal conflicts, ambiguities, and tensions extant in every system. Leadership can use this information to better prepare the worker for the environment and perhaps more importantly, reduce the ambiguities and goal conflicts in the system. Thus, organizational responses are less about error control and more about managing the system and creating an environment where workers can be successful.

Summary

Questions regarding the construction of error and assumptions about error, fact, trending, classification and adaptation were challenged by the information presented in the case studies. This chapter captured questions that were raised by the case studies regarding the nature of these assumptions and their usefulness in the pursuit of accident prevention. Traditional definitions were challenged when the language and techniques en vogue were compared to the pragmatic needs of personnel who faced conditions that were never seen before. The ascription of error to actions/decisions, simply because there was an adverse outcome, raised questions regarding the labels used to describe what well intended people had done. The value of open discussion regarding the context that surrounds action/decision was also explored in a way that points to the importance of understanding how "error" can be a catalyst to learning from events. The recognition that error is a complex issue involving judgment and not a simple observation of "fact" was an important realization that led the organization understanding the need for a different approach to serious accident investigation.

Chapter 8: Agreeing to the Concepts of the Coordinated Response Protocol and Learning Review

Introduction

This chapter describes the major challenges we encountered during the introduction of the Coordinated Response Protocol and Learning Review (CRP/LR) and how we used dialogue to understand the way that the CRP/LR fit the goals of the organization and the safety community. The Forest Service safety community is diverse and literally every person in the Forest Service has a stake in safe operations. When we introduced the CRP/LR we had to understand the different beliefs and assumptions held by members of the safety community and we had to give voice to its constituents. This chapter shows how we used dialogue and principles to garner support for the process.

Building support for the concepts of the Learning Review and Coordinated Response protocol required dialogue. For some, a logical argument supported by examples was all that was required. Others had a more emotional reaction that required a different approach. Dialogue and honest inquiry were key ways in which the space was created for this change to occur. This process utilized a series of focus groups, which brought conflicting viewpoints together in an open dialogue. Each group had input in the process and how it would be shared outside the focus groups. This process was repeated eight times across the nation and each group enjoined representatives from all facets of the safety community with practitioners and leadership. The entire process supported the concept of group sensemaking and simultaneously highlighted the importance of focus groups.

Birth of the Coordinated Response Protocol and Learning Review

The case for changing the accident investigation process had become evident to both Forest Service leadership and the organization's field staff. A grassroots movement had developed a new process that was being used for less-than-serious accidents, and Forest Service senior leaders had been introduced to new safety concepts that involved dialogue and inquiry. Successful serious accident reviews that departed from the status quo, such as Panther, were accepted, and the response was so favorable that the Serious Accident Investigation Guide's (SAIG) reliability as a prevention tool had been challenged.

Despite the desire for change among the organization's multiple levels, no process was unilaterally acceptable to replace the SAIG. Different factions of the organization supported competing beliefs and analytical models, which sent conflicting messages to leadership. This chapter will show that although there was no formal plan to address accident investigation, a journey emerged as key steps that ultimately led to change. Then a core group emerged to begin developing a process and agreement concerning steps forward. Ultimately what resulted was a series of engagement sessions that led to the development of principles and a new process to replace the SAIG.

At an organizational level, Forest Service leadership was ready for a change following a long trajectory of less-than-satisfying accident investigations and a climbing accident rate. In 2006, two key individuals, Jim Saveland and John Phipps, spearheaded an effort to bring in an outside contractor, Dialogos, with the intent of providing leadership with an outside view of the agency. The result was a diagnostic memo that highlighted areas for improvement in the Forest Service, which included reflection, dialogue, and inquiry. The Dialogos Report stated as follows:

> The agency has in general difficulty making error an objectively studied and transparently discussed source of learning and improvement. Errors are not generally embraced as opportunities for improvement, particularly now, in a climate where people fear that the admission of error may lead to criminal indictment. Many suggested that the agency has been poor at reflecting on itself, and learning from reflection. There are notable exceptions to this in the fire community, but also notable absences of it as well. For instance, one result of the recent challenges is a proliferation of rules and requirements. Rules tend to have the effect of creating compliance, but not internally motivated commitment to change and learn (Forest Service, 2007b).

Although the SAIG was the officially approved accident-investigation method, the agency saw growing agreement that the SAIG process represented one of Dialogos' many examples of systemic concerns. The desire to create something new was still hampered by a 1980 NWCG taskforce report observation, which stated that the investigative process demanded too much from the investigation report. These reports were required to fulfill organizational and regulatory mandates, which were opposite in philosophic approach and challenged teams to do more than find a culprit on which to blame the accident. In 2009, the Chief[48] of the Forest Service attempted to resolve the tension by declaring that two separate investigations must be conducted.

Within the organization, three groups were juggling with competing processes, goals, and advice, each with different views of what makes an investigation acceptable: law

[48] The administrative head of the US Forest Service is referred to as 'Chief'.

enforcement and investigations (LEI); FLA developers and supporters; and OSOH representatives.

Support for the Serious Accident Investigation Guide

Examination of the situation revealed that many OSOH leaders advocated openly for the SAIG and were FLA opponents. OSOH personnel are predominantly hired from traditional military and civilian safety organizations and are influenced by OSHA training and experience. As discussed earlier, this linear approach focuses on causal attribution, behavioral change and management of error models. The SAIG was an outgrowth of this epistemological approach.

The Field-developed Alternative (FLA/APA)

The Fire Risk Council, led by Forest Service Fire and Aviation Management (FAM) Risk Management Director Larry Sutton, saw injustice in the SAI process and partnered with a research development and application group; together they began to develop a process called the facilitated learning analysis (FLA) and the accident prevention analysis (APA).

The original FLA was designed by Paul Chamberlain, a regional ground-fire safety officer, to be a dialogic tool to facilitate a discussion following an incident between the principal incident participants. The design was elegant in its simplicity and effective in developing rapid local understanding of what had occurred. Essentially, an FLA builds context around decisions and actions through dialogue. However, no mechanism existed to extend the learning beyond the local participants.

The APA was designed for field-level learning and did result in creating a report for larger audiences. The APA espoused an administrative assurance of no punitive actions that meant that the APA could not be used as the basis for administrative punishment or actions against employees. In an apparent contradiction, the APA also advocated shifting the responsibility and culpability further up the organizational hierarchy in a process called Distributive Justice.[49] “The focus is fairness and there is recognition that leaders and administrators bear responsibility (or accountability)” (Forest Service, 2012). “Distributive justice…is distributed accountability across the system to the extent that each person and function is responsible for the outcomes” (Forest Service, 2012).

In 2011 these two processes were merged, and the blended process retained the FLA name although it was heavily weighted toward the APA process and report style. The FLA group remains ardently against anything that could inferentially result in punishment (despite advocacy for distributive justice) and object to SAIG use. The new process still had no means to address the organization’s needs in terms of systemic change and work improvement.

[49] The model of “Distributive Justice” was adopted from Justculture.org.

The Perspective of Law Enforcement

Forest Service LEI leadership was tied to a 2009 chief's letter that established the need to create two responses—one to meet legal requirements and one to meet the safety community needs. This letter spawned an interim protocol that inadvertently placed criminal investigation ahead of safety investigations in the Forest Service. The protocol mandated that Forest Service LEI conduct a criminal investigation prior to the agency initiating any safety-related investigative process.[50]

> If the [Special Agent in Charge] SAC determines that one or more criminal violations may have occurred, the Director of LEI or official with delegated authority will assign a criminal investigator to conduct a criminal investigation and will inform the Designated Agency Safety and Health Official (DASHO) that a criminal investigation will be conducted. The SAC or official with delegated authority will oversee the criminal investigation. The DASHO will assign a Chief Investigator for Safety to work with the SAC or SAC designate to determine whether a safety investigation of the incident is appropriate and can remain independent of the criminal investigation. A safety investigation team (SIT) may or may not be mobilized to perform a full safety investigation. If a safety investigation is performed, the criminal investigation will have priority with respect to access to witnesses (Forest Service, 2009, April 17).[51]

This direction's literal interpretation resulted in the initiation of lengthy LEI work prior to any safety investigation (none of which ever resulted in criminal complaint or charges). Each criminal investigation delayed safety-driven investigations and simultaneously made the field reluctant to talk with anyone about accidents.

The Emergence of the Coordinated Response Protocol and Learning Review

The Forest Service field was caught in the crossfire and did not know what to expect. Employees were fearful of both the serious accident investigation (SAI) and the criminal investigation that now preceded the prevention process. This environment of fear was not conducive to gathering information or learning from events.

The Forest Service research, development and application staff where I was working had developed and tested small-scale experiments that incorporated sound theory but did not have a large-scale corporate process to replace the SAIG. The group faced the important choice of proceeding to develop a new process or entering into the task of

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[50] Interim Protocol for Investigation of Serious Injuries and Fatalities of On-duty Forest Service Employees, April 17, 2009.

51 In the history of the Forest Service, there had only been one case where criminal charges were upheld in court (Thirtymile Fire) and there was a unilateral sense that this was unjust in the Forest Service.

getting participation and cooperation from a diverse mix of leaders and safety managers. While it would have been much easier to develop a process on our own, we felt it was important to recognize all three groups' efforts and concerns. We decided to model our philosophy of inclusion from the start.

In the fall of 2012, John Phipps, Jim Saveland, and I formed a core team to address organizational response to incidents and to explore how we could learn from them. We had three essential components that would be necessary for success: time to develop the process; the necessary experience and education; and ties to Forest Service senior leadership needed to bring the outcome forward. Phipps belongs to the senior executive service (SES) and is a standing member of the National Leadership Council's Safety Working Core. Saveland was the Forest Service human factors and risk management research program manager. I had been part of the original FLA development; written two influential reports that defied the SAIG; and completed a Master's degree focused on accident investigation. As a result, I represented the field and academic research in accident investigation.

Each of us had stories of well-intended people who made mistakes and were then blamed for their errors in formal reports under the SAI process. We each knew people who were hurt by the data collection process, the formal report, or both. We were convinced we could develop an alternative as a starting point for dialogue to align the three disparate groups around a single investigation approach. We called it a core team because our intent was and is to continue to increase the group to include all process practitioners.

Our core team began to build a list of actions required for prevention and ethics and by regulation in the event of a fatality. We explored ways that we could provide or share information between the safety investigation, Forest Service LEI, OSHA, local law enforcement, the coroner, and the media while minimizing negative impacts on personnel. Our primary intent was to place personal healing and resilience needs as the highest priority followed by learning from the event and addressing legal and regulatory needs (including other mandated investigations).

Post-incident wellbeing of our personnel emerged on the national stage following a suicide that we reviewed using the concepts and techniques that ultimately became the Learning Review. Just as Panther had done, this review pointed to the need to take care of our own. We focused on how to minimize the number of interviews survivors would be asked to give and the assurance that personnel would have access to critical incident stress management (CISM) or peer-support teams before any interviews were scheduled.

Engagement Session Focus Groups

The core team developed a concept called the coordinated response protocol (CRP). We recognized that for any process to be successful, we had to garner support and input from

LEI, the FLA group, and OSOH. The CRP represented a starting point for the discussions that we hoped would unite the three groups. In total, over 200 representatives of these groups were identified as important individuals who could add to the development process and/or who needed to be introduced to the concept to ensure its adoption by discussing it with other stakeholders.

The Forest Service had hired a new OSOH director, Steve Schlientz, just as this process began. We welcomed Schlientz into the core group and quickly brought him up to speed on our plan. He became integral to the delivery of the concept during all the group sessions.

We decided to hold eight focus-group dialogue-based engagement sessions[52] across the country, where we would bring different group members together to discuss the CRP concept. In preparation for the dialogue sessions, we created a framework that we hoped would encourage constructive input and allow us to capture important ideas we had not considered. We introduced the concept of a phased approach to learning from the event and to replace the SAIG under the name learning review (LR). Our plan was to update the CRP concept following each interaction, building on participants' ideas.

The disparity between the three groups was apparent during the first meeting, which was considered by some to be a categorical failure. Each group advocated openly for their position, and this strong disagreement indicated that no one would easily accept the others' views, much less entertain a completely new investigative concept. Following the first session, I suggested that we restructure the subsequent sessions by opening the dialogue around the development of a list of accident-investigation principles. The second meeting began with, "To build understanding and get your input on both an emerging set of principles for success and to guide safety in the Forest Service—what are the principles of a coordinated response to accidents?" (Forest Service, 2014, March).

The first and last sessions were designed to bring the most outspoken or influential members of these groups together for their initial input and then demonstrate in a final meeting how all the input was included in the product. Having the participants from the first group attend the last group allowed them to see for themselves that we were listening and including input from each of the meetings. Our hope was that this would be proof of our desire to be inclusive and sympathetic, so that they would be less likely to snipe at the emergent process. Our overall desire was to create a greater sensemaking society that could see the important aspects of their perspective represented in the emerging product.

Alignment emerged around principles as each of the groups began to agree that they wanted prevention, a safer work environment, an organizational focus on learning, and no blame—but some form of accountability. Perhaps most importantly, they all wanted

[52] We used the term focus group to describe dialogue-based engagement sessions.

to avoid doing more harm to our people. This was a breakthrough moment and provided the opportunity for Phipps, Saveland, Schlientz, and me to introduce the coordinated response protocol. Ultimately we garnered the needed support and agreed to move forward with CRP development and the process that would ultimately replace the SAIG, called the learning review (LR) process.

Engagement Session Results

Following the engagement sessions, I was assigned to develop the CRP guide as well as the LR process. I began with the principles that we had agreed to in the engagement sessions:

- Respond in a manner that is respectful and builds trust of stakeholders.
- Learn so that the system can be improved in order to prevent negative outcomes, or be more likely to achieve positive ones.
- Be consistent with applicable law.
- Be intentional, deliberate and corporate.
- Protect employees operating within the scope of their employment from being blamed or shamed.
- Focus on all aspects of work, which contributed to outcomes: both ones that are viewed as positive or negative.
- Promote a richer definition of accountability that is comprehensive, effective, and accepted by employees.
- Manage the agency interest regarding potential future claims resulting from incidents.

The Coordinated Response Protocol (CRP)

These principles along with engagement-session notes formed the basis for the CRP guide. The CRP process established teams who would train together and understand each other's needs and mission. The teams include Learning Review, Law Enforcement, Critical Incident Stress Management, Public Information and Family Liaison. The CRP places all team functions under a Response Leader, who controls access to personnel and coordinates any need for additional specialists (e.g., trauma psychologists). The CRP establishes standards of practice for how the teams work together on an incident.

Learning Review (LR)

Three concepts formed the starting point for the Learning Review. Each was designed to facilitate learning and/or to avoid bias. Most of these evolved from my Panther and Norcross experiences and my new understanding of the importance of sensemaking learned by observing the interactions following Colgan Air, combined with investigative-process research and personal training along with review of every Forest Service accident investigation report available.

We presented the concepts to the focus groups as three distinct starting points. The first method was to employ one of NTSB's common techniques: approaching the investigation in discrete phases (data collection and analysis). The second concept concerned the language used to describe the process and was based on avoiding the language of blame. The third was the inclusion of field personnel in the review process (group sensemaking). These concepts were ultimately used to create the draft guide, which the Forest Service used for the 2013 wildland fire season.

The Phase Concept

The concept of phases was introduced during the focus-group sessions (see figure 8.1). These phases were fashioned after NTSB's approach to accident investigation, wherein data collection is separated from analysis. The NTSB developed this structure with the intent of inhibiting the bias associated with looking for information to support developing theories. The idea was that data collection should be independent of the analysis process so that people did not look for information to support their favorite theory. This concept was expanded as the guide became more developed and became, "Data drives the processes used in analysis and sensemaking." Prior to this, accident investigations determined the analysis method without incident specific knowledge and the data was made to fit the analytical framework. This is the equivalent of selecting a recipe before knowing the ingredients available in the kitchen.

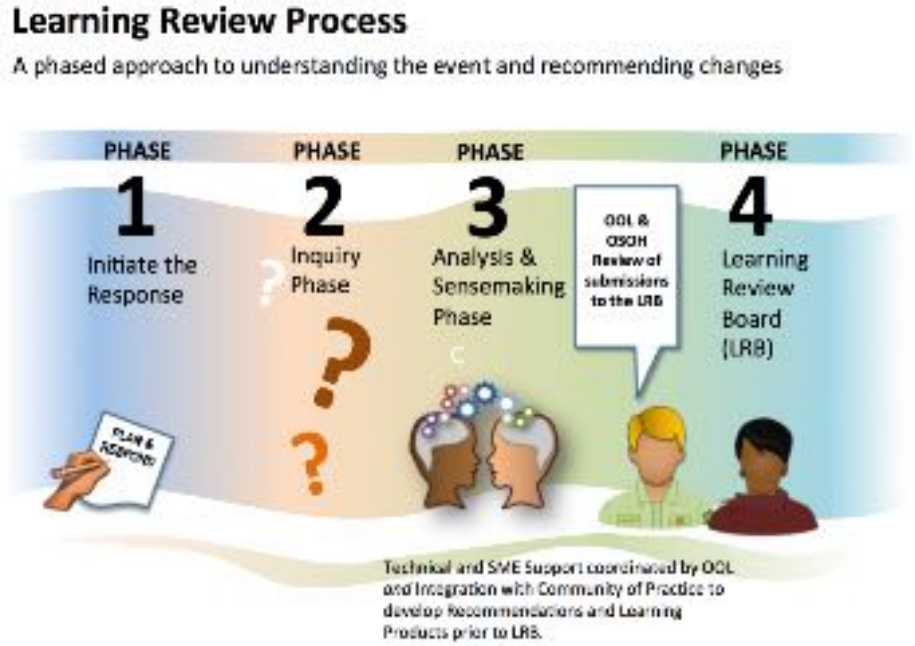


Figure 8.1: Phased approach to the Learning Review

Concept of Removing the Language of Judgment

The language of the new process reflected the goal of learning from the event while simultaneously protecting employees who were just doing their job. The principle upon

which we agreed was that no punishment should ever result from people working within the scope of their work assignment. In this way we moved away from judging actions based on outcome. The first example of this was replacing the phrase *accident investigation* with *learning review*. The concept that language can imply blame was reflected in numerous traditional Forest Service accident investigations (as recounted in earlier chapters). The removal of terms that imply judgment and thereby avoid context was a first step. The LR process, as in Panther, avoids the use of the word *cause* and instead emphasizes that actions and decisions are to be placed in context. As we entered into the 2013 season we agreed to explore the creation of network maps that graphically showed the conditions that influenced decisions and actions.

Focus Group Concept

The concept of involving field personnel was done in two ways—first by creating focus groups to facilitate group sensemaking from the information gathered in phase two. Second, focus groups were considered integral to Phase 3 and were used to review the products the review team developed, which had to be designed to create opportunities for public or immersive sensemaking.

These concepts were not fully developed by the time the fire season began and we were faced with the first fatality accident that called for the application of these techniques[53] (Forest Service, 2013) while the guide was still in draft form. This accident-tested and refined these concepts, which resulted in formally accepted versions of the coordinated response and learning review guides.

Summary

The Coordinated Response Protocol and Learning Review (CRP/LR) guide contained many of the practices that had emerged from Norcross and Panther. The practices were centered on learning and sensemaking; however, the early draft was more concept than process and as a result barely adequate in terms of meeting challenges imposed by the 2013 fire season. Establishing an agreement pre-season allowed a grand experiment to take place, where in the practices of the CRP/LR could be used, evaluated and approved.

The Forest Service faced a fatality early in the season at the Saddleback fire and shortly after 19 Arizona State hotshots lost their lives in the Yarnell Hill fire. Saddleback and Yarnell both served as test beds for the three main concepts of the CRP/LR and forced the development of more detailed guidance. The Result was a cohesive CRP/LR guide. The next section of the dissertation explores the use of these practices during the first fatality incident, Saddleback, and illustrates how this led to an organizationally approved guide.

[53] Saddleback served as an opportunity to both test and develop processes that were ultimately included in the accepted Learning Review Guide.

Chapter 9: The Saddleback Case Study

Introduction

The Saddleback Case Study shows how the concepts of the coordinated response protocol (CRP) and learning review (LR) were converted into a cohesive group of practices and that the combination of practices could result in a series of learning products that could enhance sensemaking in the organization. Espousing that actions and decisions should be placed in context was important; however, moving from concept to practice was an important step for the Learning Review. The Saddleback review demonstrates that context can be effectively presented and is important to understanding the event.

The phone rang in the office of the Forest Service Director of Occupational Safety and Health in Washington, DC (Steve Schlientz). Information was minimal; however, the caller informed Schlientz that there had been a fatality in California on the Saddleback Fire. Smokejumpers had been dispatched to a single-tree fire, and one of them had been struck by a falling branch. The injury was not survivable.

Forest Service Washington Office (WO) staff needed a team to respond to the incident. Based on the recent engagement sessions, leaders had already planned to use the CRP and LR to assess any serious accident. Their hope was that the application of the draft process would help shape a more concise guide.

Accident investigators who don't want to leave home should never answer the phone before seven in the morning. My phone rang, and I answered. The voice on the other line asked me to coach the LR process (which I had been developing) and lead the sensemaking and analysis phases of the accident review.

I recognized that phase 3, analysis and sensemaking, represented the greatest opportunity to test concepts unique to the LR. I was drawn to the possibility of refining the process.

This section of the Saddleback chapter shows how the accident review team applied major ideas and used subject-matter experts and focus groups to richen the narrative and understanding of the event. It also introduces the focus groups' reactions and input with regard to four theoretical concepts that could be used to inspire learning from the event: sensemaking, signal detection, margin of maneuver, and system-one/system-two thinking.

Phase 1 – Initiate the Response

A letter of delegation from the chief of the Forest Service assigned team members to the initial response and filled the following positions:

- Response leader (a Forest Service senior leader)
- Response lead shadow (who would learn how to act as a response leader)
- Data collection team lead (who would lead phase 2)
- Human factors subject-matter expert
- Process coach/sensemaking phase lead (who would lead phases 3 and 4 [my position])
- Safety representative
- LEI team lead
- National union representative
- Region 5 union representative
- Document specialist
- Human resources specialist
- Two human performance specialists (added later)

The team arrived in Redding, California, the smokejumpers' home base, and received a briefing, during which we were challenged by *sidebars* regarding information collection. United States Forest Service regional leadership insisted that the scope of the review was to be limited to ground firefighting operations and that the smokejumper operation would not be considered as part of the event. This was conveyed in a rather direct way, "You will consider this as a ground firefighting operation; there was nothing wrong with the aerial delivery;[54] that all worked. Your focus will be on the ground operation and what went wrong there."

The smokejumper community also added a limitation, as they were concerned about misconceptions that might arise from what they called the *t-shirt ceremony*. The day of the accident, upon safely landing on the ground at the drop zone, the three firefighters made their way to the *tool box*.[55] When they arrived, Luke (the accident victim) produced two t-shirts with the Redding smokejumpers emblem. The shirts represented the end of his companions' formal rookie status and their welcome into the Redding smokejumper community as full-fledged members. The Redding smokejumpers made it clear that their sensitivity resulted from the possibility that this action might be perceived as some form of hazing or elitism. They seemed to be reacting to a perceived long-term organizational scrutiny of the smokejumper program and threat that the program might be dissolved.

[54] Smokejumpers are one of two groups called "aerial delivered firefighters" (the others arrive at the fire by helicopter), as compared to firefighters that use motor vehicle transport.
[55] Toolbox refers to the equipment that is also dropped from the aircraft after the jumpers are safely on the drop zone. The toolbox contains the equipment and supplies the jumpers will need for approximately three days of firefighting operations.

> In my experience, the jump program feels the need to justify its operations for two main reasons, cost and safety. In regards to cost, the jump program spends more money per person on training and equipment than (I think) any other program. Costs include flight time, specialized equipment, including jumpsuit, parachutes, pack-off bags, line gear, etc. It also includes five-to-six weeks of initial training for rookie smokejumpers and two weeks of refresher training for returning jumpers. To maintain currency (sic), jumpers must jump at least once every two weeks (Smokejumper interview).

The LR team was now drawn into a challenging situation, as both these artifacts seemed to be indicative of pressures placed on the smokejumper community that might affect decisions and actions. Questions emerged regarding the influence this may have had on aggressive initial fire attack and self-imposed performance demands. As the process coach, I was concerned about the potential bias this might introduce to the information collection team and review process as a whole.

Phase 2 – The Information Collection Phase

The information collection team created the Saddleback narrative. The following excerpt is copied directly from the final report and is presented here in the font used in the original report, to separate it from the text of this chapter.

Saddleback Fire Narrative

Background

The smokejumpers arrived over the Saddleback Fire and the Modoc Duty Officer (DO) relayed the Forest Supervisor's authorization to use chainsaws in the wilderness and Leader's intent of full suppression. A single tree fire meets the criteria for a Type 5 incident. There were two Incident Commanders (IC's) in the lineup for the three-man jump including Luke, an ICT5, and another jumper who was an ICT4. Luke was first in the jump order and jumped as planned. However, the jump order was changed during the aerial size-up and the ICT4 swapped positions with one of the rookie jumpers. The area had received numerous lightning strikes and the jumpers wanted the other IC to be available, in case they were dispatched to a more complex fire.

Each of the three firefighters had at least 10 years of firefighting experience. This was Luke's third operational jump of the season, but it was the very first operational jump for the other two 'rookie' smokejumpers. Luke was one of the primary instructors during rookie training and played an instrumental role in Sam and Connor's training.

WildCAD Incident Card[56] – Modoc Interagency Communications Center: MDF 2013-198

14:50 Smoke is reported to Modoc by a civilian, on the west side of Saddleback
14:53 Engine 56 is dispatched – fire is thought to be 6 miles into the South Warner Wilderness
14:56 One load of jumpers is ordered and Engine 56 is cancelled
15:35 Jump 43 (aircraft) leaves Redding (35 minutes estimated time of arrival)
16:04 Jump 43 (aircraft) arrives over the Saddleback incident and reports updated position as one mile from the wilderness boundary, in the vicinity of Soup Springs Campground
16:08 Chainsaws are authorized; Jump 43 prepares to drop three jumpers. Size-up: single tree with ground fire, three jumpers will jump the fire, MICC will be staffing 24/7
16:18 Jumper in-charge reports on the ground with two (jumpers)

Redding smokejumper landing spot in Saddleback incident.

This is Sam and Connor's[57] first operational jump and it has gone just as planned. Luke is with them as the jumper in charge. Sam kneels at the cargo box to assemble the saw. Connor gets a couple of hand tools and he and Luke walk toward the single burning tree. Luke stops about 20 yards upslope of the tree to establish radio contact with Modoc Interagency Communications Center (MICC) and calls in a size up:

[56] WildCAD is a GIS-based Computer-Aided Dispatch (CAD) system developed wildland fire agencies. WildCAD is targeted for Emergency Communications Centers of all sizes.
[57] Fictitious names are used in this narrative, with the exception of Luke.

Luke: "Saddle Back IC, I have a size-up, when you guys are ready – copy."

MICC: "Saddle Back IC, go ahead with size up."

Luke: "Yeah, we got a single lightning struck tree, mid-slope. Break. It's about a ten by ten spot of ground fire, and we can handle with resources on the ground here. Also, received a lot of moisture here in the area."

MICC: (Modoc reads back Luke's transmission)

Luke: "Affirmative, also have a lat. & long., if you are ready to copy…"

Time: 16:22 - Sam and Connor do not hear this radio transmission, as their radios are turned off to conserve batteries. As a result, they are unaware of the latitude and longitude, or the fire name.

Lightning-strike tree photo taken from the uphill side.

Connor continues to the tree and does a top-to-bottom assessment – general lean to the downhill side, bole looks pretty stable… There are a lot of green branches on the ground and it looks like the tree was struck hard by lightning.[58] He sizes up the situation to decide where to start work. From the direction of his approach to the tree, it appears that there is less work on the right side, which will allow them "to put line in quicker." On this side of the tree, there are more ladder fuels and brush outside where he plans to scratch line.

Sam starts walking over to the tree with the saw. The tree is a big, ugly red fir[59] and there is a burning jackpot of fuel at its base. It is so hot near the base of the tree that there's no consideration of cutting it down.

Even from their different vantage points, Sam and Connor sense pretty much the same things - the ground is wet and the fire is probably not going anywhere until the fuels dry out, so there's no need to rush.

Sam is about 100 yards out, when he suddenly hears an impressive "Crack!" The sound draws his eyes to the treetop and he watches it fall to the ground and smash into a mess. Sam loses sight of Connor. He fears the worst, because he last saw Connor approaching the tree.

Luke calls to Connor, who shouts out that he is all right. When the treetop fell, Connor had darted side-hill and dropped his Pulaski, which was now trapped under the burning treetop. He feels a sense of relief that he was able to see, hear, and avoid the treetop. However, Connor is now hyper-alert to the slightest sounds. He has

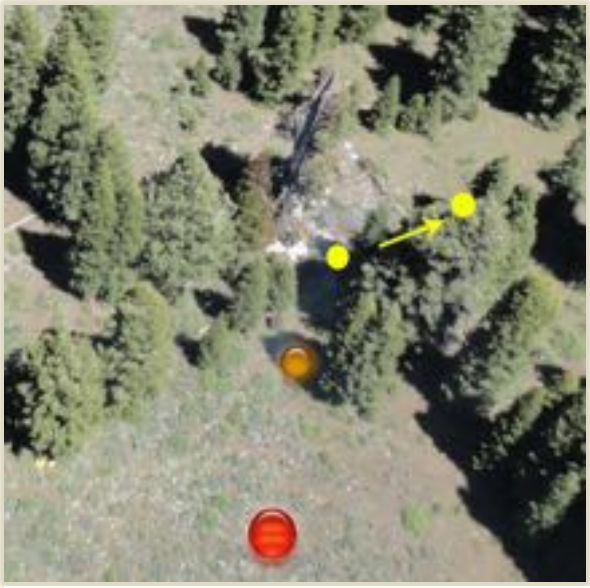
[58] Sheriff's observation: "There was wood debris from the lightning strike that extended in the neighborhood of 100 yards from the base of the tree that I observed."

[59] After the incident, the tree was identified as a white fir, which shares many of the same features and behaviors with a red fir (they are very difficult to tell apart from each other). White fir trees can be particularly hazardous, as they can have multiple 'spike' tops, shed branches, and tend to rot in the middle.

just come back to wildland fire, after taking a year off to work as an EMT on an ambulance. For a moment, Connor questions why he came back.

With the top out of the tree and Connor okay, Sam has a sense of relief, "like a storm has passed." There is a big jackpot of fuel on fire at the base of the tree. Sam moves close to Luke, they look at the tree and decide not to put line under it. Luke tells Sam, "Put a quick little check-line around it and we'll call it good."

Sam and Connor have been on hotshot, helitack, and engine crews and have seen fires like this before. They join up by the tree and Connor says, "Let's keep our heads-up, stuff is falling out." It is a "big ugly tree[60] that will probably burn itself out by morning." They start clearing a scratch line upslope from the tree, heading down toward their left. Sam cuts and Connor pulls for him, throwing green into green and black into black.



Approximate positions of the firefighters when the treetop comes out. Red circle: Sam, who is assembling the saw (general position); Orange circle: Luke, who is on the radio; Yellow circles: Connor, who runs in the direction of the arrow to avoid the falling treetop.

The jump ship has returned overhead, after a short recon flight, and Luke tells them about the top breaking out of the tree. He yells to Sam and Connor to "head that way," pointing to the right side of the tree, where Connor originally started working and where the fuels look more combustible and likely to support fire spread. Sam and Connor start building line on this right side of the tree. They both feel as though they are a good distance away from the bole.

Luke finishes his radio call and joins the others. None of them wants to spend more time than necessary to get the line finished, so Sam cuts with the chainsaw, Luke swamps and puts in line, and Connor follows to put in finishing touches. The scratch line "encompasses the burning treetop and then takes a downhill trajectory."

Suddenly, Connor hears a "Whoosh!" sound. In his peripheral vision, he sees a limb fall and hit Luke, driving him to the ground.[61] Connor lets out a shout. Sam, who had momentarily stopped cutting, turns at the sound and also sees the limb hit Luke. They are both shocked by what they see.

Connor and Sam are both EMT's and want to find a safer location to care for Luke. They carefully carry him uphill, 'fireman style', with Sam at the shoulders and Connor at the legs. They feel for a pulse, do a quick head-to-toe patient assessment, and Sam starts chest compressions.

Connor runs back to grab Luke's radio, because it is on the correct frequency to call dispatch:

Connor: "(garbled)… emergency traffic, copy."

[60] This is how Sam and Connor referred to the tree, meaning they recognized it as a hazard tree.

[61] The limb was reported to be 5 - 6 feet long and 6 - 8 inches in diameter (it was consumed by post-incident fire). During interviews, Connor and Sam did not remember if they had to move the branch, in order to begin their assessment of Luke.

Illustration of the approximate bend in the scratchline (white areas are ash from the ground fire).

MICC: "Go ahead with emergency traffic."

Connor: "We have a firefighter down; he was hit by a snag.

We need a medical ship out here for evacuation, immediately!"

MICC: (Modoc copies) "Could you repeat your identifier?"

Connor: "Redding Smokejumpers, we jumped out of jump 42."[62]

MICC: "Affirmative."

(Time: 16:53)

Soon after this transmission, Connor contacts dispatch again, asking them to divert the jump ship back to their location to drop the trauma kit and oxygen. The five remaining jumpers land in support of the rescue operation. They quickly establish an IC, who takes charge of the incident within an incident. Through their efforts, Luke is airlifted by helicopter to the nearest hospital, in Alturas, where medical professionals determine there is no hope of recovery.

Map showing relationship of the Saddleback Fire to terrain features, roads, and towns.

[62] The transmission referred to "jump 42;" however, the jump aircraft was "jump 43."

Phase 3 – The Sensemaking and Analysis Phase

I read every tree-strike accident report I could find in the system in an effort to understand how the organization had reacted to similar events in the fairly recent past and to identify any commonalities in these events. I also reviewed the participants' qualifications and backgrounds.

The sensemaking and analysis team led the remainder of the process. To the extent possible, we tried to reconstruct what the firefighters had done in the days prior to the event. However, because some of this information was perishable and no longer available,[63] its relevance could no longer be assessed. The team also added the dispatch information (WILDCAD incident card) and the two short dialogue sections the dispatch center had recorded to the narrative.

Adhering to the region's demand that we remain focused on the ground operation, we started trying to build context around the actions and decisions made by the Saddleback firefighters. The first decision/action considered was that the firefighters had begun work without a completed 360° analysis[64] of the tree and the fire. One question centered on why their sense of risk was reduced when the first branch or treetop fell, almost hitting Connor (as conveyed to the team during interviews). This prompted discussion regarding signal detection and signal masking.

The First Focus Group[65]

The narrative did not provide all the information we felt was needed to make sense of the event; however, it did indicate that those involved fell into a routine and did not notice that they had drifted under the lateral extent of the tree. Routine can be contrasted with expertise-based intuition and is defined as four process-oriented phases: situation assessment, plan formulation, plan execution, and team learning (Salas, Rosen, & Diaz Granados, 2010). In the Saddleback operation, most of these processes were attempted with varying degrees of completion.

The team convened a small focus group via teleconference. Four senior firefighters were given the narrative and any supplemental information they requested. A lively discussion ensued as the firefighters began to make sense of why the level of risk would have

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[63] Information is still emerging that provides insight regarding the conditions that may have influenced actions or decisions.

[64] A 360° is a visual scan of the fire and the tree from every angle – a circle walked around the tree or fire to look for hazards and opportunities, in order to develop a tactical plan.

[65] Focus groups are defined as, "Bringing different levels of the organization together in a way that is not threatening to capture interactions and conditions, through one or more dialogues, as these groups engage in making sense of a narrative and associated information." Focus groups can be made up of academic specialists, field groups representing a community of practice, and/or organizational leadership.

seemed to be less following a near-miss (the treetop nearly hitting Connor). The group was divided; with two agreeing that the top coming out of the tree was an indication that the tree had unloaded its risk and was less dangerous. The other two participants hung tenaciously to the idea that if one branch fell, they would consider the tree to be even more dangerous. The team engaged Najmedin Meshkati, a subject-matter expert in signal detection; this meeting resulted in the development of three written descriptions of signal detection and questions about fire operations.

Three questions emerged to validate the concepts being introduced. Each question was preceded by a short description of a learning concept. These were shared with a small group of firefighters before presenting them to the focus group to see how the concepts would resonate with representatives of the firefighting community of practice.

Question 1

Signals can be physically masked, or they can be socially masked. Social masking can be the story we tell ourselves. Consider what an individual with 12 years of experience in helitack (a helicopter-delivered firefighter) said:

> If we're about to dig a line downhill towards a fire and I don't think it's safe, in my mind I'm thinking to myself, If I bring this up they're going to ask, one: 'Why don't you think it's safe?' Which is easy, usually, for me to answer. Two: 'What would you suggest?' Which is not always easy for me to answer. I don't always have an alternative to getting the job done and for that reason there's a lot of times that I haven't spoken up because I'm thinking to myself, I don't know what the alternative is, so I guess we'll take this risk.

At Saddleback, the firefighters mentioned a "heightened sense of awareness" followed by a sense of relief, as though a "storm had passed" once the first branch fell.

How are these two contradictory feelings rectified in real-time?

Question 2

There is an observed cultural expectation of work—not working can sometimes be interpreted as laziness. In the Devil's Den Wildland Fire Lessons Learned video one significant lesson was, "Leading is working." This concept suggests that a person who has the leadership role is responsible for maintaining a larger view of the operation, which includes paying specific attention to signals. "Who's got the ball?" In other words, who has the big picture or keeps the tactical view, (e.g. watching for drift, hazards, and the unexpected or what is dumb, dangerous, and different)?

Based on our current system demands, training, and/or culture, were there other options that were not explored by those at Saddleback?

Question 3

Second Branch Falling – Expectancy was reduced and signals were degraded.

Once the firefighters began line construction, visual signal detection was significantly degraded. Assessment of the limb hazard was likely reduced or impeded by the inability to see the weakened branches of the tree due to individual position relative to the tree, smoke, location and posture.

It is quite possible that the auditory signal (sound made by a limb breaking free from the tree) was masked by background noise due to close by chainsaw operation. Another possibility exists that a sound was never made at all because the limb was already dislodged from the tree and was somehow hung up.

Expectancy was lowered by a sense of security; the first limb falling reduced expectancy based on personal experienced with falling limbs, which created a sense that the risk had passed. The firefighters stated, “It felt like we had good distance around the tree and we had good eyes.”

Why might this have made sense to the firefighters at Saddleback?

The focus group reviewed the questions and unilaterally rejected the signal-detection concept. They found it to be contrary to their view of the incident and not useful in terms of learning from the event. This section was subsequently removed from the LR. However, the concept of “upward voice” and sensemaking did receive interest from this group when they responded to question two.

The focus group remained divided with regard to the Saddleback firefighters’ sense of risk after “the top fell out.” The sensemaking team was not certain what this meant; however, we wanted to explore it further. We considered the possibility that this was an indication that the current approach to risk management might need improvement.

More Perspectives – More Questions

Seeking additional ground firefighting perspectives, two additional subject-matter experts were individually consulted to explore other ways to understand the event. These two each had extensive fire backgrounds and over 25 years of experience. They began by reviewing the available information from the inquiry phase and reflecting on their own experience. They chose to view the situation in terms of what was missing from the actions taken by those involved at Saddleback. They concluded that there were five possible ways to explore the actions/decisions:

- Was it an issue of miscalculation or missed signals?
- Was it a normalization of risk?
- Was it "routinization," i.e., falling into a routine?
- Was it a failure to recognize change or hazards?
- Was it distraction?

A discussion followed the creation of this list, wherein the participants concluded that the incident was, in some way, influenced by all of these. The participants agreed that the report could say that individuals fell into a routine, miscalculated signals, normalized risk, failed to recognize changes or hazards, or were distracted—but these labels required exploration as to why each may have occurred.

The Second Focus Group

The next focus group was made up of eight senior firefighters, who were presented with the question, "Why did the firefighters fall into a routine, miscalculate signals, normalize risk, fail to recognize changes or hazards, or get distracted?" The group saw this question as "judgmental" and felt that it needed to be more general in tone yet simultaneously specific to the action. The resulting dialogue began to fill in a complex network of influential conditions around a new central question, "Why did the action/decision to build line where they did make sense [to the firefighters at Saddleback] at the time?" (Interview notes).

The result was a general map of the network of influences that affected action/decisions (see figure 9.1). Further group discussions filled in details around central topic areas until a larger causal network map was created. The map depicted influences common to wildland firefighting operations.

Figure 9.1: Network of Influence Central Topics.

The Third Focus Group

The team shared the developing map was shared in person with 18 smokejumpers in a third focus group. This third group was presented with the basic network of influence map and asked to add to it. They were also introduced to conceptual models that I had been working with before the fire season started, including *margin of maneuver* and Daniel Kahneman's *system-1 system-2 thinking* (these will described in detail in the next field-learning products section). These two theoretical concepts were placed in the context of the Saddleback incident for the focus group. The group saw value in both concepts and felt these theories could reach beyond the Saddleback incident with potential to extend into future learning and prevention. They encouraged us to create ways to present these ideas to a wider firefighter audience.

This focus group was asked to "assume that people act in a way that reflects their desire to do well" (otherwise their actions may be seen as sabotage, or suicidal, which is quite another problem).[66] The team explained that understanding the situational influences being captured on the network of influence map could be included in the Saddleback review. We explained that conditions are important in at least two ways—first, they provide an opportunity for systemic improvement (Dekker, 2006; Rasmussen et al., 1990; Reason, 1990). Second, because conditions can influence[67] participants' decisions and actions, understanding the conditions could be a critical aspect of analysis of the human contribution to all events, regardless of outcome.

We then asked group members if they agreed with the conditions captured on the map based on their experience. No time was spent trying to quantify the influences; instead, they were simply mapped in order to understand the pressures that exist in firefighting operations. These might also support the actions/decisions reported at Saddleback. The third focus group substantially enhanced map details (see figure 9.2), and we concluded the effort when the group no longer offered new influences or connections.

[66] In Norcross, we could see a number of conditions that were only connected by the actions of the pilot on the second mission (which was almost identical to the first, with the exception of the accident that took his life). Without consideration of the conditions that supported or influenced decisions and actions, we could only conclude that the pilot made an error, which was causal. What does this say about our system in terms of fragility or resilience, which are concepts that are unexplored in the label "Pilot Error"? This label "Pilot Error" also masquerades as an explanation and becomes the unstated goal of investigation, distracts us with blame and litigation and ultimately does little to promote the creation of a safer work environment.
[67] 'Cause' was considered to be too strong a word to represent the effect of the event conditions.

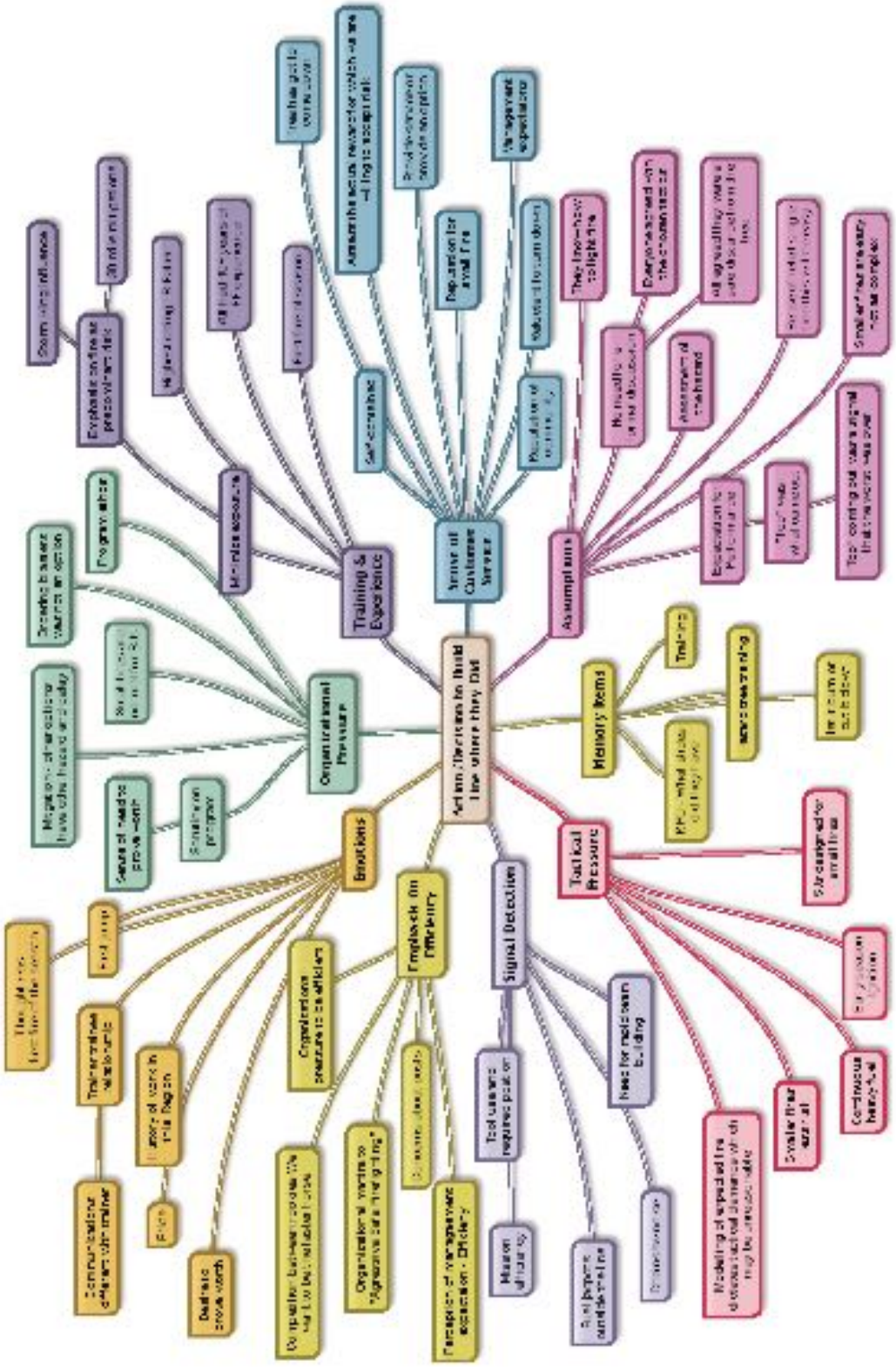

Figure 9.2: Expanded Network of Influence Map.

Common investigative practice rarely focuses attention on conditions that lie outside the specific incident. Our approach allowed us to include common practices, beliefs, and assumptions that firefighters hold regarding this type of mission. The approach also broadened the event's exploration and supported the concept of "latent conditions," as introduced by Reason (1990a). Reason cites Hart and Honoré, who differentiate between causes and conditions.

> Causes are what made the difference. Mere conditions on the other hand, are …just those [things] that are present alike both in the case where the accidents occur and in the normal case where they do not. It is this consideration that leads us to reject them as the cause of the accident even though it is true that without them the accident would not have occurred (1990a).

This reinforced of the importance of conditions in understanding the event and created the basis of the organizational learning product, which by design could be used by leadership to address systemic influences.

The Fourth Focus Group

We convened yet another focus group made up of five senior firefighters, who were also fireline leaders. The team posed the question, "How do you commonly make decisions in the fire environment?" The initial response was a request to qualify the question—what was meant by "How do we make decisions?"

We introduced a decision model developed by Daniel Kahneman: system one (intuitive) and system two (deliberative). Once this model was explained, the respondents unanimously agreed that most decisions fell into the system-one category (Kahneman, 2012). This focus group insisted that the time constraints common to firefighting operations demand rapid responses and the intuitive approach is the only way to achieve the goals set by the organization.

At this point, I was shaping some ideas about how we might learn from the event as a community of firefighters. Thus, I consulted Karl Weick, who is an expert on sensemaking and organizational studies. He and I explored the benefits associated with an intuitive approach to work. These included speed and accuracy, especially in systems that are predictable.[68] (Klein, 2003). We reached the conclusion that when the system delivers something unexpected; the outcomes of the intuitive approach may be outside the participants' control or influence. When intuitive actions are applied to uncertain or

[68] The discussion assumed that the crew at Saddleback was not constrained by time. This was based on their narratives, which all agreed that they felt the risk of a rapid fire spread was low.

unexpected conditions, there is a potential for the intuitive response to be a poor fit for the conditions and the cost could be as extreme as a loss of life. This seemed like an opportunity to introduce group sensemaking to firefighting crews, who often encounter the unexpected.

Wildland fire fits the description of a complex adaptive system (per chapter 7) and as such, uncertainty should be expected. However, uncertainty does not lend itself to procedural interventions. Instead, innovation is required to manage the unexpected (Dekker et al., 2011; McDaniel, 2007; Morin, 2008). These innovations can result from sensemaking, particularly group sensemaking (Weick discussions, 2013). The Saddleback influence map identified a number of cultural and systemic assumptions and norms that interrupted or prevented group sensemaking in the fire environment. Our conversation turned toward practices that could foster sensemaking, including framing, upward voice, soliciting feedback, and deliberation.

Synthesis and the Learning Review Board

The recognition that "objective truth" may not be possible challenges the traditional model of accident investigation; however, the LR embraces this concept. Accident prevention is not predicated solely on factual data; it is also realized when readers makes sense of the information presented and convert the narrative and contextual information into meaning or significance based on their own suite of experience. This is what I have called immersive sensemaking in chapter 6. To achieve this goal there must be a shared level of trust between the individual reader and the information-conveyance method and/or process that created it.

The organizational learning product or report would have to answer the two major questions for our leaders: How did this happen? How could it be prevented? However it had to go farther. We had to create an image of what happened that demonstrated an opportunity for systemic improvement; we had to ensure that leadership and the field were aligned; and we had to ensure that leaders felt they had a role in making the system safe.[69] The organizational-learning product would be presented to a learning review board (LRB) made up of senior leaders who could approve field-learning product development, recommend changes, or reject the whole effort and ask us to re-do the entire process.

We believed that the organizational-learning product had to set the stage for the field-learning product. Every firefighter with whom we spoke had a near-miss story involving a falling tree or branch. This problem was not going to be fixed. We believed the field-

[69] The learning review was challenging models of safety by acknowledging the system cannot be made *safe*, only *safer* than it was, i.e. this was an organization wide journey of continuous improvement and learning.

learning product was central to prevention and thus believed it had to be developed as fully as possible.

We began by exploring the importance of sensemaking and system-two thinking. This led to the development of the margin-of-maneuver (margin or MOM) concept. We were convinced that the organizational-learning product would have to be a report that convinced the LRB to support the margin concept. We crafted the report to present this case for approval during the LRB.

Learning Review Reflection Resulted in Learning Products

What lies in the area between results and the creation of cause-effect relationships may be an intricate web of rules that don't make sense; rules in conflict with each other; mistakes; rule transgressions; misunderstandings; system vulnerabilities; adaptations that work; innovations that don't work; luck or bad luck—this list can be overwhelming. Outcomes are often tied to the actions of those closest to the event, which is often confused with deliberate choice (Dekker, 2014). “What makes this harder is the ‘banality of accidents’ (Vaughan, 1996) that the vulnerable conditions, rule transgressions or mistakes were not unique to that event or had no demonstrable causal connection to that particular outcome” (Dekker, 2014).

Currently there is no method to challenge casual attributions that arise from work where the outcome is perceived to be positive. Until the codification of the learning review process, the same thing could be said for accident studies. The sources of ritual, best practice, tradition, and perhaps even the culture of firefighting were rarely explored much less challenged in terms of reviewing the conditions that may have had as much influence on outcomes as the triggering action. The resulting oversimplification attributed outcome to specific action and ultimately led to assumptions regarding cause. “Assumptions can remain largely transparent and closed to critique in safety work precisely because they are so self-evident and commonsensical” (Dekker et al., 2011).

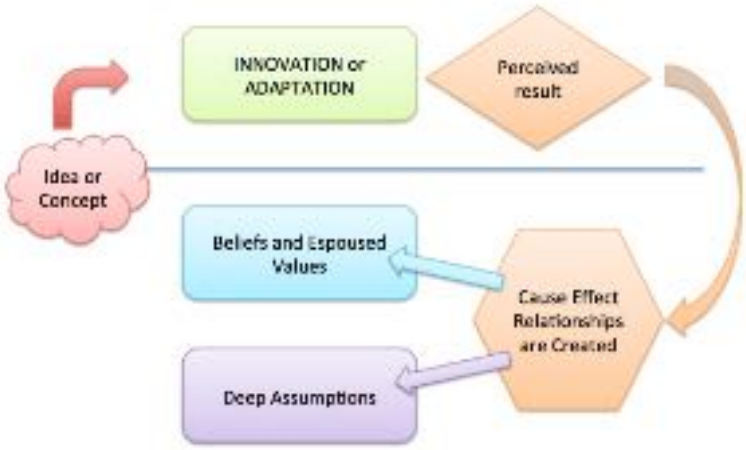

Figure 9.3: Results are Related to Cause and Converted to Assumption. This diagram is derived from Professor Edgar Schein's model of cultural influence as depicted in INPO TechDoc1329.

The development of deep assumptions and beliefs is depicted in figure 8.8, which shows the creation of causal relationships emerging from an innovation or adaptation that seems to be the cause of a perceived result. There may be any number of significant influencing factors that will go unnoticed without inquiry and reflection focused on their identification. Deep assumptions can form readily in a process that does not routinely consider influencing conditions and credits the idea or concept with the outcome. This can lead to ritualized actions and responses to situations that appear similar. The worst case will result in catastrophic outcomes, and in the best case the difference will go unnoticed because the margin was large enough to absorb the system variability.

The learning review-process challenges the causal ascriptions associated with triggering actions that once dominated investigative processes, where people were blamed for causing accidents through labels like human error, negligence, failure, and complacency.

These labels can result in increasing the belief that actions directly dictate outcomes. When outcomes are negative, these actions can be labeled causal and become the target of prevention efforts. This is often manifested in personnel admonishment. A perhaps more insidious and dangerous result emerges when the outcome is positive and the actions are incorporated into work practice without reflection. In the absence of reflection and questioning, causal ascription can result in ritualized behavior or culturally accepted routines and dogmatic responses, which will work as long as the system delivers what is expected or anticipated. To build on the epidemiologic metaphor, this is the equivalent of treating the symptom, not the disease.

The LR is designed to interject a deep level of reflection into accident and incident studies in order to determine the multiple conditions that resulted in the observed outcomes. In using this approach in Saddleback, we confirmed that learning products should address

systemic improvement as well as local learning. This realization resulted in the development of multiple learning products, each vetted through the community of practice (via focus groups) and tailored to specific audiences appropriate to the learning objective. Organizational learning targeted the ways that leadership could influence systemic improvement, and the field product focused on ways to improve work or approaches to work.[70]

To date the organization has invested significant resources to respond to accidents or incidents. This investment does not have an equivalent when outcomes are considered positive. Introducing the additional step of review or reflection to normal work was viewed as a significant accident-prevention tool. We introduced this step to focus groups in two ways: Kahneman's concept of system-two thinking and Weick's concept of sensemaking. The phase 2 focus groups received these concepts well. However, it is not easy to introduce either of these concepts in an organizational culture that is built on reactive responses, efficiency, and task completion.[71] Operators often perceive that reflection takes time away from production; it is often viewed a trade-off between efficiency and thoroughness (Hollnagel, 2006) and opportunities to learn from normal work outcomes are frequently squandered. During the Saddleback focus group interactions, I recognized an opportunity to use the margin concept as a way to activate sensemaking or system-two thinking.

Field Learning Products

The field-learning products were developed cooperatively between focus groups and academic research to provide the best opportunity to leverage what was learned in phase 3 into useful products. Field products included a narrative of the Saddleback event presented to inspire dialogue with an accompanying facilitator's guide; a video introducing the margin concept (also included in the facilitator's guide); and a hazard-tree awareness video.

Development of Margin of Maneuver as a Field Learning Practice

The sensemaking team who crafted the final learning products largely ignored the original sidebars; however, the intent to not focus on smokejumper operations was not forgotten. We viewed the smokejumper community as a body that embraced the margin concept

[70] Work improvement is seen as learning better ways to do work, or recognizing things that should not be done in the work environment. Improving the approach to work is viewed as developing ways to improve the workers ability to recognize the system's potential to do harm (in Saddleback this was seen as developing dialogue around the development of a sense that margin of maneuver is decreasing).

[71] Occasionally the organizational response has been the response: when all else fails blame it on the culture and call for culture change. An example was South Canyon when senior leadership blamed the "can-do" firefighting culture, which was the same culture that the organization praised for mission completion largely due to that same "can-do" culture.

and used it every time they jumped out of an aircraft. From this perspective we were able to show that the success of the program was based, albeit unintentionally, on the practice of margin (statistics indicate that there is a lower likelihood of injury or death in smokejumping than in sport parachute jumping operations).

The Saddleback events pointed to actions/decisions common both to other accidents and to positive outcome events, including routine and intuitive practices being used in situations marked by uncertainty {McDaniel & Driebe, 2005). This was not a new realization, and the fire organization had tried to introduce mindfulness and high reliability organizing (HRO) as ways to mitigate this issue. The field relied on voicing reminders to be vigilant and to maintain situational awareness and warnings to use the Ten Standard Firefighting Orders or to "Check LCES."[72] These concepts and practices had limited success.

Prior to the 2014 fire season I had been experimenting with new concepts designed to help firefighters to recognize changes in the environment. I had observed that when field personnel recognized danger they would balance their behavior to address the threat. This was consistent with Adams' (1995) and Wilde's (1976) work on risk compensation. Adams (1995) described the model using six parameters, which significantly influenced the approach to risk being developed in the Saddleback learning products as well as the LR formulation:

- Everyone has a propensity to take risk.
- This propensity varies from one individual to another.
- This propensity is influenced by potential [perceived] rewards of risk taking.
- Perceptions of risk are influenced by experience of accident losses—one's own and [those of] others.
- Individual risk-taking decisions represent a balancing act in which perceptions of risk are weighed against propensity to take risk.
- Accident losses are, by definition, a consequence of taking risks; the more risks an individual takes, the greater, on average, will be both the rewards and losses he or she incurs (2005).

This model helped me understand how risk was normalized in the complex work environment of wildland fire and why routine reaction to situations was commonplace.

The concepts I was exploring were also based on my personal experience in combat aviation operations, where upward voice[73] was critical to safe operation, and how as the

[72] LCES stands for – Lookouts, Communication, Escape Routes and Safety Zones

[73] Upward voice is a specific kind of feedback that addresses issues of power. It is someone lower in a hierarchy (with less power) giving feedback / speaking their truth, to someone higher in the hierarchy (someone in a position of power).

pilot I had challenged crewmembers to speak up if they saw anything that appeared "dumb, dangerous, or different." This is a reflection of a power dynamic that can be relationally interrupted through humble inquiry.

I spoke with Woods about awareness and upward voice, and he suggested that I look into a concept he called *Margin of Maneuver* (*MoM*[74] or *margin*). He explained margin as the ability or capacity to handle the next surprise. At first I did not understand the concept or how to apply it.

I was familiar with a form of margin from military flight training, where it was discussed during pre-flight training, specifically for formation flights. Maintaining a safe margin was considered to be the key to formation flight. In this context, margin is distance between aircraft that pilots deliberately establish and maintain.

Margin was clearly not a "one-size-fits-all" and to be useful, it had to be tailored for the wildland fire environment. Converting the observations into a meaningful field-learning product remained a challenge. I reflected on the five questions brought up by the two subject-matter experts consulted early in the sensemaking process:

- Was it an issue of miscalculation or missed signals?
- Was it a normalization of risk?
- Was it "routinization," i.e., falling into a routine?
- Was it a failure to recognize change, or hazards?
- Was it distraction?

These questions were haunting me. They did appear judgmental, as had been noted; however, they also placed a label on actions that once observed, I could not overlook.

I consulted Weick a second time for his expertise with regard to sensemaking (Weick & Sutcliffe, 2007). It was becoming apparent to me that Wood's margin concept and Weick's sensemaking concept had the potential to be synergistic in a field application. Margin was beginning to make sense to me, but I needed to tie it to sensemaking and system-2 thinking. I saw this approach working in a way that could activate or energize procedures that we already had by increasing awareness of the potential danger in the system (Adams, 1995).

The dialogue with Weick focused on the usefulness of the margin concept and its importance and relevance to sensemaking in complex adaptive systems. Weick pointed out, "Sensemaking is focused on directions rather than decisions," and in this way it could be seen as a decision aid. Common themes emerged as causes in wildland fire accident reports, such as loss of situational awareness and human error. Most of these reports

[74] Some focus group members were put off by the acronym *MoM* so *Margin of Maneuver* was changed to "*Margin*."

admonished practitioners to “increase vigilance;” “be aware of surroundings at all times;” and to “never get complacent.” Realistically though, people will commonly fall into routines when they are performing tasks they perceive to be safe or repetitive, and when this happens any failure could be described using one of these labels. The fourth focus group summed it up: “Years on the fireline can make a person numb to danger” (focus group 4 participant).

We discussed the common Forest Service term situational awareness and realized that this idea had become static in firefighting operations. Where it may once have had a dynamic use, the phrase had been nominalized (shifted in practice from a verb into a noun) and in the process had lost its power to generate inquiry regarding the environment. Introducing sensemaking as a way to build or create situational awareness was seen as a possible way to gain a perspective of inquiry and action; however, something had to engage people to look at the environment and break the sense of being “numb to danger.”

We explored ways to trigger sensemaking as a dynamic part of everyday work. This was not intended to admonish the Saddleback firefighters but instead to be helpful in exploring ways to trigger observation and inquiry. This intent is substantively different than investigative processes that focus on participants’ failures to perform a function. Alternatively it was designed as a method to frame future situations to help firefighters recognize and avoid similar outcomes.

“Sensemaking involves turning circumstances into a situation that is comprehended explicitly in words and that serve as a springboard for action” (Taylor & Van Every, 2000, p. 40). By this definition and use, sensemaking is a proactive strategy or framework that can be used to evaluate the conditions that surround individuals in dynamic situations. The sensemaking concept was tied to mindfulness following the 1994 Storm King Mountain fatality fire. However, it was not getting consistent traction in the community of practice.

Recognizing the growing importance of conditions and the need for adaptive responses to unanticipated conditions, I also began to question the usefulness of the current approach to risk management, which was based on the need to mitigate hazards in the environment. This could only occur if the hazards were recognized or anticipated. When I considered this approach in the context of the Saddleback firefighters who felt the risk was low following the top of the tree falling and nearly hitting Connor, I concluded that they may have believed the hazard had been mitigated and therefore the tree no longer posed a threat. This response to conditions did not match the reality of the situation.

The idea of matching the response to the conditions is intended when people engage in sensemaking. Recognition of changes in the environment is the intent when firefighters talk about situational awareness. Both of these require dialogue, especially in the face of

uncertainty. However, expectations and experience can help to simplify the world and steer people away from disconfirming information. The influence can by summarized as follows:

- We see what we want to see.
- We see what we have labels to see.
- And we see what we have skills to manage.

These three qualities seemed related to the five questions the subject-matter experts posed in the Saddleback incident. Weick and I explored sensemaking as a way to create a more varied and differentiated picture of the environment in order to infuse inquiry into common practice in firefighting. “A reliable [or resilient] system is one that can spot an action going wrong, not an action gone wrong” (Reason, 1990a). Inquiry was considered as a way to disrupt assumptive behaviors noted at Saddleback, Norcross, and Panther. In order to spot an “action going wrong” some combination of observation (mindfulness) and sensemaking had to be triggered. Margin was considered as a way to accomplish this goal by changing the frame of observation from risks and hazards, which were largely normalized, to trends in margin that could be something as simple as a feeling or intuition that the situation had changed and that margin was in some way reduced.

The challenge became how to make the concepts of margin and sensemaking accessible to the field. The idea of a network of conditions surrounding and influencing personnel in active pursuit of mission goals came to life using imagery through a toy called a *Hoberman sphere*. This scientific toy has interconnected arms that allow the sphere to change size uniformly, depending on pressures applied to it. The sphere gets larger and smaller as the network of joints (each representing a different condition) are moved away from or toward each other. The image of space getting smaller inside the sphere represented conditions becoming more closely coupled, which would reduce margin.

Margin was introduced in eight focus groups to a wide variety of personnel in several land management agencies who engage in fire (Forest Service, Bureau of Indian Affairs, Bureau of Land Management, National Park Service, and US Fish and Wildlife Service). A sensemaking team member, a former firefighter who had personally been in a fire entrapment, conducted the focus groups. She represented the concept of margin through a personal story about her entrapment and demonstrated the concept of margin getting smaller through her story. She had individuals represent different conditions and as she told her story they were asked to move toward her or away from her as their condition changed (if a participant felt the changing condition put pressure on the crew in her story, then that person would move closer and vice versa). By the time she had finished the story, the participants were packed in tightly around her.

The concept created a visual image that tied margin to changing conditions, linking them together in a way that demonstrated a trend. The firefighters were asked, “What could you do about margin decreasing?” The ensuing dialogue resulted in a unilateral

agreement that firefighters could identify margin more easily than individual risks or hazards. We then linked decreasing margin with sensemaking and system-2 thinking by suggesting that when people detect decreasing margin[75] that should trigger sensemaking and a deliberate plan review.

She then solicited stories from the participants. The Hoberman sphere allowed the participants to adjust the sphere size based on how they felt margin changed in their own stories. We filmed several focus groups to show how the margin concept applied to daily work and how field personnel could quickly understand and use the concept to assess changes in the environment.

The concept of viewing the operational environment through the lens of margin asks that the participants recognize the strength and benefit of being vulnerable. Vulnerability, in this case, is the recognition that full control of the situation or environment is impossible and that the conditions cannot always be managed. Margin poses that when the conditions get the upper hand (margin is decreasing) then the individual or group should manage margin. This was summed up during a recent staff ride when margin was being introduced. A participant who was faced with the question of what to do when conditions were different simply said, “Step back!” In order to accept margin, participants must recognize the system has the potential to do harm and accept that they are vulnerable.

Development of the Organizational Learning Report

The organizational learning product was designed to address how to support systemic changes. The leadership in any organization have the authority to change policy, rules, processes and in some cases regulations. It is incumbent upon leadership to reduce organizational confusion regarding goal conflicts; rules and policies that don’t make sense; infrastructure limitations, etc. The Organizational Learning Report is considered to be quality staff work that provides guidance to leadership regarding systemic changes that have been vetted through the community of practice. However, it is also viewed as a dialogic tool.

> We have a tendency to believe that post-accident reports will answer all our questions—they don't. We want to believe that they can be written for all audiences—they can't. This is why we have developed multiple products. This Review will answer some questions, but it is likely to raise others. It is designed to do just that, which makes it different from traditional reports. Look inside the cover of this Review for answers, but more importantly, look inside yourself (Forest Service, 2013).

[75] This is the definition of mindfulness, and this sentence demonstrates how mindfulness, margin, and sensemaking work together.

We shaped and re-shaped the report a number of times. Each section was carefully created to present theory about the LR process or information so that the LRB members could engage in their own learning journey. The report structure included the following:

- Introduction
- Purpose of the Learning Review
- Field Perspective
- Typical Mission Flow
- Saddleback Fire Narrative
- Organizational Narrative
- Synthesis, Analysis and Sensemaking
- Key Concepts and Techniques
- Building Context
- Analysis
- Sensemaking Discussion
- Using this Information to Learn
- Margin of Maneuver
- Hazard Tree Awareness
- Proposed IWI Study
- Organizational Learning
- Glossary of Terms
- List of Appendices
- Supporting Information

The report opened with a section titled “Typical Mission Flow,” which explained common practice (or perhaps espoused common practice). This part of the report was an outgrowth of the focus groups and was vetted prior to release. It represented common practice, which could then be compared to the narrative. We understood that some readers would not be familiar with smokejumper operations; this section provided background so the reader could discover differences between common practice and the narrative for themselves.

To date, no report had presented common practice and it was generally assumed the reader was familiar enough to understand operational changes when they were simply described in the event narrative. The report also broke new ground by presenting the perspective of the leadership involved with the incident. To this end, another influences map was created that reflected the conditions that supported leadership’s actions/decision to staff the fire (see figure 9.4).

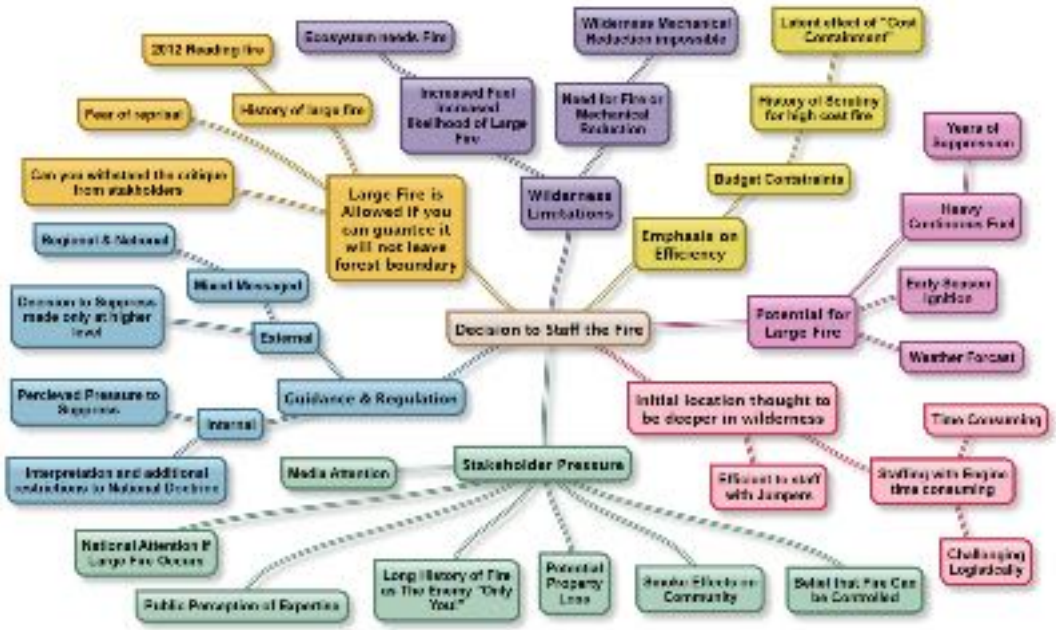

Figure 9.4: Map illustrating the expanded network of leadership influence.

The Learning Review Board did not seem interested in this work. Instead of engaging in dialogue they wanted to know what to do to improve the system. The realization that leadership needed to be involved in the creation of a safer work environment, resulted in a shift in focus to supplying the LRB with recommendations.

Rather than the traditional findings and conclusions, the Saddleback report has a section titled “Using this Information to Learn and Improve.” This section explored what the team learned in the report-creation process that was relevant to leadership and as well as important focus-group findings, including areas considered significant for additional research, analysis, or sensemaking. The key messages included margin application and focus group results and hazard-tree awareness. Both topics were developed into field-learning products. This was quickly converted into recommendations for the board to approve.

The lesson we learned was that we had to be prepared to deliver vetted, staffed, and, if needed, researched recommendations for the LRB. Learning from the event meant changing something to the leadership and we had to shift the LR to reflect this need.

Presentation to the Learning Review Board

Most board members were accustomed to belief in objective truth, so I opened the LRB meeting with this statement:

> The aim of the Learning Review is to understand the rationale for the actions/decisions involved in the incident and then, if possible, to learn from them. Achieving this goal requires a deliberate effort to place decisions and actions in the detailed context in which they occurred.

I approached this presentation just as I had the focus groups while recognizing that this group had the authority to tell me to change all that the team had done. Even in my subordinate position I saw an opportunity to speak truth to see if those in power are open to learning. The statement above was a litmus test—if a lot of discussion emerged on this point, then I would believe the process was in trouble. Everyone in the room nodded or voiced support for the concept.

The LRB wanted recommendations, and I was caught off guard. I had anticipated a process that was free from rapid decisions regarding what to fix and saw learning as the prevention forum. This was a learning moment for me that indicated a new LR section had to be created to develop recommendations. I engaged senior leaders in an informal focus group and determined a review of policy including efficacy, delivery, and clarity was needed. The fundamental question considered whether policy should be changed based on this experience alone (simply changing or adding to policy based on a single data point). The Saddleback experience pointed to the need to involve the community of practice as subject-matter experts prior to making policy-change recommendations to the LRB.

Influences on the Learning Review Process

Seven major concepts emerged from the Saddleback LR and were captured in the final Learning Review Guide:

First, I recognized that no narrative could be complete or accurate. There are always missing aspects, including the things that people forget or memories that have changed (memory is malleable); people may also be unwilling to tell their story, for any variety of reasons. Each account is a personalized telling of a memory and as such, it cannot be complete or represent *objective truth*. Attempting to convert personal accounts to objective truth changes the meaning that was created by those involved, which cannot help readers understand the event or learn from it.

Second, narratives or stories can be supported by numerous information sources, many of which are considered to be *factual* (e.g., training records; relationships between participants; history with similar events; communications issues; cultural influences, etc.). There is a temptation to use this information to refute the memories of those involved, as evidenced by traditional reports that have done so (e.g., Esperanza, Thirtymile, Tanker-10, Cramer, the list goes on). This tendency was intentionally avoided in the draft LR process and was further developed in the guide.

Third, the language used in narratives can influence meaning and sensemaking. The language chosen can support a specific perspective or sway opinion. The narrative's tone and content could either set the environment for learning or prevent it. The LR guide captured these tendencies and suggested that focus-group, academic, and peer reviews could mitigate linguistic biases.

Fourth, the belief that we could not know, observe or discover everything was humbling and important. It established the tone for the team's conduct. The guide needed to recognize that we did not know the answers and were genuinely on a quest to understand the event rather than to explain it. This resulted in the inclusion of as many perspectives as possible. As a team, we discussed that one major impetuous for learning was to allow the reader/viewer to make their own sense of the event through dialogue. This lesson was supported by the Colgan Air case and had been a major point of Paul Chamberlain's original FLA concept.

Fifth, I recognized that a major contribution of the LR was its ability to present information so that sensemaking could occur. The focus group interactions supported that dialogue serves at least two purposes. First, it allows the participants to begin to make sense of the event in a non-judgmental environment, in which they often found healing.[76] Second, getting people from outside the event to talk about the incident served to generate meaning and understanding of the event in their own terms, using their own heuristics. This challenged the model of learning used in traditional reports, which focused on delivery of a specific message, usually the conclusion of the investigation team. Instead learning through dialogue appeared to inspire a deeper understanding of the event conditions and how they influenced the outcome. The focus on conditions appeared to be a valuable approach to the development of individual ways to recognize influencing conditions and the learning review focused on presentation of information to facilitate this type of dialogue.

Sixth, the importance of focus groups to understanding the event and to shaping learning products was realized. The team engaged in several focus groups, consisting of members of the community of practice, peers, subject-matter experts, and academic specialists. Focus groups ranged in size from one to 18 people and became a critical component of the study. When we approached the focus groups with scripts or scripted questions the group usually challenged the presented material. When we were less scripted, information flowed readily and unpredictably. Both methods seemed to have merit. The key realization was that the information was most powerful when it was merged with academic theory to create concepts; however, these concepts also required new focus groups to help us to create learning products that the target audience could accept.

[76] This is also a primary benefit delivered from the Forest Service application of staff rides and why the field community of practice has accepted them as a learning forum.

Seventh, our goal was to avoid attribution. “We humans have an irresistible urge to explain behavior; attribute it to some cause; and therefore to make it seem orderly, predictable, and controllable” (Myers, 2012, p. 5). We tried to genuinely listen to those we interviewed, and as a result a network of influence (rather than cause) emerged. This was not a network of direct causality; rather it was a network of conditions that appeared present in the system and that may have influenced decisions and actions. For a brief period we were challenged by the idea of trying to tie each condition to the Saddleback incident directly. However, we realized that this was not the most important aspect the network of influence map. The importance was in what the map reflected with regard to systemic pressures to perform or to act in a certain way.

Previous incidents also demonstrated that the entire process had to consider the wellbeing of everyone in the organization, as well as the families of those involved. For example, our team met with Luke’s family at the end of phase 2 and answered all the questions we could. Also, each product developed out of Saddleback was vetted through the community of practice it affected. The development of concepts and learning products emerged from the interaction between the team and the community of practice. The result of this approach addressed a fundamental goal of the LR by capturing multiple perspectives and interpretations. It also met the first principle of a CRP/LR, “Do no further harm to the system or the people within the system.”

Summary

The information collection phase resulted in a narrative that indicated the Saddleback firefighters had operated in an intuitive or routine way. The reliance on intuition was found to be pervasive in the firefighting community; it was looked upon as the best way to fight fire, given the time constraints common to rapidly evolving fire scenarios. However, at Saddleback, time did not seem to be a constraint; there was not much fire activity and thus no need to rush. Questions emerged regarding why the firefighters fought this fire the same way that they would one that was rapidly growing. The team explored this with the community of practice through focus groups and also consulted academic specialists to help expand the concepts and develop learning strategies.

During Phase Three, I recognized that sensemaking, innovation, and learning were critical aspects in facilitating the creation of safety at the point of work. This was based on recognition that complex adaptive systems deliver the unexpected as a natural byproduct and that routine or procedural responses will not meet all the situations that may be encountered in complex systems. Schön (1983) explained the experimental nature of decisions and actions in complex systems, “There are those who choose the swampy lowlands. They deliberately involve themselves in messy but crucially important problems and, when asked to describe their methods of inquiry, they speak of experience, trial and error, intuition, and muddling through.” The imprecise nature of actions and decisions is a

reflection of the uncertainty inherent in complex adaptive systems and the need for people to adapt or innovate when they face uncertain or unanticipated situations.

The network of influences map (see figure 9.2) indicated that there was a complex network of interdependent conditions that influenced firefighters both within and outside the Saddleback event. Traditional reports tend to focus on the creation of corrections based on incident-specific conditions. The new LR process indicated that some influences were not unique to this accident but rather existed in many operations. This pointed to a need to address include systemic conditions as well as those observed in the accident scenario.

The recommendations of traditional accident investigations often address what workers should and/or should not do in the future. These recommendations may be based on hindsight information that was not available to those involved in the incident. The LR team felt that it was necessary to move beyond this simple, counterfactual approach. We agreed that if the data supported corrections to procedure or common practice, these should be addressed immediately. This did not seem to be the case at Saddleback, where the conditions facing the firefighters were relatively common and shared by others outside the event. It became clear that the Saddleback report should highlight this, yet it was also an opportunity to help future firefighters learn to rapidly assess and make sense of conditions that might affect their work and safety.

Conditions (rather than trends) in complex adaptive systems are the currency or language that we can use for comparison of different incidents to each other. It is likely that if the "ingredients are long in the cooking" (Reason, 2000), then they exist in more than one incident. The concatenation of conditions and decision/action all work interactively to produce both success and failure. Focusing attention on conditions can lead to systemic improvements that go beyond simply learning what to do or what not to do—and can lead instead to developing practices and development of expertise that can help workers to recognize the system's potential to do harm (Pupulidy, 2014a). This recognition can result in innovations and critical thinking that disrupts the cycle of drift and excites sensemaking in the workplace.

Chapter 10: Reflections on Transformation through the Lens of Social Construction

Introduction

This dissertation taught me that we live in a world of narratives created and made meaningful by relational contexts. While some believe their story to be the only story, it has long been recognized that any situation can be described—or storied—in a variety of ways (Busch, 2003). From a constructionist perspective, there are no facts, only varying accounts from different perspectives rendered by those involved in a given situation (Gergen, 2009). Accounts are voiced human perspectives about events, experiences, and feelings, which are often presented as singular and defensible explanations. Social constructionism allows exploration of these accounts and the relational contexts within which they are crafted. This exploration provides an opening to multiplicity, community, sensemaking, and life-affirming learning. While this language is not common to accident investigation, its value cannot be understated.

In this chapter, I present a constructionist lens that is applicable to this dissertation. Each chapter is then explored through this lens of social construction. The chapter concludes by contrasting the current accident investigation model with a constructionist approach to the organizational response to incidents and accidents.

Social Constructionist Lens

The traditional model of organizational response to accidents is referred to as "investigation." It is typified by a belief that everything in the world can be observed, measured, recorded, and controlled. This is characteristically accomplished by using checklists or models (Whitlock et al., 2005). In contrast, I suggest an approach to organizational response that is grounded in social constructionist theory and understanding that meaning is constructed dynamically through social relationships.

In this section, I provide a description of social constructionism and contrast it with the current investigational praxis of organizational response to accidents.

Social Construction

In his landmark book *Sensemaking in Organizations*, Karl Weick describes how people engage in constructing the very situations they are attempting to comprehend (Weick,

1995). He goes on to elaborate on group sensemaking as what exists between people and is co-created (Weick, 2010). Sensemaking, by this description, can be viewed as a form of social constructionism. Just as Weick locates sensemaking as happening between people, Cooperrider and Whitney describe constructionism as replacing the individual with relationships. “Constructionism is an approach to human science that replaces the individual with the relationship as the locus of knowledge” (2005, p. 50). Sensemaking, as a function of relationship, can then be seen as the capacity to understand or make meaning of these relationships. This points to organizations, regardless of size, as sensemaking entities.

Social construction’s central premise is that social systems create or determine realities through narration and dialogue (Cooperrider, Whitney, & Stavros, 2008). In this way knowledge is created through interaction with and within social systems (Cooperrider et al., 2008). The knowledge that emerges from societal interactions is therefore reliant on multiple perspectives, interpretations, dialogue, language, and narration. Each of these components influences the way that societies or communities construct what they believe to be reality. This reality in turn influences, beliefs, actions, and decisions.

Three concepts important to social construction form the lens through which the cases will be evaluated. First, sensemaking is most helpful to communities when multiple perspectives are included. Second, sensemaking as a constructionist practice benefits from free and open dialogue (Weick, 2005). Third, sensemaking is critical when individuals or communities recognize surprise or discrepancy.

Recognizing and Embracing Multiple Perspectives

Social constructionist practices take into account diverse perspectives; “all social action is open to multiple interpretations, not one of which is superior in any objective sense” (Cooperrider et al., 2008, p.15). This is important to the field of accident investigation because during the review of an incident or accident, multiple realities often emerge as different people report different perspectives of the same event.

Sensemaking as a Constructionist Practice Benefits from Free and Open Dialogue

There are a number of definitions of sensemaking; however, they all share a common need to share perspectives and information. They all require communication (Maitlis, 2014). Likewise the construction of societal values also relies on communication. “The most powerful vehicle communities have for changing the social order is through the act of dialogue made possible by language” (Cooperrider et al., 2005, p 15).

This dissertation points to two potentially new ways to define sensemaking: immersive and community. Both of these modes of sensemaking involve enjoining groups of people

in communities of practice to engage in a sensemaking exercises through dialogue. The central process is building an environment of open communication (Isaacs, 1999). "Communication is about tolerance, trust, being oriented to the present and non-contractual cooperation" (Weick, 2007, p. 213). Communication is recognized as an important aspect of sensemaking and learning (Jordan, Lanham, Crabtree, Nutting, Miller, Stange, & McDaniel, Jr., 2009). "Conversation is really hard. It is easy to say, 'the issue is communication; we have to talk to each other.' But it is hard to collaborate, make meaning and improvise" (Jordan et al., 2009).

Sensemaking as a Dynamic Activity among People

Sensemaking is a dynamic relational activity that occurs as people recognize something in the form of surprise and interact to make sense (Weick, 1995b). Weick posits that sensemaking does not occur all the time; rather it's a central practice of social construction that occurs as people recognize surprise or discrepant cues and begin to make sense of them (Weick, 1995b). Organizations lend themselves to multiple conflicting interpretations, all of which are plausible (Weick, 2001). Recognizing the potential multiple interpretations of information, people can be unsure. People in this situation "bring events and structures into existence and set them in motion," which Weick called "enactment" (Weick, 2010). Weick (2010, p. 307) describes the product of enactment as "an orderly, material, social construction that is subject to multiple interpretations." Building on this description, enactment can be seen as the relationships between interactive, interconnected, drivers and adaptive components of a system, which can also be interrelated in a non-linear way with each other (McDaniel ,2007).

Group sensemaking allows for and encourages self-expression, the acceptance of multiple diverse perspectives, and life-affirming growth or learning to occur, which is made more powerful as people interact and develop meaning through dialogue (Weick, 2010). It is reasonable to define the development of meaning as sensemaking, which is one way a community can add to learning from an event. Group sensemaking is something that exists between people and is co-created (Weick, 2010). Sensemaking, by this description, can be viewed as a form of social constructionism that exists in every community.

Synopsis of each Chapter through this Lens of Social Construction

Chapter 1 – The History of the Forest Service. The Forest Service emerged on the political landscape through dialogue and was sustained in its early years through relationships. As the President of the United States wrestled with the challenge of protecting timber reserves, he turned to those he trusted. The first Chief of the Forest Service Gifford Pinchot educated all his Forest Supervisors at Yale University and thereby simultaneously created collaborative relationships through common experience and language.

The commonalities that made the Forest Service collaborative also contributed to a worldview that sustained a common narrative of preservation and "war on waste." It took

a major event that was inexplicable within the shared mental model and language to evoke inquiry, which began to challenge deep assumptions about man's control over nature and how the land should be *managed*.

The firefighting community was part of a larger worldview and an organizational mantra, "the war on fire," which was influenced by the perceived need to control the natural world (Pyne, 2004). Influences shaped decisions, ranging from the acceptance of clear-cutting practices to the ultimate sacrifice of *heroes* who were preventing the loss of resources due to natural events like fire. The control of fire became a core value of the Forest Service, which instilled a sense of emergency in fire responses. Nature was substantively driven from the dialogue, which became dominated by principles of efficiency, management, and control.

Chapter 2 – The Evolution of Accident Investigation. Within five years of becoming an agency, the Forest Service suffered the loss of 85 lives, 76 of which were firefighters, in the pursuit of wildland fire control. The organizational response to accidental death at that time was not based on a process; instead a response emerged that captured a narrative of the event and honored the fallen. This may have been shaped by the relationships inherent in the leadership community due to their common education and history. It could also have been influenced by the presence of a less litigious society (than that of today). The dominating view seemed to reflect a need to understand actions that were taken by well-intended people. Over the next 50 years, this approach was gradually replaced by a series of reductionist processes that began to exclude descriptions that fell outside boundaries that could be measured, observed, or described as error or violation. Achieving an "objective truth" became the goal of investigative processes, which reduced multiple narratives to a singular narrative that fit the model of those assigned to the investigation and thereby given the power to write the report.

Lost in this drift toward "factual" reports were the multiple perspectives and the stories of the people closest to the accident. A singular truth emerged from what had been a complex network of conditions that challenged the ability of participants to make sense of unfolding events. *Reality* was unconsciously constructed and delivered as causal explanations of violations and error, which were neatly fit into categories to support trend analysis or a perceived *right* way that people should have behaved. "If they would just follow the rules they would all be safe" became a dominating mantra, which did not consider the possible lack of fidelity, understandability, or the conflicting nature of rules. Narratives, which were once progressive, became tales of a failure to perform, loss of situational awareness, or simply human error. The definition of human action was being unintentionally constricted.

This shift was associated with the best of intentions to prevent future accidents. Yet to understand this shift, we have to understand the dominating social model. *Safety* had become something that was believed to be definable, measurable, and controllable, and

accidents were expected to follow the same trend. The linear, reductionist, Newtonian thinking dominated the cultural landscape in the Forest Service (Steen, 2004; Saveland, 1998) and science demanded answers, prediction, and control. This model had been credited with the reduction of aircraft accidents through its ability to trend and predict mechanical failure (Hollnagel, 2002) and it was being used to define the process of *human factors* analysis.

Chapter 3 – The Serious Accident Investigation Guide (SAIG) – Pressure to Standardize the Approach to Investigation. In 2001, the interagency fire community published the first Serious Accident Investigation Guide (SAIG). There had been pressure to standardize the investigation process in the Forest Service and associated agencies for over 20 years. As early as 1980, the National Wildland Fire Coordinating Group (NWCG) called for the community to develop "Uniformity, quality, and availability of reports" that would "identify common causes and make recommendations to reduce the occurrence of accidents" (NWCG, 1980). Federal agencies with regulatory oversight, like the Occupational Safety and Health Administration (OSHA) and the National Transportation Safety Board (NTSB), influenced the creation of the SAIG (Saveland, 1984).

The SAIG called for the creation of factual reports, the identification of cause, and the listing of findings that could be used as evidence to support recommendations that would prevent the accident from happening again. The process appeared to be effective in the identification, prediction, and prevention of mechanical failures and relied on the identification of failure, determination of cause and correction, or repair, of the defective component. The analysis of the human contribution was bound to this pattern of practice. Human decisions were listed as causal, and they were labeled, classified, and trended much like the mechanical failures of simpler systems. Human error became the metaphorical enemy of safety, with one company even espousing to fight the "Global War on Error." The prevailing language describing human actions and decisions included the following terms: failure, inadequate, loss of situational awareness, holes, neglect, negligence, violation, unsafe acts, willful disregard, overreliance, failure to adhere to rules, etc. Perhaps one of the most absurd of these was "acceptance of a high-risk situation or assignment" (Whitlock et al., 2005, p. 21), which is absurd as all fire assignments could be seen as high-risk. These labels began to manifest as explanations, which were consistent with what Gergen calls "labeling theory:" "...the way in which the labels we give to phenomena come to be self-fulfilling. Thus to call a given behavior a 'criminal act' creates what we take to be a crime and as well a population of criminals" (Gergen, 2009, p. 23). In 2001, Forest Service employees were brought up on criminal charges for actions and decisions that were made during the Thirty-Mile fire in west central Washington.

The belief that human action is causal supports the "bad apple theory," where people are the culprits and should be removed from the otherwise perfect system (Dekker, 2006). The same deep cultural assumption is reflected in McGregor (1960, p. 46) "Theory X:"

"The average human being prefers to be directed, wishes to avoid responsibility, has relatively little ambition, and wants security above all." McGregor (1960, p. 59) contrasts Theory X with Theory Y: "The average human being learns, under proper conditions, not only to accept but to seek responsibility." The focus on the control of individual action is highlighted in the recommendations section of the SAIG, which states, "Remember that nothing changes in safety management unless management causes it to happen" (Whitlock et al., 2005, p. 38).

The SAIG process discouraged multiple perspectives, and investigators were told to develop linear accident sequences. "The accident sequence is established based only on the facts determined during the investigation" (Whitlock et al., 2005, p. 16).

Time was also constructed as a linear concept. The SAIG encourages timelines to list actions in a chronological order based on hours, minutes, and seconds. The narrative is described as "A detailed chronological record of the facts before, during, and after the accident" (Whitlock et al., 2005, p. 40). The construct of time in this way influences the interpretation of actions and decisions. Consider the different ways that a person could be influenced by the fact that an accident sequence took five minutes. A reader of an accident report could interpret this as: They had *five whole minutes!* Or they *only had five minutes*. Without context, chronological listing can inadvertently obscure key conditions that would otherwise aid in understanding the event.

The SAIG process is based on assembling "objective facts" for the reader in an effort to establish a single, organizationally approved truth. This truth is unconsciously constructed by use of a process that espouses to be unbiased and objective, without acknowledging that both of those qualities may be out of reach in a human community, or a complex environment.

Chapter 4 – The Norcross Case Study. This case study represents the first challenge to the construction of reality espoused by the SAIG. At the time of this accident, I did not know about social construction or complex adaptive systems, as I had been trained in the traditional forms of accident investigation that do not include these concepts. My clumsy effort to reconcile cause and effect in this investigation did, however, result in inquiry; that inquiry pointed to deficiencies in the process, not in the humans who were doing the best they could with their perception of the *conditions* (their reality or fact).

Norcross began to open up a dialogue simply because it did not resolve the tension that exists when multiple perspectives are viewed side by side. Rather than following the SAIG in the creation of labels, labels were avoided. A different reality was explored; one that involved people working in an environment where things did not always make sense and alternatives did not present themselves as right or wrong ways of completing the mission. Interactions and relationships were not described in linear sequences; instead, challenging networks and interrelationships were recognized to be important. Without

the language of complex adaptive systems or social construction, the representation of these relationships was simplistic; however, the approach was recognized as different, which did result in additional inquiry and dialogue at several levels of the organization, including senior Forest Service leadership, who encouraged greater experimentation.

Chapter 5 – The Panther Case Study. The Panther accident occurred one year after Norcross. This investigation represented a greater departure from the SAIG and a broader understanding of the complex nature of relationships and actions/decisions. It also represented a significant shift in language, as terms like blame and cause were completely avoided in the report. The narrative presented different perspectives of the event, which were presented as intertwined stories. It would have been easy to say that the fatality resulted from the failure of the deceased to recognize the inadequacy of the shelter deployment site, which could have been factually substantiated by citing that the comparably trained partner of the victim realized this and fled the area. This would have been consistent with the SAIG and is an example of resolving the narrative into a single story that made sense from a single perspective; however, there is little to learn from this approach, and learning had become a major goal for my team.

In the Panther investigation the team explored the traditional methods recommended by the SAIG and found that they influenced us to ignore specific connections between actions and conditions. What emerged was a network of influences, rather than causal linkages. The narrative expanded into a collection of narratives as we began to realize that every person involved in the incident interpreted information based on their values and deep assumptions.

Conditions that influenced people to develop their beliefs became a much more compelling story and provided a “sense of explanation” (Gergen, 2009, p. 38) rather than a factual explanation. Of course, the definition of *factual* is suspect in this description, as it could be argued that a sense of explanation is more open to information and would, therefore, be more factual. The investigation team built a “network of influence map” to help us understand how interconnected perceptions and traditional *facts* influenced the decisions made by those involved in the incident. What emerged was a report that used softer language, multiple truths, and diverse perspectives.

The report introduced another major change in the presentation of information as we began to ask, “Who is the report for and how can it be used?” Rather than directing the information in the report solely to leadership so that they could enact changes, the report also addressed field personnel. People became the focal point of the process, including the family of the victim. We were exploring the ability to develop relationships that could potentially result in increased opportunities and ways to learn.

Chapter 6 – The Importance of Sensemaking Communities to Accident Prevention. A major revelation from Panther was that the association of human error, regardless of the

label, was an artifact of a cultural tradition, or as Gergen (2009) suggests, "narrative structure [and rules] will direct the historian's choice of what counts as fact." If *facts* are subjective and not extant in the system, waiting to be discovered, then how can they become the basis for cause-and-effect-based solutions? Another pathway to accident prevention had to be recognized if the products of investigations were to be meaningful or useful.

A commuter airline accident occurred in upstate New York, which was investigated by the National Transportation Safety Board. The investigation was public and drew a great deal of interest from the media. The results were not unlike most of the traditional narratives until the families of those most affected by the incident began to question the results. The families were not part of the culture that created the report and were not satisfied by the answers provided by that culture. Theirs was a world of trying to make sense of the accident, rather than answering a question regarding the mechanical nature of cause.

These families banded together in an effort to make sense of the event, and they wanted the voices of those who died to be heard in a way that made a difference for the future. What they did challenged the method and substance of the final report by merging many stories with the statistics and factual representations produced by the NTSB. Their new amalgamation of stories shaped a different understanding of the event, which resulted in meaningful inquiry on the part of the NTSB, the Federal Aviation Administration, and even the U.S. Congress.

This inquiry was centered on two types of sensemaking. The first tried to understand why specific actions, which could be seen as errors from one perspective, actually made sense to those involved in the accident. The second was a form of emergent, social, post-event sensemaking that I named immersive sensemaking. This took place as the community tried to knit information together to make sense of the event using a language and approach that they could understand.

Chapter 7 – Learning from Error. To learn from error we have to agree there has been an error, which is not as simple as some models would suggest. When actions are classified as errors based on the outcome of the event, a number of assumptions are created and maintained. This construction of error can influence the way that we begin to understand worker actions and what is required to prevent adverse outcomes. When the worker engages in an assignment or task two narratives can emerge. First, the workers are good people doing the best with what they had. Second, the workers are flawed people who missed opportunities to get it right.

Panther demonstrated that two comparably trained people did not perceive the same conditions in exactly the same way. This difference suggests that there are internal and external conditions that support interpretations and actions that are not universally consistent from one individual to another. The focus of traditional investigations centers

on the individual (often the one who died) and generates narratives that see the *triggering act* as a *choice* that should be avoided in the future. The same is true in events with less catastrophic outcomes, where a *triggering action* is identified in a *causal chain*. Rooting out the weak link in the chain becomes the overarching goal of the investigative process. The weak link is identified as an individual who can be *fixed*, which is an artifact of values and deep assumptions of the culture.

The concept of human agency, or free will, is assumed and perpetuated in the traditional narrative. This model presumes that faulty choices made by fundamentally flawed people are the reason for the accident. As in criminal acts, the culprit has to have free will for the conviction to stick. The model becomes more constrictive when it employs agentive language that keeps the individual in the center of the spotlight. Cultural, historical, circumstantial, and perceptual differences are ignored, and the common result is the creation of a new policy, barrier, or procedure to ensure that the failure never happens again.

The strong bond between the error and cause removes the ability of the community or the individual to recognize the importance of the relationships we all have with our history, culture, environment, and each other. This bond creates a profound adverse effect on information sharing and dialogue, which only serves to make the system more brittle. Actions and decisions have to be seen in context, with the express goal of understanding why they made sense to those involved (Dekker, 2006). Recognizing the importance of relationships, dialogue, and context became a principle of the new process of accident inquiry for the Forest Service, called the Learning Review.

Chapter 8 – Agreeing to the Concepts of the Coordinated Response Protocol and Learning Review (CRP/LR). Forest Service leadership increasingly saw the need for change. People had been prosecuted based on information obtained during accident investigations, practitioners were afraid to talk, and accident rates were not improving—in fact, some statistics showed they were getting worse. Grassroots movements and individual innovations challenged the assumed conventions and models of investigation. The field was paying attention and felt that the products of these new approaches had value. Senior leadership was willing to experiment, which created space for dialogue.

The first Engagement Session was an opportunity to understand the levels of conflict that we faced as an agency. We recognized the importance of relationships and the need to make room for multiple perspectives. In a way, these engagements modeled a focus group concept that was included in the Learning Review Guide. The second Engagement Session solicited input from many sources to support the development of new basic principles of investigation. We agreed to conditions of success and co-created a list of principles for use when dialogue broke down or when it was dominated by the advocacy of one perspective over another. The facilitator would reflect on the principles and the position that was most aligned with the principles would be accepted. From this

guidance, a shift in both tone and language began to emerge, and all the participants were given voice in the process.

Chapter 9 – The Saddleback Case Study. Saddleback represented the first opportunity to use the major practices and concepts contained in the Learning Review guide to deliver learning products. These learning products focused on a sensemaking schema, where "experts determine what is true and valid" (Gergen, 2009, p. 130). Experts were broadly defined as members of the communities of practice who would engage in dialogue initiated by the learning products. In this way learning was considered to be the product of individual and small group inquiry and co-creation of knowledge through dialogue and sensemaking.

Unlike traditional investigation processes, witnesses were considered to be knowledge experts, who, due to their experience during the event, held more knowledge than anyone else about the accident. As a result, witnesses were encouraged to participate in the creation of the narrative.

Saddleback also demonstrated the importance of capturing multiple perspectives. This included the perspectives of the community of practice, leadership, and the participants. All perspectives are important in shaping narratives that can lead to understanding the event. The tension that can result from multiple interpretations can inspire dialogue and expand the domain of participation. It also reduces the control over the direction of sensemaking, showing respect for the learners in the community and increasing the likelihood of new and diverse ways to view the situation and to create potential learning opportunities (Gergen, 2009). This was shown to be the case in the focus groups that were convened during the creation of the Saddleback Learning Review.

As a whole, the case studies confirmed that all narratives are constructs of reality and only represent what we *believe* is real or agree to believe is real. Like photos or paintings, a case study can represent a single perspective and tell a single story. Saddleback pointed to the need to incorporate as many perspectives as possible, leaving the interpretation and learning to the reader rather than have the investigation team resolve the perspectives in order to teach a specific lesson.

Contrasting the Current Investigation Model with a Constructionist Approach

The models used in any process influence the creation of narratives, which purport what is established as true or valid (Cooperrider et al., 2008). Accident models represent theoretical lenses and beliefs, which underlie all investigation processes and influence or even determine the way that narratives are created and what readers will see. Traditional models espouse an ability to engineer interventions designed to make the system safe

(Hollnagel, 2002). They form the basis for (1) the conduct or process of investigation; (2) the analysis of information, commonly referred to as data or evidence; (3) designing prevention strategies and interventions; and (4) determining risk levels, in an effort to evaluate if the operation should be continued or abandoned (Woods et al., 1995).

Forest Service investigators may not be consciously aware that they are using models and often refer to their work as factual and objective. This phenomenon can be seen in this excerpt of a recent communication from the leader of the Forest Service aviation accident investigation group:

We agreed to leave Causal determination to the NTSB; however, we will still identify findings of FACTs (not assumptions or conclusions based on hearsay or innuendo). The report should provide adequate information for a Board of Review to get an understanding of the timeline and factual events surrounding the mishap and develop their own conclusions. We do not use bias in aviation investigations and never had, so this will not be an issue.

Box and Draper (1987) said, “essentially, all models are wrong, but some are useful.” Models are important because they provide a means for understanding phenomena and recording that understanding in a way that can be communicated to others (Fischhoff & Goitein, 1984). Note that all models are abstractions, they simplify the thing being modeled by abstracting away what are assumed to be irrelevant details and focusing on the features of the phenomenon that are assumed to be the most relevant (Box et al., 1987). The selection of what is relevant or irrelevant is entirely on the choice of the modeler, and it is critical in determining the usefulness and accuracy of the model. However this selection, while it may appear to some to be arbitrary, is based on the deep assumptions and values of the modeler, or as Cooperrider et al. (2008, p. 15) say, “An observation, therefore, is filtered through conventional stories, belief systems, and theoretical lenses.”

Summary

Traditional reports represent the product of a process that was influenced by the effective reduction of mechanical failures through investigation and engineering design. Problem solving dominated these mechanical investigations, and improvements were typically supported by statistics and hard sciences like metallurgy, physics, and mathematics. The efficacy of these approaches became embedded in a social narrative that sought solutions to problems in order to restore the system to a state of safe operation (Whitlock et al., 2005). The apparent effectiveness of the methods used in mechanical investigations influenced society to accept both the language and content of these types of reports and the process that generated them, which followed the model of “logical empiricism” (Cooperrider et al., 2008 p. 15; Gergen & Thatchenkery, 2004, pp. 231-232). The sustaining narrative of traditional investigations was “nature is there to be

discovered through detached, value-free, observations and methods" (Cooperrider et al., 2008, p. 15).

"Each society has its regime of truth, its 'general politics' of truth: that is, the types of discourse which it accepts and makes functional as true; the mechanisms and instances that enable one to distinguish true and false statements, the means by which each is sanctioned; the techniques and procedures accorded value in the acquisition of truth; the status of those who are charged with saying what counts as true" (Foucault & Rabinow, 1984, Foucault, 1980).

The traditional "factual" reports often result in the objectification of individuals and by so doing, these reports can harm people. A byproduct of this objectification can be the creation of fear in the society that influences people to be unwilling to share accounts with those who represent the organization. This effectively drives valuable information that can be used to improve safety underground and inhibits dialogue.

A second byproduct of objectification is an unanticipated emergence of communities that challenge the way that truth was created. Truth is not static; what is true for one generation may not be true for the next. Likewise truth is not the same from one perspective to another. As the Colgan Air incident demonstrated, communities can be inspired by the conclusions and language of a report, to arise in a dialogue that is free from the constraints or language inherent in traditional investigations. Once free to explore, they can generate a new narrative that may force a renegotiation of truth. The same is true for the community of investigators who challenged the SAI process and who acted outside the restrictions imposed by the SAIG to freely explore ways to present multiple perspectives and to avoid conclusions of blame, which changed the pattern of narration. "Dialogue, free from constraint of distortion, is necessary to determine the 'nature of things' (social constructionism)" (Cooperrider et al., 2008, p. 15).

This dissertation introduces an organizational response to incidents grounded in constructionist concepts such as the following: relational, multi- centered participatory learning through dialogue, and recognition of the value of highlighting context, and including local knowledge and the perspectives of front line operators. Witnesses, communities of practice, subject matter experts, and leaders are seen as a partners or co-creators in three key ways. First, focus groups, made up of field personnel, are used to co-create the narratives and to build context around decisions and actions. Second, focus groups made up of diverse agents are engaged to create meaningful interventions, which will be offered as recommendations to leadership. Third, we call on the communities of practice to draw their own conclusions from the information presented in learning products, allowing mutual understanding or sensemaking to emerge organically. This is designed to facilitate community engagement in inquiry, dialogue, and sensemaking; which is supported by a major constructionist point: "the idea that a social system creates

or determines its own reality" (Cooperrider et al., 2008). We are moving in the direction of making that a conscious, open, volitional act.

Chapter 11: Summary and Conclusions

Introduction

The overall aim of this dissertation has been to chronicle the transformation and evolution of accident investigation processes in the USDA Forest Service, with an emphasis on the human contribution to events. The journey entails a movement from being centered on finding cause to an approach based on sensemaking and learning. The dissertation is a representation of how the traditional accident investigation model was developed and how it was proactively challenged during investigations. Case studies are used to show how the organizational response to incident and accidents transformed over time. Additional chapters are dedicated to understanding the research trends and academic thoughts on key topics central to understanding the goal of a sensemaking and learning approach. The academic literature is intentionally distributed throughout the dissertation, which places it in context in terms of chronologic flow of its discovery and its historical integration in the development of the new approach to investigation.

The case studies challenged five key assumptions that supported traditional investigations, which are introduced below. Once challenged, Forest Service leadership began a process of reflection that redefined accident prevention in terms of learning. The meaning of learning evolved as Forest Service leadership led a national dialogue called the Safety Engagement Sessions. A collaborative process emerged that included diverse perspectives, community sensemaking, participatory sensemaking, and the co-creation of knowledge.

This chapter summarizes the shift in the five key assumptions and then introduces and explains five key practices that emerged from the research and experience chronicled in the dissertation. I also present recommended areas for further research and my personal conclusions and experiences, which led to my transformation during the course of the research for this dissertation.

Shifting Five Key Assumptions

Five key assumptions bound the Forest Service and investigators such as me to the Serious Accident Investigation Guide. The first assumption is that the past is a key indicator for the future. Second, accidents can be universally represented as causal chains. Third, the best way to improve safety is to control or eliminate error. Fourth, correcting or fixing individual system components, alone, can improve safety. Fifth, complex systems behave in a linear, predictable manner. Each of these assumptions and the challenges that emerged during the transformation are presented in this section.

Assumption 1 – The past is a key indicator for the future. While all accidents have similarities, they are also very different. Each of the case studies used in this dissertation supported a growing recognition in the academic community that uncertainty, or the unexpected, is a natural product of complex adaptive systems (Page, 2011; Morin, 2008; McDaniel, 2005; Weick, 2001). The presence of uncertainty was found to be significant enough to question approaches based on prediction and control of the natural world. Common responses to accidents result in trending, the demand for rote procedural responses and additional regulation and/or the admonishment of personnel, which is often based on the interpretation of a small group of people who are tasked to conduct the investigation (Whitlock et al., 2005). Procedural, step-by-step, techniques work well when the system continues to deliver the expected; however, they cannot address the variability inherent in complex adaptive systems (CAS) that personnel will face in the work environment (Flyvbjerg, Landman, & Schram, 2012; McDaniel, 2007).

Exploring the relevance of complexity and complex adaptive systems research to actual incidents and accidents led to the recognition that unique adaptive responses tailored to the conditions extant in the actual work environment are necessary to deal with uncertainty in the workplace (McDaniel, 2007). Associated with this revelation was that the same adaptations that result in success can also lead to failure, which challenges long held assumptions regarding cause and effect relationships. These challenges indicate that past experience may only have limited applicability to future events and the past will not consistently provide insights into future operations.

The cases also indicate that the analysis of accidents is based on the belief that discrete causes are identifiable, measurable, and controllable. In hindsight, all accidents are preventable simply because we can see more than the participants of the event and can understand that the post-event implications were not so clear, as the event was unfolding. With hindsight it is easy to see what someone should or should not have done. However, this is of little use to the practitioner, unless the exact same conditions can be repeated (Dekker, 2006).

Assumption 2 – Accidents can be universally represented as causal chains. Accidents were assumed to be chains of events where each event was triggered by a preceding action or event (Dekker, 2006; Wiegmann et al., 2001; Reason, 1990; Wood et al., 1995). This assumption seduces investigators to work backward from an accident or incident, in order to identify the accident chain that will lead them to a root cause (Hopkins, 2014; Dekker, 2006; Hollnagel et al., 2006; Hollnagel, 2002; Wiegmann et al., 2001; Wood et al., 1995; Reason, 1990). The case studies indicated that causal chains were not always “there to be discovered.” In the case of simple mechanical failures, the causal chain can often be identified and mapped. However, when the same process was applied to the human contributions, a linear relationship had to be constructed based on the perceptions, guidance, and intent of the investigation team. Teams that used this approach developed

micro-models designed to explain events using hindsight bias and counterfactual arguments (Woods et al., 2010; Dekker 2006; Hollnagel, 2002).

The accidents studied in this dissertation demonstrated that causality was inconsistent. Each event had common conditions, but the conditions had variable influence on the decisions or actions. Each person, as Panther pointed out, also had markedly different perceptions of the conditions, and as a result there were vastly different outcomes. The linear model was further challenged when the ability to predict outcomes was not possible.

In complex systems the factors were better represented as networks or concatenations of complex interactions (Dekker et al., 2011; Morin, 2008; Snook, 2000; Perrow, 1984). The components within these networks were not seen as causal; rather they were viewed as influential, with levels of influence changing as people and conditions changed. The result was the development of a practice to identify conditions that supported actions and decisions. This allowed teams to explore how the same conditions could exist in missions that did not have adverse outcomes.

Assumption 3 – The best way to improve safety is to control or eliminate error. This assumption is based on the ability to clearly and objectively identify error. The Federal Aviation Administration concluded that 70 to 80 percent of all crashes are the result of human error (DOT/FAA/AM-013 2001). Media outlets similarly jump to conclusions about pilot or driver actions when they cover a transportation crash. Blatantly absent in these descriptions are references to the conditions that contributed to or influenced the actions. Just as scientists make claims to the truth, public declarations of cause influence society's conception of truth (Gergen, 2009). This represents the social construction of error associated with accidents. This construction supports an enduring narrative, that error control equals accident reduction or prevention (Reason, 1990).

A thorough review of Forest Service accident reports indicates that error need not be present for an accident to occur. This is supported in other industries, such as Snook's landmark book, "Friendly Fire: The accidental shoot down of US Black Hawks over Northern Iraq (2000)." Error is not only subjective in the case of human interaction with complex adaptive systems; it can also limit or undermine the ability to learn from the event (Pupulidy, 2014, 2015).

The case studies demonstrated that error is not an objective *fact* waiting to be discovered. Perrow (1999) contends that even if a technical failure precedes the human action, "there is a strong tendency to place the blame on human error, inadequate response on the part of the operator, or a failure on the part of the operator to act appropriately." The idea that any of these judgments can occur objectively has been challenged throughout the dissertation. Yet, significant and common societal ascriptions of cause are common. Correspondingly, the idea that actions and decisions alone result in

positive outcomes is also challenged. Chapter 7 of the dissertation explores the various ways this assumption was challenged in the Forest Service and in the academic literature.

Assumption 4 – Correcting or fixing individual system components alone can improve safety. Many accident investigation processes focus on individual components as failed units that need to be replaced or repaired (Dekker, 2006). The case studies indicated that behavior is influenced by the conditions extant in the operational environment. The case studies also pointed to the interaction and interconnection of a greater social network that included legislators, regulators, industry associations, communities of practice, organizational leadership, workers, front line leaders, technical personnel, etc. Correcting or fixing the person involved in the incident based on the perception that the person failed does not consider how the individual arrived at the point of failure. Aside from this language being essentially mechanical in nature, the entire premise assumes that individual behavior is the problem and that correcting it will prevent accidents.

Edgar Schein's work in organizational culture aided the understanding of human actions in this dissertation. Schein (2004) provides a way to view actions as artifacts of deeper influence that include espoused values, beliefs, and deep assumptions. Bill Issacs of Dialogos, in his program "Leadership for Collective Intelligence," offers a derivative of Schein's model to explain organizational reactions, which he calls the "flame model." At the base of the flame is *identity*; moving upward is *tone*, *structure*; and finally at the top of the flame is *action*. Bill teaches that blowing on the flame will move it for as long as you have breath to blow; but when the blowing stops, the flame will move right back to its original position.

These models are valuable in understanding the futility of investigative practices that are designed to change individual performance or behaviors. Simply correcting or fixing the broken person, which is commonly a euphemism for punishing or firing the individual, does not address the deeper assumptions, values, or beliefs that anchor those actions. Punitive actions do nothing to affect the system that supported the actions or decisions. Without identifying and learning how to manage the conditions that supported the actions and decisions, it is virtually guaranteed that the next person placed in those conditions will eventually drift to the same failure in the system.

Assumption 5 – Complex systems behave in a linear, predictable manner. Shifting this assumption required that we recognize the non-linear interdependencies that exist between agents in the system. To date, the focus has been to either make the agents better or to restrict their actions. Forest Service attempts to address conditions, for example, have been limited to the imposition of more rules, regulations, policies, procedures, and physical barriers or to admonish personnel. In many cases, this has added to the complex nature of work or confused otherwise difficult trade-offs between competing goals. The case studies indicated that the identification of conditions and subsequent dialogue facilitate sensemaking in communities of practice, who have a much

deeper understanding of the culture. These communities can then develop ways to address the conditions, as they emerge in the work place. In this way, workers are valued members of a team that includes leadership, guidance, policy, and other stakeholders in a collaborative approach to safety improvement.

While the goal of establishing control over complex systems remains out of reach, understanding of complex adaptive systems is leading to better ways to live with uncertainty, as indicated by the frontier science referred to in the literature as Complex Adaptive System (CAS) (McDaniel, 2007, 2005; Jordan et al., 2009; Morin, 2005; Cilliers, 2001). Morin (2005, p. 45) posits, "In the classical view, when a contradiction appears in reasoning, it is a sign of error. You have to back up and take a different line of reasoning. However, in a complex view, when one arrives via empirical rational means at contradictions, this points to the fact that we have reached a deep layer of reality that, precisely because of its depth, cannot be translated to our logic." In this quote Morin creates a bridge between the constructionist and complexity academic dialogues. Morin (2005) strengthens this bridge when he differentiates between two forms of Complexity theory "restricted" and "general." Morin (2005) elaborates that restricted complexity remains within the epistemology of classical science. General complexity requires an epistemological rethinking and a paradigmatic shift from reductionist, simplification and controls common in the natural sciences, to a form of complexity that "requires one to comprehend the relations between the whole and the parts" (Morin, 2005).

Morin (2005) further refines his view of complexity as a pragmatic approach to the construction of knowledge. He proposes four key ways to foster creativity in an approach that he calls "Transdisciplinary":

1. A focus that is *inquiry-driven* rather than discipline driven. This in no way involves a rejection of disciplinary knowledge, but the development of knowledge that is pertinent to the inquiry for the purposes of action in the world.

2. A stress on *the construction of knowledge* through an appreciation of the *meta-paradigmatic* dimension – in other words, the underlying assumptions that for the paradigm through which disciplines and perspectives construct knowledge, Disciplinary knowledge generally does not question its paradigmatic assumptions.

3. An understanding of *the organizational knowledge*, isomorphic at the cognitive and institutional level, the history of reduction and disjunction (simple thought) and the importance of contextualization and connection (what Morin calls complex thought).

4. The *integration of the knower in the process of inquiry*, which means that rather than attempting to eliminate the knower, the effort becomes one of acknowledging and making transparent the knower's assumptions and the process through which s/he constructs knowledge.

This dissertation has led to the recognition of a bridge between social constructionism and CAS through recognition of the importance of relationships that is strongly reflected in general complexity as described by Morin (2005). CAS posits that relationships and contexts of an organization can influence conversational possibilities (Jordan et al., 2009; McDaniel, 2007). The tie between CAS and constructionist ideas is clearly indicated by Jordan (2009):

> The generation of productive conversation should be considered as one of the foundations of intervention efforts. We suggest that intervention facilitators consider the following actions as strategies for reducing the barriers that conversation can present and for using conversation to leverage improvement change: evaluate existing conversation and relationship systems, look for and leverage unexpected conversation, create time and space where conversation can unfold, use conversation to help people manage uncertainty, use conversation to help reorganize relationships, and build social interaction competence.

CAS research also adds to the term "relationships" when it is applied to the assessment of the human contribution to incidents. McDaniel (2007) states that CAS exhibit the following characteristics: "1. Diverse agents that learn; 2. that interact with each other in nonlinear ways; and therefore, 3. self-organize; 4. have emergent properties; and 5. co-evolve with the environment." From this description, we can conclude that humans and organization are considered to be complex adaptive systems (McDaniel, 2007).

The concept of relationships in CAS includes the components of the system that are nonlinearly interdependent. Relationships between agents become a central focus for understanding and working in CAS (Jordan et al., 2009; McDaniel, 2007). This is comparable to the descriptions of the conditions that support decisions and actions as demonstrated in the Saddleback case study. The case studies also demonstrated that sensemaking is a key way to begin to understand the nonlinear relationships between components. Sensemaking is a social act and the quality of sensemaking is highly dependent on the nonlinear relationships among the agents in the system (Weick, 2001, 1995; Weick & Sutcliff, 2001).

Transformational Practices

Five transformational practices were developed through the case studies used in this dissertation and are described in detail below.

- The importance of placing actions and decisions in context, including the conditions that influenced decisions and actions.
- Focus groups extend the level of understanding of context beyond the abilities of an accident investigation team.
- Multiple learning products designed for specific audiences replaced traditional one-size-fits-all accident investigation reports.
- Community sensemaking became a valued aspect of the investigative process. Community sensemaking can occur when a community of practice and subject matter experts are included in participatory research.
- Immersive sensemaking occurs when readers, or practitioners, make sense of the information presented in learning products and add to that information with personal experience, to create meaning or significance.

Each of the case studies furthered the understanding of these key transformational practices. Norcross and Panther contributed to the understanding of context. The Colgan Air case helped to highlight the importance of community and immersive sensemaking. Saddleback explored the use of focus groups and multiple learning products. Each key practice has the potential to improve the products of a review. However, they are considered to be most effective when used in conjunction with each other.

These practices differ from traditional accident investigative processes in four distinct ways. First, they are inclusive in the way that they gather and deliver information. Second, they acknowledge that the information and expertise existing throughout the organization can be valuable to the analysis of the incident. Third, they recognize the differences in the needs of learners, by presenting information developed for specific audiences. Fourth, the overarching goal of the Learning Review is not to answer specific questions or develop ways to correct and/or fix the organization or the people in the organization. If corrections and fixes emerge during the review, then the process is equipped to include them in the recommendations.

Key Practice 1 – The importance of placing actions and decisions in context. The case studies indicated the importance of considering environmental, organizational, and cultural influences that were extant in the entire system. Norcross, for example, explored the conditions associated with “errors, weaknesses and actions,” which was consistent with much of the research available to the team (Wiegmann et al., 2000; Reason, 1997; Reason et al., 1995; Reason, 1990). The largest academic influences on Norcross were in the field of Human Factors. The published work of James Reason and coaching of Najmedin Meshkati, who was hired as a consultant to the investigation, were central to

the investigation. At the time, the common view of accident investigation was centered on finding and fixing holes in the "Swiss-cheese" (Wiegmann et al., 2000; Reason, 1997). Finding ways to communicate conditions that influenced actions and decisions without causal ascription or blame was a significant and markedly different than the model suggested by the SAIG. Norcross opened inquiry regarding the importance of context, which was tied directly to the conditions that supported decisions and actions. One additional realization in Norcross was that conditions did not all have the same value; each could have a strong influence that appeared causal in some cases while in others the same condition could have no apparent effect. The application of conditions was still somewhat linear in Norcross, as the interaction and interdependence *between* conditions was not fully considered.

In Panther, context was expressed in terms of conditions, which began to see conditions as being interrelated and interdependent. Conditions could be viewed as having different values for different individuals, and this brought to light the concept of a complex network of influence. Early attempts to capture this were exhibited through sticky notes placed on a three-foot tall continuous piece of paper on a wall. Each sticky note represented a condition and these were arranged around key decisions or actions, making the interrelationship and interconnection graphically more obvious. However, capturing this idea as a practice was difficult to articulate in a report, and I began to recognize that investigations, especially those with a substantial need for human factors analysis, were more of an art than a science.

At the time of Panther, most of the accident literature was focused on the categorization of error, perhaps best represented by the Human Factors Analysis and Classification System (HFACS) introduced by Wiegmann and Shappell (2000). Human factors accident investigation training and the Serious Accident Investigation Guide (SAIG) were focused on the application of this product for the determination of cause. "The challenge for accident investigators and analysts alike is how best to identify and mitigate the causal sequence of events, in particular that 70-to-80 percent associated with human error" (Wiegmann et al., 2006, p. 6). This "war on human error" was in vogue and HFACS was able to reduce a complex problem into simple categories, designed to detect the holes in the "Swiss cheese" and to create barriers to defend against breaches in the layers of defense (Wiegmann et al., 2006). By the time that I was engaged in the Panther accident investigation, I had abandoned HFACS and was able to focus attention on techniques designed to capture the conditions of influence, especially those present in the operational environment.

The traditional accident investigative model is not completely unusable. For example, where there is a linear causal relationship, such as in simple or complicated mechanical systems, it should be used. However, research shows that complex systems (such as those involving human interaction) rarely exhibit direct cause-effect relationships, and as a result there is a need to capture multiple non-linear influences on actions. This means

that it is equally important to consider the conditions that are associated with actions rather than simply listing the items that we believe triggered an event.

Key Practice 2 – The importance of focus groups to develop understanding. A small group, like an accident investigation team, often has a hard time developing an understanding that results in meaningful recommendations. Issues that are important to the community of practice can be overlooked. Community members may only air this information after the report is released, which is commonly in the form of a critique of the investigative process. Teams are also limited by their own biases, prejudices, experience, and knowledge.

During the accident investigations used as case studies, some of the conditions experienced by those involved in the accident could be captured, if there were survivors who were willing to tell their stories and the investigation team was willing to listen. However, there was a large body of information that was available in the community that was often overlooked because there was no mechanism to capture or include information that existed outside the incident.

Rather than taking great pains to keep the report secret until it was released, I began to share the narrative with people I trusted or with the participants involved in the event. The wider the circle, the more perspectives and conditions the team was able to capture. At some point, the increasing number of people brought into dialogue received the label of *focus groups*. The perspectives captured during focus group interactions were included in the reports. When this information was presented to Forest Service leadership, the interconnected nature of conditions helped to develop an understanding of the goal conflicts being faced each day during normal work.

The multiple perspectives technique was more fully developed in Saddleback, where key decisions were mapped using a computer program that produced an image of the conditions that had influenced decisions and actions. This visual map, later called the *Network of Influence Map,* was then used as a starting point for dialogue with each subsequent focus group, expanding the understanding of the network of influencing conditions.

The *Network of Influence Map* developed for Saddleback was the outgrowth of five focus group interactions. The resulting map was similar to Snook's "Causal Map" (Snook, 2000, p. 21) and it served a similar role. The *Causal Map* in Snook (2000) helped readers to understand the complex network of confusing and affirming influencing conditions from multiple perspectives. In much the same way, the "*Network of Influence Map*" (see figure 9.4) is designed to provide the same insight to the readers of the learning products produced by the Saddleback Learning Review. Developing ways to identify and

communicate conditions became a fundamental practice in the Learning Review Process.[77]

Key Practice 3 – Multiple Learning Products. Traditional investigations resulted in the creation of a single report. These reports were described as meeting the various needs of the organization, for the purpose of prevention (Whitlock et al., 2005). These reports typically contained a "factual section made up of an executive summary; narrative; findings; causal and contributing factors; and appropriate appendixes" (Whitlock et al., 2005). The format and content supported the assumption that data is observable, measurable, recordable, and meaningful. However, in most cases the meaning is created by the investigation team and legitimized by the organization. Once traditional reports were released, it was believed that these reports represented a definitive explanation of events and corrective actions that would restore the system to safe operation.

The multiple learning product approach is based on the need to offer more to the community than an explanation of an event and corresponding corrective actions. The design and content of learning products can emanate from any combination of focus groups and academic specialists. The presentation of information can take any form that facilitates dialogue in the target audience. While it may seem trite, the idea is to leave the audience with questions rather than trying to resolve them. The principle goal of a learning product is to elicit dialogue and allow sensemaking to occur organically.

Accidents were no longer seen as adverse events that we had to put behind us; instead, we borrowed from the concept of the Army Staff Ride and used accidents as learning opportunities that we could continue to revisit for new insights. Single accident investigation reports were replaced with multiple learning products, each designed for a specific audience. This concept emerged during the early development of the Learning Review process and was introduced in the national focus groups discussed in Chapter 8. The concept was converted into practice in Saddleback, where an organizational learning report, a field learning product, two video products, and a facilitation guide were developed and released. This concept was included in the final Learning Review Guide, which was approved by the Chief of the Forest Service in 2013.

Sensemaking was seen as the major goal of the investigative process on two levels. First, the team had to make sense of the information and narratives through the expertise represented in focus groups; this became *Community Sensemaking*. Second, the team had to create documents or multimedia products that supported sensemaking for the different audiences that would read or view it; this *Immersive Sensemaking* became a fundamental goal of the Learning Review process.

[77] The Learning Review Guide replaced the Serious Accident Investigation Guide (SAIG) in 2013 for all Forest Service responses to serious accidents.

Key Practice 4 – Community Sensemaking. The concept of focus groups is enhanced by considering the role that practitioners have in sensemaking. This concept began with the recognition of the role that the community played in learning from the Colgan Air disaster. An impromptu community formed, made up of people who had an interest in prevention. They entered into an open dialogue, regarding what could be learned from the event. They were not trained in accident investigation, and at least in part, they were not constrained by models of investigation that could channel their inquiry. The blend of open dialogue between practitioners, academics, and subject-matter experts resulted in a different kind of learning and recommendations than had been achieved by the traditional process.

The quality of open dialogue and freedom to ask any question exhibited by the Colgan survivors is captured in the concept of community sensemaking. This process engages a mix of specialists, practitioners, and potentially stakeholders to develop a deeper understanding of the context surrounding the incident. The information and perspectives of this interaction guide the understanding of the event from multiple perspectives. The information, learning, knowledge, and perspectives are used to develop learning products.

Key Practice 5 – Immersive Sensemaking. This concept involves placing people in a position where they can develop their own understanding of the event and make sense of it from their perspectives. Immersive sensemaking is the major goal of the learning products. Communities and individuals are presented with information including a narrative of the event that represents multiple perspectives, recorded information, technical reports, the conditions that seemed to support decisions/actions (context), and any raw information discovered during the review.

The purpose of this type of un-judged presentation is to allow the reader/learner to make sense of the connections, interdependencies, innovations, influences (positive or negative), adaptations, etc. Learners are encouraged to discuss, role-play, and bring in other information or expertise in an effort to organically explore why it may have made sense to those involved in the accident to do what they did. With this understanding they are ready to design applicable learning products based on their interactions. Learning products represent a form of raw information that communities can use to create their own knowledge, practices, and/or heightened awareness for improved performance.

Unlike previous investigations, the concepts of inquiry, learning, and sensemaking were intentionally extended beyond the investigation team and the final report. Groups and individuals are encouraged to explore the creation of meaning and knowledge through immersive sensemaking. This includes both practitioners and leadership. Some groups demanded that answers be provided to questions like: Why were they there? Or why didn’t they finish scouting the line? The value of questions like these may be greatest when not answered by an authoritative process. For years, we had been creating

organizational answers that were much like the conclusions drawn by the NTSB, following the Colgan Air tragedy. Thus, the workforce had come to disregard the conclusions made by accident investigation teams, instead focusing most of their attention on the narrative and engaging in their own interpretations. This observation was critical to understanding the need for immersive sensemaking and for its inclusion as a practice.

Communities emerge in dialogue to make sense of event that surprises them (Weick, 1995). This occurs naturally as it did in the Colgan Air example. Tailoring the presentation of information so that readers/users can build their own understanding facilitates is what I call immersive sensemaking. Immersive sensemaking facilitates learning from the event by allowing individuals to use their own experiences to make sense of the narrative, add to the pool of inquiry, and develop their own ideas of how to apply lessons learned.

The five key practices were folded into the Learning Review Guide. The overall design of the guide is to help investigators develop learning products for two specific audiences: organizational leadership and field personnel. Each of these audiences has different power and authority to enact change, to develop a safer work environment. Each audience also has different questions and needs different information to make sense of their complex work environment. In simple terms, this means that we should be willing to create multiple learning products based on the information gathered during the review. We must also address the specific needs of the audiences affected by those products.

Implications for Further Research

This study was designed to develop new techniques for incident review, which are quite different than traditional modes of investigation. It is not, however, the end of the discussion. The review of incidents is a developing art, which in some cases has to be blended with traditional science, where traditional science is just one of the voices in the sensemaking process. This blend will assuredly result in competition between traditional modes of scientific investigation and non-traditional efforts to understand why it made sense for people to do what they did. There will likely always be a need for improvement in either the process or the blending of processes.

Five areas of additional research became apparent during the research for this dissertation. First, there is an expressed need from leadership to understand if investigative processes have been effective. More research is needed to understand how to capture organizational and individual learning from events and how that learning may translate into safer operations. Second, more research is needed to evaluate practices that enhance adult learning. A core issue is the effective use of modern multimedia approaches for the dissemination of information that can facilitate immersive sensemaking. Third, the research and case studies indicated that Forest Service systems are dynamic and experience nonlinear changes as people interact with the system. Research might include a focused study regarding what organizations can learn about

performance improvement in a complex adaptive system. Such a study could assess the following:

- What aspects of the organization or culture serve to constrain relationships?
- What affects relationships at different organizational levels?
- What practices could improve the quality of performance and how they could be assessed or measured (The assessment suggested here could be grounded in a sensemaking approach rather than traditional measurements, which have questionable efficacy)?

Fourth, most performance metrics are related to production or goal accomplishment. Failures, when tied to this same metric, can result in a focus of energy and attention on learning from adverse outcome events. More research is needed to study positive or neutral outcome events instead of giving all the attention to negative outcome events. Positive/neutral events occur more often and thus present more opportunities to learn. They may also be less influenced by biases, which seem to become more apparent when investigators are faced with extremely stressful events, like the loss of human life.

The fifth area of new research is to address the efficacy of developing recommendations based on single adverse outcome event. Each accident represents a single data point (snapshot in time) of system function, in a complex adaptive system. To get a more complete picture, we need to look at multiple serious accidents, non-serious incidents, and even normal work events. This could be a pathway to what Weick (1995, p. 170) describes as “Generic Sensemaking.” The requirement for recommendations in accident reviews reflects the organization’s desire to restore or maintain “control over disbursed resource, legitimacy in the eyes of stakeholders, measurable outcomes and accountability” (Weick, 1995). Recommendations are likely to remain an artifact of organizational culture. To meet this need in a more meaningful way, research is needed to develop methods of comparison between events, regardless of outcome. Initial forays have demonstrated the importance of this kind of comparative data (see Appendix 1 Tree Strike Fatality table); however, more dedicated research is needed to develop consistent evaluative processes.

Personal Reflections

People naturally have a need to construct cause around events, which I began to see as detrimental to learning and thus accident prevention. Building context open social forums appeared to disrupt this natural tendency by adding new voices and perspectives. The ability to share and make sense of concepts requires relationships that are built largely on trust. Relationships between agents are critical to improving the organization and the individual. However, our traditional focus has been to find ways to make the agents

better, often through coercive or manipulative methods, and the overarching system is largely left alone.

Through my introduction to social construction, I was immediately able to see the judgment-laden language and content of our organizationally accepted accident investigation process. We were constructing simple answers to wicked problems that often blamed the dead for their own misdeeds. This was based on both individual and organizational assumptions. I recognized that if we wanted a better process, one that built trust, we would have to start by building relationships.

The organizational response to incidents is only part of building the capacity of the organization to learn. The case studies pointed out five areas where performance could be improved: improvisation, sensemaking, collaboration, communication, and learning.

What this means to me is that there is a need to facilitate understanding and encourage sensemaking that is tied to the development of relationships. Relationships can be seen in the more technical sense as social contracts, and in a more personal sense, they are a reflection of trust: trust in each other and in the agents of the system. From the perspective of complex systems, relationships are a function of interconnected, interactive, and interrelated agents that we contact within the system. These relationships are nestled in context and based on trust.

A considerable part of this dissertation is focused on the importance of context. Rather than limiting context to the discovery of facts, this dissertation recognizes the importance of dialogue-based practices that open inquiry to more people. Included in the dissertation are five practices designed to improve the organizational response to incidents or accidents. Understanding the influence of context in everyday operations is equally, if not more, important. For example, the exploration of relationships within organizations includes a study of influencing factors that can enhance or inhibit sensemaking, improvisation, learning, dialogue, and ultimately trust.

Edgar Schein (2013) posits that building relationships and trust is a function of humble inquiry. Exploring this concept with Ed in conversation, I found a profound link to social construction, appreciative inquiry, and complex adaptive systems. Each of these fields recognized the importance of humble inquiry, heedful interaction, mindfulness, respect for the ideas of others, and understanding in concert with explanation. Flyvbjerg (2012, p. 22) makes the tie to the origin of social science, as he points to the need for understanding, as expressed by Max Weber. “The debates that preoccupied Weber and his colleagues were framed in terms of whether social science ought to be more about *erklären (explanation)* or *verstehen (understanding)*…interpretive approaches emphasize that it is more important to try to arrive a understanding how the social world is subjectively experienced and interpreted by people than it is to provide an explanation of what caused social phenomena to happen.” This understanding builds an enduring tie

between the conclusion of this dissertation, social science, and social constructionism. It establishes that the primary goal of each of these is to build the capacity for understanding rather than just provide an explanation.

Complex Adaptive System Theory (CAS) offers a way to frame this opportunity around recognizing the importance of relationships that enhance the capacity of the organization to learn. Relationships like these emerged as a central conclusion of the dissertation. Both social construction and complex adaptive system theory recognize and support the importance of relationships. “My ability to learn is dependent on your ability to learn” (McDaniel, 2015). This is consistent with Gergen (1994): “Constructionism replaces the individual with the relationship as the locus of knowledge.” Sensemaking and meaning are tied to each other through relationships as McDaniel (2015) asserts that relationship between complex agents is key to understanding and sensemaking and Gergen (1994) ties meaning to relationship “Words take on their meaning only within the context of ongoing relationships.”

For me, the organizational response to incidents became part of a larger network of cultural influences. Many of the conditions that influence decisions and actions are embedded in the organizational culture and the interdependence of agents in the system. I discovered that the same conditions could influence our ability or willingness to learn and to share what we have learned. Safer work environments in complex adaptive systems are possible if we continually learn and improve practices that improve our capacity for learning, compassion, improvisation, sharing, vulnerability, and sensemaking. We can achieve this through dialogue that emerges from relationships built on trust while simultaneously understanding the limits of our control over the natural world.

Postscript

Evaluation or Valuation

This dissertation explored a gap between traditional evaluative approaches that judge actions/decisions and an appreciative construct that strives to understand actions/decisions in context. The conclusions do not intend to exclude evaluative practices, as they do have a place in the organizational review of incidents and accidents. In Norcross, for example, a thorough evaluation of the aircraft was needed to ensure that mechanical failure could be ruled out. The evaluation of the social contribution to incidents is more difficult, due to the implications of causality with respect to blame.

It is not unreasonable to expect that the actions of individuals must be both explained and understood. The explanation phase is important to sensemaking in terms of recognizing if actions/decisions were inconsistent with established standards of performance or to establish if such standards existed at all. This, however, has been the stopping point of most traditional processes, leaving the investigator in position of having

to evaluate the actions. The result is a judgment of actions and decisions, which can be significantly influenced by outcome and societally induced biases. Understanding the actions/decisions in context is a function of making sense of the interdependencies and relationships between multiple adaptive agents, which have the ability to influence actions/decisions (reflected in the network of influence maps).

There is an enduring belief that safe system function is dependent upon compliance with rules, regulations, maxims, and guidelines. This challenges no-blame investigative processes to prove that prevention can be achieved through other means, such as learning. The driving force behind this challenge is the assumption that a cause-effect relationship exists between the actions/decisions and the outcomes of the events.

Support for this causal relationship emerges as we recognize that systems are not exclusively simple, complicated, or complex. Simple systems are only simple. Complicated systems can have simple components. However, complex systems can be a composite of all three systems. All three systems need to be recognized and addressed in order to make the overall system safer. However, misapplication of the cause-effect model can result in unnecessary damage to relationships within the organization. This damage is often seen as a lack of trust in the system, or on occasion, outright distrust of the leadership of the organization.

Recognizing the way evaluative practices have emerged in society is reflected in reviewing synonyms commonly associated with the word evaluation; assessment, appraisal, judgment, gauging, rating, estimation, consideration; analysis, examination, checkup, workup, test, review. There is a growing intuitive sense that there is more to events than reductive methods can deliver, which is common to that which is broken. What we have come to recognize is the value of multiple perspectives, context and dialogue that facilitate our ability to suspend judgment, which creates the space for learning to occur.

Evaluation of a system can be a function of gathering statistical information, evidence, causal factors, etc., with the express purpose of scrutinizing and judging their effect on performance. In simple and complicated systems, judgment can be fruitful and accurate. For example, when a mechanical flaw is detected, it can be eliminated in production or design. Complex systems may not benefit from this approach. The cause-effect relationship is inconsistent at best, and judgment of action is almost always biased in some way. Judgment in complex systems has been shown to result in a focus on individual behaviors and ultimately on the individuals themselves (see figure 11.1).

The reductionist methodology central to evaluative processes separates agents of the system from each other. Coupled with the judgment inherent in the approach, the relationships between active and inactive agents in complex systems can be obscured.

Valuation	**Evaluation**
Dialogue and Story	*Facts and Data*
Reflection & Learning	*Correcting and Fixing*
System Interdependencies	*Focus on Individual Performance*
Understanding	*Explaining/Judging*
Context Rich	*Isolated Findings*
Multiple Perspectives	*Singular Perspective*

Figure11.1 Valuation vs. Evaluation Comparison.

This dissertation has demonstrated a history of evaluation of individual performance following accidents and/or incidents, where people were described as part of a causal chain, often as the weak link that had to be corrected or fixed. The individual and organizational costs associated with this practice have also been described (e.g. trust, sharing information, dialogue, etc.). These costs, it has been posited, have had deleterious effect on improving operational safety.

Afterword

Historically, accident investigation processes focused on the creation of "factual" reports and recommendations based on “findings of fact.” This analytical and technical approach is often based on procedures and models that restrict the participant’s narrative, in order to find a single truth that can be resolved. As demonstrated throughout the dissertation, discovery of a single truth only works as long as the system being analyzed is simple, or complicated and this often results in a technical report or analysis. The Learning Review process does not exclude technical analysis; however, it is specifically designed to explore ways to understand human actions in complex systems. The Learning Review does this by exploring questions about what is "true" rather than judging what is true. Socially our truths and facts are often given meaning from individual perceptions and specific settings. As a result, the truths and facts are contextual, and the discussion must move from the evaluation of actions to the conditions that supported or influenced those actions.

Latour and Woolgar (1979) have shown that cultural norms and social practices often determine which ideas become accepted as facts. The Learning Review process encourages the community of practice to explore the event through collaborative sensemaking in order to understand what influenced action/decisions. This approach involves all the readers of reports and/or the users of learning products in a form of situated learning that is specifically designed to inspire dialogue (Cottor, Asher, Levin & Weiser 2004), which is substantively different than traditional models.

The Learning Review shifts the focus to an adaptive learning model (Tyre & von Hippel, 2013). Adaptive learning uses situational context, or the physical setting, to provide a perspective from which people can learn. "Learner's physical context, although often overlooked as mundane detail, is in fact a critical and poorly understood component of adaptive learning processes in organizations" (Tyre & von Hippel, 2013, p.71).

One main reason for this shift in the approach to accident investigation was exposed during the review of the Colgan Air accident investigation and stakeholder response. People willingly engaged in sensemaking, even though the technical report was remarkably complete. Additionally, people from diverse backgrounds self-organized to offer solutions and approaches that any accident investigation team would be challenged to develop. The Learning Review, by design, recognizes the importance of a collaborative exploration of information and creation of meaning through community sensemaking.

Learning is not limited to understanding what to do - or not do, given a specific set of conditions, mainly because it is unlikely that the set of conditions will ever repeat in the same way. Therefore, some aspect of learning must be focused on recognizing when other prevention barriers and systems are failing, or have failed. Many systems refer to this as the "stop-work" policy. It is easy to establish a stop-work policy for known conditions; however, in complex systems workers do not believe that their actions will result in an adverse outcome, or they would stop work (Dekker, 2002). Kahneman (2011) and Flyvbjerg (2001) indicate that highly experienced personnel are more adept at recognizing hazardous conditions and demonstrate an increased capacity to determine when to stop, reflect and change actions. Based on this realization, the definition of learning is expanded to include the development of knowledge that leads to increasing the capacity to recognize changes in conditions.

Learning Review Applied to Non-fatal Events

The Learning Review has been applied to several fatality events; however, the process was also applied to a non-fatal incident that involved the theft of a laptop computer containing personally identifiable information (PII) for over 30,000 USFS employees. The concept of learning from events transcends all levels of the organization. However, all levels have to be willing to learn. In the case of the stolen laptop, the learning products were most applicable to the leadership of the organization. Because the Laptop Learning

Review was so different, with regard to application it is important to explain the efficacy of the Learning Review approach in this situation.

In September of 2014, a Forest Service employee was scheduled for knee surgery. His particular job skill was related to providing approval for supervisors to access employee time and attendance (T&A) records. This access allows supervisors to approve T&As so that employees can be paid. No one else in the office had access to the data or system knowledge required to perform this task.

Voluntarily, the employee offered to take his Forest Service laptop computer home and to continue doing his job during sick leave. He was well aware of the potential adverse consequences others might face if their supervisors could not access the T&A approval site. On the way home from work, the employee stopped for an appointment. He locked his pickup truck in a public parking lot, with the laptop in a backpack on the floor behind the driver's seat. He had covered the bag, so it was not visible through the windows of his truck.

When the employee emerged from his appointment, he found that his vehicle had been broken into and the backpack (including the laptop) was gone. He called the police and his supervisor to report the incident.

Many said that this was an obvious problem that should have been addressed long before this incident occurred. However, we found that this entire division of the Forest Service was operating on the same small margin. Staffing was described as being "one-deep," indicating there was no redundancy in staffing. This meant that only one person on the staff was qualified to conduct critical pay related system updates and data transfers. Well-intended and dedicated employees characteristically used personal time to ensure that the system functioned without catastrophic failure, which is an excellent example of how safety is created at the point of work.

The preliminary information provided a fairly clear image of the "holes in the Swiss-cheese" and it would have been really easy to blame someone for allowing the system to become so fragile. Yet, this approach would likely have focused attention on the individual position that suffered the loss and we would have missed the larger network vulnerability.

The Learning Review process allowed us to approach the situation by asking, "why it made sense" for the system to be in the condition that we observed. We did not find negligent people acting recklessly, without regard for the safety of information. Nor did we find that people were they cavalier about their approach to system safety or risk. Rather, we found a group of people who had normalized what must have seemed to be small risks at the time, in order to ensure that the work got done in the face of ever-

shrinking budgets and staffing. The system worked, until it didn't. There were no small failures that could serve as indicators of a larger impending disaster.

The organization tried to default to the traditional, "human error" approach to incident analysis, before the Learning Review was organized. The conduct of the individual who lost the laptop was questioned immediately, which resulted in the initiation of a misconduct investigation. Fixes were offered, almost as quickly. These fixes were created without input from front line employees and no attempt was made to understand how the system had drifted to this point. It became evident that the Learning Review process would help to develop an understanding of organizational drift and the conditions that influenced it.

The first focus group dialogues centered on two things: First, the pervasiveness of the issues surrounding workload and life balance. Second, identify interventions, which were developed at the local level, to reduce organizational vulnerabilities that could result in data loss. The second focus groups began to explore why it had become an accepted practice to be only "one-deep" in critical positions (senior level leaders were included in this focus group). Long-term systemic improvement became the central topic for the last series of focus group dialogues; these groups were made up of a mixture of senior leaders and front line workers, along with their supervisors.

The result was a combination of additional barriers and prevention strategies (fixes) alongside an enhanced understanding of the workforce and leadership pressures. As leaders became more aware of the local pressures that were exerted over years of drift and demands to do more with less, they also began to realize how workers had made sacrifices and created innovations to avert or prevent catastrophic failures. Many of these innovations became key ways to improve the system and once they were recognized, listed as recommendations and implemented.

Leaders began to ask meaningful questions that were perceived to be genuine and a trust relationship began to form. This relationship started with the small group of employees who were directly responsible for the T&A process and grew to the 300+ employees of the Human Relations (HR) group. Leadership held a "safety stand-down" to inform all the HR employees about what was emerging from the Learning Review. Though this may seem like a common practice, they did something that was unusual – they asked the HR employees if they thought the process was on track and if it was serving employee needs.

The last of these employee/leader sessions was largely dedicated to informing the HR employees about the status of the large pool of recommendations. I gave a short talk about the process and mentioned that the recommendations were derived from input from the HR community, primarily from those closest to the work. I also informed them that no one was punished or shamed in the course of the Learning Review.

A supervisor from HR came up to me after the session. She bluntly stated that she felt that I was wrong and that people were still being punished. She proceeded to explain that she had been forced to give letters of reprimand to personnel in her staff, who had made mistakes that resulted in a data breach. I asked if the incidents were recent—specifically, after the release of this Learning Review. She immediately replied, "I gave a letter of reprimand to one of my employees just this morning, just before this meeting."

The senior leader who convened the meeting was on the other side of the room, and we approached her. The supervisor explained the story, and the senior leader said, "If we are going to learn from mistakes, this is a good place to start." Within hours she initiated a process to revoke all letters of reprimand associated with data breaches, going back two years. The letters of reprimand were replaced with letters of apology. In addition, she began a process of learning by asking those who were involved in data breaches, as well as other interested personnel, to participate in focus group discussions to help identify system vulnerabilities and mitigations that could prevent further data breaches.

Organizations Can Change – An Example of Transformation

Correcting and fixing problems is an important part of addressing any complex system, mainly because complex systems include some components that are simple or complicated. What we realized though this transformation is that learning has to be recognized as a mitigation tool, and it must take place at multiple levels of the organization.

Learning is also being re-defined during this transformation. For example, learning now includes understanding how to approach complexity and the associated uncertainty, both locally and organizationally. This has resulted in a number of practices and experiments, like Margin, which is designed to help us to recognize changes in the system as they are occurring. This learning is not limited post-incident (or after-action) reviews and now includes how we can learn before, during, and after work.

Each case study, along with my personal operational experience, demonstrated that when humans encounter complex systems they must go beyond specific techniques, types of equipment, technical enhancements, or policy improvements. We have to adapt to changes as they are perceived. Success and improvement depend on three critical, related theoretical activities of adaptation: sensemaking, learning, and Improvisation.

The Forest Service transformation is ongoing. There are still people throughout the organization who want to hold people accountable for errors and mistakes. There are still those who find the old agentive language of blame necessary. However, there is emerging support for a different approach. This was summed up in a video presentation given by the Chief of the Forest Service when he introduced the Learning Review to the organization:

Throughout my Forest Service career I have placed a special emphasis on our attention to safe work practices. As your Chief, I am compelled to do everything possible to ensure that you are appropriately equipped to safely work in the complex work environments you face. I want you to feel positive about coming to work every day. I want you to know that nothing is more important to me than having each of you return home safely at the end of each workday. However, when accidents do happen, our organization's response does affect both our employee morale and our future safety. We must learn everything we can from events to prevent recurrence.

Our past efforts to prevent or reduce serious incidents, including fatalities, have not always been as effective as intended. Even though we've always stressed safety, our fatality frequency rates remained unchanged for 40 years. This is one of the key reasons why we decided to look into how the Forest Service culture was maybe a factor, and as a result, we committed to our safety journey.

Serious accidents and fatalities, they bring sorrow and hardship to families colleagues and other loved ones that are left behind. In addition we have come to realize that witnesses, and others close to the incident, can unintentionally be harmed by our current accident investigation and response processes. Therefore we have developed a strategy, designed to minimize the negative impact of our accident review methods on survivors and on witnesses. It essential that we consider these effects as we gather the necessary information needed to fully understand and learn from the incident.

This effort called a Coordinated Response Protocol, CRP for short, represents basic changes in how the Forest Service responds to and learns from tragic events. The CRP uses pre-trained response team members who work to lessen potential future harm to our employees. By design, this process takes every opportunity to minimize the number of interviews our personnel are exposed to as well as control access to her employees as much as possible.

Another important CRP component is the Learning Review, which replaces the serious accident investigation process. The Learning Review will collect information to help create learning products to support our ability to learn from the event. Learning Review information will not be used as a basis for

disciplinary action or to place blame on employees. I cannot stress this enough the Learning Review is about learning, it's about understanding what happened so if possible we can make changes to produce a different outcome in the future. We owe it to those who make the ultimate sacrifice, to honor their service by learning everything we can (Tidwell, 2013).

Bibliography of References

Abramson, L. Y., Seligman, M. E., & Teasdale, J. D. (1978). "Learned helplessness in humans: Critique and reformulation," *Journal of Abnormal Psychology*, 87(1),49-74.

Adams, J. (1995). *Risk*, Oxen, England: Routledge.

Always Remember Web site - All Incidents. Retrieved from http://www.wlfalwaysremember.org/incident-lists/all-incidents.html

Amalberti, R. (2001). "The paradoxes of almost safe transportation systems," *Safety Science*, 37(2), 109-126.

Anderson, R. A., & McDaniel, Jr., R. R. (2000). "Managing health care organizations: Where professionalism meets complexity science," *Health Care Management Review*, 25, 1: 83–92.

Box, G. E. P., & Draper, N. R. (1987). *Empirical Model-Building and Response Surfaces*, New York: Wiley.

Boyd, J. R. (1987). *A disclosure on Winning and Losing*, US Air Force Leadership Training Manual, Maxwell Air Force Base, Alabama.

Bramwell, L. (2012). 1911 Weeks Act: the legislation that nationalized the US Forest Service, *Journal of Energy and Natural Resources Law*, 30, 325-336.

Brauneis, K. (2002). (1937). *Blackwater Fire investigation: Boost for smokejumpers?* (including: Blackwater Fire Investigation Report) [reprinted], *Fire Management Today*, v. 62, no. 2, p. 24-26. http://www.fs.fed.us/fire/fmt/fmt_pdfs/fmt62-2.pdf

Busch, F. (2003). "Telling stories," *Journal of the American Psychoanalytic Association*, 51, 25-42.

Byrne, D. (1998). *Complexity theory and the social sciences: An introduction,* London and New York: Routledge.

Cilliers, P. (2005). "Complexity, deconstruction and relativism," *Theory, Culture & Society.* 22 (5), 255–267.

Cilliers, P. (2001). "Boundaries, Hierarchies and Networks in Complex Systems," *International Journal of Innovation Management*, Vol. 5 No.2, pp. 135-147.

Clark, C., & Rossiter, M. (2008). "Narrative learning in adulthood," *ACE New Directions for Adult and Continuing Education*, 61-70.

Congress, United States 107th. (2002, July 24). *Public Law 107-203,* Retrieved from http://wildfiretoday.com/documents/Cantwell-Hastings_Public_Law_107-203.txt

Cooperrider, D. L., Whitney, D. K., & Stavros, J. M. (2008). *Appreciative inquiry handbook for leaders of change*, (2nd ed). San Francisco, CA: Berrett-Koehler.

Cooperrider, D. L., & Whitney, D. K. (2005). *Appreciative inquiry a positive revolution in change*, San Francisco, CA: Berrett-Koehler.

Cornell University Law School (2014). *16 U.S. Code § 472 - Laws affecting national forest lands,* Legal Information Institute. Retrieved from http://www.law.cornell.edu/uscode/text/16/472

Cottor, R., Asher, A., Levin, J., & Weiser, C. C. (2004). *Experiential learning exercises in social construction: A field book for creating change*, Chagrin Falls, OH: Taos Institute Publications.

Creswell, J. W. (2009). *Research design: qualitative, quantitative, and mixed methods approaches,* Thousand Oaks, CA: SAGE Publications, Inc. 3rd ed.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches,* Thousand Oaks, CA: SAGE Publications.

Dekker, S. (2002). *The field guide to human error investigations,* Burlington, Vermont: Ashgate Publishing Company.

Dekker S. W. A. (2003). "Illusions of explanation: A critical essay on error classification," *International Journal of Aviation Psychology*, Vol. 13, Issue 2, pp. 95-106.

Dekker, S. (2005). *Ten questions about human error: A new view of human factors and system safety,* Mahwah, New Jersey: Lawrence Erlbaum Associates, Inc.

Dekker, S. (2006). *The field guide to understanding human error*, Burlington, Vermont: Ashgate Publishing Company.

Dekker, S. (2010, September). "*Organizing for high reliability: Processes of collective mindfulness,"* Lund Learning Lab Presentation. Lund, Sweden.

Dekker, S. (2011a). "The criminalization of human error in aviation and healthcare: A review," *Safety Science*, 49, 121-127.

Dekker, S. (2011b). *Drift into failure: From hunting broken components to understanding complex systems*, Burlington, Vermont: Ashgate Publishing Company.

Dekker, S. (2013). *Second victims: error, guilt, trauma, and resilience*, Boca Raton: CRC Press, Taylor and Francis Group.

Dekker, S. W. A. (2014). "The psychology of accident investigation: epistemological, preventive, moral and existential meaning-making," *Theoretical Issues in Ergonomics Science*, 1-12. doi: 10.1080/1463922X.2014.955554

Dekker, S., Cilliers, P., & Hoffmyer, J. H. (2011). "The complexity of failure: Implications of complexity theory for safety investigations," *Safety Science*, 49(6), 939-945.

Department of Interior, United States. (2003). *Serious Accident Investigation team training course*, Phoenix, AZ.

DOT/FAA/AM Department of Transportation, Federal Aviation Administration, Office of Aviation Medicine (2001). *A human error analysis of commercial aviation accidents using the human factors analysis and classification system (HFACS),* National Technical Information Service publication, Springfield, VA.

Dreyfus, H., & Dreyfus, S. E. (1986). *Mind over machine,* New York, New York: Simon and Schuster.

Edmonson, A. C. (2012. *Teaming: How organizations learn, innovate and compete in the knowledge economy,* San Francisco, CA: Wiley & Sons, Inc.

Fausey, C. M., & Boroditsky, L. (2010). Subtle linguistic cues influence perceived blame and financial liability, *Psychonomic Bulletin & Review*, 17(5), 644-650.

Fielding, E., Lo, A. W., & Yang, J. H. (2011). "The National Transportation Safety Board: A model for systemic risk management," *Journal of Investment Management*, 9(1), 17–49.

Fischhoff, B. (2007). "An early history of hindsight research," *Social Cognition*, 25, 10-13. doi: 10.1521/soco.2007.25.1.10

Fischhoff, B., & Goitein, B. (1984). "The informal use of formal models," *The Academy of Management Review*, 9(3), 505-512. doi: 10.2307/258290

Fisher, W. R. (1987). *Human communication as narration: Toward a philosophy of reason, value, and action,* Columbia: University of South Carolina Press.

Flick, U. (2009). *An Introduction to Qualitative Research* (4th ed.), Thousand Oaks, CA: SAGE Publications.

Flyvbjerg, B. (2001). *Making social science matter: why social inquiry fails and how it can succeed again,* Oxford, United Kingdom: Cambridge University Press.

Flyvbjerg, B., Landman, T., & Schram, S. (2012). "*Real social science; Applied phronesis*," New York: Cambridge University Press.

Forest Service, United States Department of Agriculture (1937, December 6). *Fire control notes*. Retrieved from https://archive.org/details/firecontrolnotes19361937fore and http://www.fs.fed.us/fire/fmt/fmt_pdfs/001_07.pdf

Forest Service, United States Department of Agriculture (1953, July 9). *Rattlesnake fire.* Retrieved from

http://www.wlfalwaysremember.org/images/incidents/documents/1953-07-09-rattlesnake-report.pdf

Forest Service, United States Department of Agriculture (1957). *Report of the fire task force,* Retrieved December 8, 2013 from http://www.fireleadership.gov/toolbox/staffride/downloads/lsr2/lsr2_resource8.html

Forest Service, United States Department of Agriculture (1957, January). *Inaja forest fire disaster,* Always Remember. Retrieved from http://www.wlfalwaysremember.org/images/incidents/documents/1956-11-25-inaja-report.pdf

Forest Service, United States Department of Agriculture (1966, November 1). *Loop fire disaster,* Retrieved from http://www.wlfalwaysremember.org/images/incidents/documents/1966-11-01-loop-report.pdf

Forest Service, U.S. Department of Agriculture (1967). *Report of the fire safety review team: a plan to further reduce the chances of men being burned while fighting fires,* Washington, DC: U.S. Department of Agriculture Forest Service.

Forest Service, United States Department of Agriculture (1994). *Forest Service aviation accident review,* A-200/300, Retrieved from Wildland Fire Lessons Learned, http://www.wildfirelessons.net/orphans/viewincident/?DocumentKey=db 8d7d be-5f56-4b4b-bfe4-aec1a4e40b53

Forest Service, United States Department of Agriculture (2001, September 26). *Thirtymile fire investigation: Accident investigation factual report and management evaluation report,* http://www.fs.fed.us/t-d/lessons/documents/Thirtymile_Reports/Thirtymile-Final-Report-2.pdf

Forest Service, United States Department of Agriculture (2007a). *Forest Service aviation accident review,* A-200/300, Retrieved from http://www.fs.fed.us/fire/av_safety/assurance/mishaps/FY07_Accident_Review_internet.pdf

Forest Service, United States Department of Agriculture (2007b). *Integrating mission accomplishment with safety at the U.S. Forest Service,* Dialogos Report, Retrieved January 10, 2013 from www.wildlandfire.com/docs/2007/dialogos-safetyreport.doc

Forest Service, United States Department of Agriculture (2008, July 25). *Accident investigation report: Dutch Creek incident,* Retrieved from Always Remember at http://www.wlfalwaysremember.org/images/incidents/documents/2008-07-25-palmer-dutchcrk-final.pdf

Forest Service, United States Department of Agriculture. (2008, July 26). *Panther fire entrapment accident investigation report,* Retrieved from http://www.fs.fed.us/im/foia/frequent/PantherFire/Panther_Fire_Accident_Investigation_Report.pdf

Forest Service, United States Department of Agriculture (2009, April 17). *Interim protocol for investigations of serious injuries and fatalities of on-duty Forest Service employees.* Washington, DC.

Forest Service, United States Department of Agriculture (2010, December 14). *USFS aircraft accident investigation report: Tanker 44 overrun (N1386C, Lockheed P2V-5 Airtanker),* Internal Report. National Interagency Fire Center.

Forest Service, United States Department of Agriculture (2012). *Facilitated learning analysis guide.* Forest Service internal document. https://ems-team.usda.gov/sites/fs-wo-ese/SitePages/Home.aspx

Forest Service, United States Department of Agriculture (2013). *Saddleback firefighter fatality learning review.* Retrieved from https://higherlogicdownload.s3.amazonaws.com/WILDFIRELESSONS/Saddleback%20FLR%20Final2.pdf?AWSAccessKeyId=AKIAJH5D4I4FWRALBOUA&Expires=1418845077&Signature=2QQYsadSAjSEYSPmhDvOzvCEgUU%3D

Forest Service, United States Department of Agriculture (2014a). *About the agency.* Retrieved from http://www.fs.fed.us/about-agency

Forest Service, United States Department of Agriculture (2014b). *Fire safety.* http://www.fs.fed.us/safety/fire.shtml

Forest Service, United States Department of Agriculture (2014c). *History and culture*. http://www.fs.usda.gov/main/psicc/learning/history-culture

Forest Service, United States Department of Agriculture (2014d, February). *Learning from unintended outcomes training,* Tucson, AZ.

Forest Service, United States Department of Agriculture (2014, March). *Coordinated response protocol (CRP) training,* Denver, CO.

Forest Service, United States Department of Agriculture (2014, March 10). *Coordinated response protocol communication plan rollout*, NLC Briefing Paper.

Foucault, M., & Rabinow, P. (1984). *The Foucault reader,* New York: Pantheon Books.

Foucault, M. (1980). *Power/knowledge: Selected interviews and other writings, 1972-1977*, New York, New York: Random House.

Fujita, Y., & Hollnagel, E. (2004). "Failures without errors: quantification of context in HRA. Reliability and Engineering System Safety." *Reliability Engineering System Safety; 83(2):145–151.*

Gabbert, W. (2013, September 21). "New guide for accident reports," *Wildfire Today*. Retrieved from http://www.wildfiretoday.com

George, A. L., & Bennett, A. (2005). *Case studies and theory development in the social sciences,* Cambridge, MA [etc.]: MIT Press.

Gergen, K. J. (2009). *An invitation to social* construction (2nd ed.), Thousand Oaks, California: SAGE Publications, Inc.

Gergen, K. J. (2009). *Realities and relationships: Soundings in social constructionism*. Cambridge, Harvard University Press, 356 pages.

Gergen, M., & Gergen, K. J. (2003). *Social construction: A reader,* Thousand Oaks, CA: SAGE Publications.

Gergen, K. J., & Thatchenkery, T. J. (2004). "Organization science as social construction: Postmodern potentials, "*Journal of Applied Behavioral Science*, 40, 228-249.

Grabowski, M., & Roberts, K. H. (1996, January). "Human and organizational error in large- scale systems," *IEEE Transactions on Systems, Man, and Cybernetics-Part A: Systems and Humans*, 26(1).

Groth, K. & Mosleh, A. (2012). "A data-informed PIF hierarchy for model-based human reliability analysis," *Reliability Engineering and System Safety*, 108, 154-174.

Hersman, D. (2009). *Testimony of the Honorable Deborah A. P. Hersman, Chairman National Transportation Safety Board, before Aviation Subcommittee Committee on Commerce, Science, and Transportation at the U.S. Senate.* Retrieved June 28, 2014 from https://www.ntsb.gov/news/speeches/hersman/daph100225.html

Hollnagel, E. (2000). "Looking for errors of omission and commission or The Hunting of the Snark revisited," *Reliability Engineering & System Safety*, 68(2), 135-146.

Hollnagel, E. (2002). "Understanding accidents-from root causes to performance variability," *Human Factors and Power Plants. Proceedings of the 2002 IEEE 7th Conference*.

Hollnagel, E. (2004). *Barriers and accident prevention*, Aldershot, United Kingdom, Ashgate Publishing Company.

Hollnagel, E., Nemeth, C. P., & Dekker, S. (2008). *Remaining sensitive to the possibility of failure* (Vol. 1), Burlington, VT: Ashgate Publishing Company.

Hollnagel, E. (2009a). *The ETTO principle: efficiency-thoroughness trade-off; why things that go right sometimes go wrong*, Burlington, Vermont: Ashgate Publishing Company.

Hollnagel, E. (2009b). *Safer complex industrial environments: A human factors approach*, Hoboken, New Jersey: CRC Press.

Hollnagel, E., & Woods, D. D. (2005). *Joint Cognitive Systems: Foundations of Cognitive Systems Engineering*, Boca Raton, Florida: CRC Press.

Hopkins, A. (2014), "Issues in safety science," *Safety Science*, 67, 6-14

Interagency Management Review Team (1994, June 26*). Final report of the interagency management review team: South Canyon fire*, Retrieved from http://www.wildfirelessons.net/orphans/viewincident/?DocumentKey=db8d7dbe-5f56-4b4b-bfe4-aec1a4e40b53

International Association of Fire Chiefs (2002). *Crew Resource Management (CRM) Manual for Firefighters*, Retrieved from http://www.iafc.org/files/1SAFEhealthSHS/pubs_CRMmanual.pdf

International Civil Aeronautic Organization (2004). *Manual of aircraft accident and incident investigation*, A/N695, ICAO Publication

Isaacs, W., (1999). *Dialogue and the art of thinking together: A pioneering approach to communicating in business and in life*, New York, NY. Doubleday

Jeong, H. S., & Brower, R. S. (2008). Extending the present understanding of organizational sensemaking, *Administration & Society*, 40(3), 223–252.

Johansen, M. (2014). "FAA sets new pilot standards thanks to families of Continental flight 3407," *International Business Times*. Retrieved March 8, 2014 from http://www.ibtimes.com/faa-sets-new-pilot-standards-thanks-families-continental-flight-3407-1341289

Jordan, M. E., Lanham, H. J., Crabtree, B. F., Nutting, P. A., Miller, W. L., Stange, K. C., & McDaniel, R. R., Jr. (2009). "The role of conversation in health care interventions: enabling sensemaking and learning," *Implementation Science*: IS, 4.

Kahneman, D. (2012). *Thinking, fast and slow*, London [etc.]: Penguin.

Kahneman, D., Slovic, P., & Tversky, A. (1982). *Judgment under Uncertainty: Heuristics and Biases*, Cambridge University Press.

Kahneman, D., & Klein, G. (2009). "Conditions for Intuitive Expertise: A Failure to Disagree," *American Psychologist*, 64, 515-526.

Kaiser, B. A. (2006). The national environmental policy act's influence on USDA Forest Service decision-making, 1974–1996. *Journal of Forest Economics*, 12(2), 109-130. doi: http://dx.doi.org/10.1016/j.jfe.2006.03.002

Kern, T. (1999). *Darker shades of blue: the rogue pilot*. New York: McGraw-Hill.

Kern, T., & McKay, D. (2013). The war on error: Human error as a strategic risk management concern, *Risk Management*, 60(4):32–37.

Klein, G. (2003). *The Power of Intuition*. New York, New York: Currency Doubleday.

Koch, E. (1910). *History of the 1910 Forest Fires – Idaho and Western Montana. When the Mountains Roared: Stories of the 1910 Fires*. Retrieved from http://www.foresthistory.org/ASPNET/Publications/region/1/1910_fires/sec1.htm

Latour, B. and Woolgar, S. (1979), *Laboratory of Life: The social construction of scientific facts,* Beverly Hills, CA: Sage Publications.

Leape, L. L & Berwick. D. M. (2005). "Five years after to err is human: What have we l earned?" *The Journal of the American Medical Association*, 293, 2384-2390.

Leopold, A., & Schwartz, C. W. (1987). *A Sand County almanac: And sketches here and there*, New York, New York: Oxford University Press.

Lewis, J. G. (2005). *The Forest Service and the greatest good: A centennial history*, Durham, North Carolina: Forest History Society.

Lorbiecki, M. (1996). *Aldo Leopold: A fierce green fire*, Helena, Montana: Falcon Press.

Lundberg, J., Rollenhagen, C., & Hollnagel, E. (2009). "What-you-look-for-is-what-you-find—The consequences of underlying accident models in eight accident investigation manuals," *Safety Science*, 47(10), 1297-1311.

Maitlis, S. (2005). "The social processes of organizational sensemaking," *Academy of Management Journal*, 48(1), 21–49. doi:10.2307/20159639

Maitlis, S., & Christianson, M. (2014). "Sensemaking in organizations: Taking stock and moving forward," *The Academy of Management Annals*, 8(1), 57–125.

Maurino, D. E., Reason, J., Johnston, N., & Lee, R. B. (1998). *Beyond aviation human factors: Safety in high technology systems*, Burlington, Vermont: Ashgate Publishing Company.

May, S. K. (2006). *Case studies in organizational communication: Ethical perspectives and practices,* New York, New York: Sage Publications. Available at http://books.google.com/books?id=pEzuAAAAMAAJ

McDaniel, R. R. (2015). Personal dialogue regarding complex adaptive systems, UT Austin.

McDaniel, R. R. (2007). "Management strategies for complex adaptive systems: Sensemaking, learning, and improvisation," *Performance Improvement Quarterly*, 20, 21-41.

McDaniel, R. R, & Driebe, D. J. (2005). *Uncertainty and surprise in complex systems: Questions on working with the unexpected*, Berlin, Springer.

McGregor, D. (1960). *The human side of enterprise.* New York: McGraw Hill.

Meister, D. (1991). "The epistemological basis of human factors research and practice," *In: proceedings of the Human Factors Society 35th annual meeting*, Santa Monica, CA: Human Factors Society, 1275–1279.

Meister, D., & Farr, D. E. (1967). The utilization of human factors information by designers, *Human Factors*, 9, 71–87.

Moray, N. (2005). *Ergonomics: major writings*, New York: Routledge.

Morel, G., Amalberti, R., & Chauvin, C. (2008). "Accidents, safety, and human error-Articulating the differences between safety and resilience: The decision-making process of professional sea-fishing skippers," *Human Factors: the journal of the Human Factors Society,* 50,1.

Morin, E. (2008). *On complexity*. Cresskill, New Jersey: Hampton Press, Inc.

Myers, G. (2012). *Social psychology* (11th ed.), New York, New York: McGraw Hill.

National Transportation Safety Board (NTSB). (2008). *Norcross fatality investigation report.* Retrieved from http://www.ntsb.gov/investigations/dms.html

National Transportation Safety Board (NTSB). (2010). *Loss of control on approach, Colgan Air, Inc. Operating as Continental connection flight 3407 Bombardier DHC-8-400, N200WQ, Clarence Center, New York, February 12, 2009, NTSB/AAR-10/01,* Washington, DC: National Transportation Safety Board.

National Transportation Safety Board (NTSB). (2014). *Aviation Accident Database and Synopses.* Retrieved from http://www.ntsb.gov/_layouts/ntsb.aviation/index.aspx

National Wildfire Coordinating Group (NWCG) (1980). *Preliminary report of task force on study of fatal/near-fatal wildland fire accidents*. Boise, Idaho: National Interagency Fire Center. Retrieved from http://www.wildfirelessons.net/documents/NWCG_Joint_Task_Force_Fatal_Near_Fatal _Wildland_Fire_Accidents_1980.pdf

Newell, A. (1982). "The knowledge level," *Journal of Artificial Intelligence*, 18, 87-127.

Occupational Safety and Health Administration (1970). *Recording and reporting occupational injuries and illness, 29 CFR 1904.7,* US Government Publication. Retrieved from

https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p _id=9638

Office of Inspector General, United States Department of Agriculture. (2004, June 9). *Report of investigation*. Retrieved from http://www.usda.gov/oig/webdocs/rptinvestigations

Page, S. E. (2009). *Understanding complexity: Course guidebook, the great courses,* Chantilly, Virginia: The Teaching Company.

Page, S. E. (2011). *Diversity and complexity,* Princeton, NJ: Princeton University Press.

Paparone, C. R., Anderson, R. A., & McDaniel, Jr., R. R. (2008). "Where military professionalism meets complexity science," *Armed Forces and Society*. 34(3), 433–449.

Perrow, C. (1999). *Normal accidents: living with high-risk technologies*, New York: Basic Books.

Pinchot, G. (1910). *The fight for conservation,* Seattle, Washington: University of Washington Press.

Pupulidy, I., (2014). "Recognize Error to Prevent Accidents," *Wildland Fire Magazine, International Association of Wildland Fire*, August 2014, p. 38-40

Pupulidy, I., (2015). "Novices, experts, and errors: Toward a safer fire ground," *Wildland Fire Magazine, International Association of Wildland Fire*. 24.1, 32-36.

Pupulidy, I. (2014, March 3). *High-leverage learning products,* USFS Briefing paper, Washington, D.C.: Fire and Aviation Management, Forest Service, United States Department of Agriculture.

Pupulidy, I., (2014, September 14). *Building a foundation for a coordinated response,* USFS Briefing paper to the Office of Occupational Health and Safety, Forest Service, United States Department of Agriculture.

Pyne, S. J. (2014). *Tending fire: Coping with America's wildland fire,* Washington. Island Press.

Pyne, S. J. (2010a). *America's fires: A historical Context for policy and practice,* Durham North Carolina, Forest History Society Press.

Pyne, S. J. (2010b). "Between two fires: The past and future of fire in America," *Penn State Environmental Law Review*, 18(2), 129-139.

Pyne, S. J. (1996). *Introduction to wildland fire* (2nd ed.), New York: Wiley.

Ragin, C. C., & Becker, H. S. (1992). *What is a case? : Exploring the foundations of social inquiry,* Cambridge: Cambridge University Press.

Rasmussen, J. (1986). *Information processing and human-machine interaction: An approach to cognitive engineering* (Vol. 12), New York, New York: North-Holland.

Rasmussen, J. (1997). "Risk management in a dynamic society: a modeling problem," *Safety Science*, 27, 183.

Rasmussen, J., Nixon, P., & Warner, F. (1990). "Human error and the problem of causality in analysis of accidents [and discussion]," *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 327, 449-462.

Reason, J. (1990a). "The contribution of latent human failures to the breakdown of complex systems." *Philosophical transactions of the Royal Society of London. Series B, Biological Sciences*, 327(1241), 475-484.

Reason, J. (1990b). *Human error,* New York: Cambridge University Press.

Reason, J. T. (1997). *Managing the risks of organizational accidents,* Brookfield, Vermont: Ashgate Publishing Company.

Reason, J. (2000). "Human error: Models and management," *BMJ, 320(Education and Debate)*, 768-770.

Reason, J. T., & Hobbs, A. (2003). *Managing maintenance error: a practical guide,* Burlington, Vermont: Ashgate Publishing Company.

Reason, J., Maurino, D. E., Johnston, N., & Lee, R. B. (1995). *Beyond aviation human factors,* Burlington, VT: Ashgate.

Reason, J., Hollnagel, E., & Paries, J. (2006). *Revisiting the Swiss cheese model of accidents,* France: Eurocontrol Experimental Centre.

Robbins, W. G. (1975). *Early conservation movement in Oregon*. Eugene, Oregon: University of Oregon.

Salas, E., Rosen, M., & Diaz Granados, D. (2010). "Expertise-based intuition and decision making in organizations," *Journal of Management*, 36, 941-973.

Saveland, J. (1998). "Prescribed fire: the fundamental solution (In: Pruden, T.L.; Brennan, L.A., eds. Fire in ecosystem management: shifting the paradigm from suppression to prescription)," *Tall Timbers Fire Ecology Conference Proceedings, No. 20*. Tallahassee, FL: Tall Timbers Research Station.

Schein, E. H. (2013). *Humble Inquiry: the Gentle art of asking instead of telling,* San Francisco: Berrett-Koehler Publisher

Schein, E. H. (2004). *Organizational culture and leadership* (3rd ed.), San Francisco, California: John Wiley & Sons.

Schön, D. A. (1983). *The reflective practitioner: how professionals think in action*, New York: NY: Basic Books.

Schrader, S. M. (2004). "Performing Narratives: Telling the Story of Theory," *Teaching Education*, 15, 203-214.

Sedjo, R. A. (1998). *Forest Service vision: Or does the Forest Service have a future*., Washington, DC: Resources for the Future, http://www.rff.org

Shappell, S. A., & Wiegmann, D. A. (1997). A human error approach to accident investigation: The taxonomy of unsafe operations. *The International Journal of Aviation Psychology*, 7, 269-291.

Snook, S. A. (2000). *Friendly fire: The accidental shootdown of US Black Hawks over Northern Iraq*, Princeton, NJ: Princeton University Press.

Staff Writer. (1905, January 6). "*Timber famine near*," *New York Times*. http://www.newspapers.com/newspage/20658268/

Starbuck, W. H., and Milliken, F. J. (1988). "Challenger: Fine-tuning the odds until something breaks," *Journal of Management Studies*, 25(4), 319–340.

Steen, H. K. (1976). *The U.S. Forest Service: a history*, Seattle, Washington: University of Washington Press.

Steen, H. K. (2004). *The U.S. Forest Service: a history* (Centennial ed.), Seattle, Washington: University of Washington Press.

Sumwalt, R. (2010). *Speech at Embry-Riddle University, Daytona Beach, Florida*. Retrieved June 28, 2014 from http://www.ntsb.gov/news/speeches/sumwalt/rls100108.html

Sutcliffe, K. M. (2013). *Sensemaking*, In M. Augier & D. Teece (Eds.), The Palgrave encyclopedia of strategic management. Basingstoke: Palgrave Macmillan. Advance online publication. Retrieved from http://www.palgraveconnect.com/pc/doifinder/10.1057/9781137294678.0623

Taylor, J. R. and Van Every, E. J. (2000). "The emergent organization: Communication as its site and surface," *Communication Abstracts*, 23(3).

Tidwell, T. (2013). *Chief's Letter: Response to incidents and accidents as a coordinated response protocol*, USDA Forest Service Correspondence.

Tidwell, T. (2013). *Chief's Speech: Introducing the Coordinated Response Protocol and Learning Review,* USDA Forest Service Video.

Tyre, Marcie and Eric von Hippel (1997). "The Situated Nature of Adaptive Learning in Organizations," *Organization Science*, Vol. 8, No. 1 (January-February) pp. 71-83.

University of Washington. (2014a). *Important laws related to federal forest lands.* Retrieved from http://courses.washington.edu/esrm315/pdfs/ESRM315ImportantLaws.pdf

University of Washington. (2014b) *Organic Act of 1897*. Retrieved from http://www.cfr.washington.edu/classes.esrm.459/yellowstone/yellowstone/Project1/Yellowstone_Docs/ORGANIC%20ACT%20OF%201897.pdf

Vaughan, D. (1996). *The Challenger launch decision: Risky technology, culture, and deviance at NASA,* Chicago, Illinois: University of Chicago Press.

Vesel, C. (2012). *Language bias in accident investigation,* Master of Science Degree Dissertation, Sweden: Lund University.

Webber, B. (1975). *Retaliation: Japanese attacks and allied countermeasures on the Pacific Coast in World War II,* Corvallis, Oregon: Oregon State University Press.

Weick, K. E. (1993). "The collapse of sensemaking in organizations: The Mann Gulch disaster," *Administrative Science Quarterly*, 38, 628-652.

Weick, K. E. (1995b*). Sensemaking in organizations,* Thousand Oaks, CA: Sage Publications.

Weick, K. E. (1995). "South Canyon revisited: Lessons from high reliability organizations (In Putnam, T*)," Findings from the Wildland Firefighters Human Factors Workshop. Missoula, Montana*: Forest Service, United States Department of Agriculture, Missoula Technology and Development Program.

Weick, K. E. (2010). "Reflections on enacted sensemaking in the Bhopal disaster," J*ournal of Management Studies*, 47, 537-550.

Weick, K. E., & McDaniel, Jr., R. R. (1989). *How professional organizations work: Implications for school organization and management. Schooling for tomorrow: Directing future reforms to issues that count*, Boston, Massachusetts: Allyn & Bacon. 330–55.

Weick, K. E., & Sutcliffe, K. M. (2007). *Managing the unexpected: Resilient performance in an age of uncertainty*, San Francisco, California: Jossey-Bass.

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (2005). Organizing and the process of sensemaking, *Organization Science*, 16(4), 409–421.

Weick, K.E., Sutcliffe, K.M. & Obstfeld, D. (1999). "Organizing for high reliability: Processes of collective mindfulness. In: R. I. Sutton & B. M. Staw (Eds.)," *Research in organizational behavior* (21, 81–123). Greenwich, Connecticut: JAI Press.

Whitlock, C. (2001). *Accident investigation guide: 2001 Edition*. Missoula, Montana: Forest Service, United States Department of Agriculture, Missoula Technology and Development Program.

Whitlock, C., & Wolf, J. T. (2005). *Accident investigation guide: 2005 Edition*. Missoula, Montana: Forest Service, United States Department of Agriculture, Missoula Technology and Development Program.

Whitney, D., Trosten-Bloom, A., & Cooperrider, D. (2010). *The power of Appreciative Inquiry: A practical guide to positive change*, San Francisco: Berrett-Koehler Publishers.

Whitney, D., Trosten-Bloom, A., & Rader, K. (2010). *Appreciative Leadership: Focus on what works to drive winning performance and build a thriving organization*, New York: McGraw Hill.

Wickens, C. D., Mavor, A. S., & McGee, J. P., Eds. (1997). *Flight to the future: Human factors in air traffic control,* Washington, DC: National Academy Press.

Wiegmann, D. A., & Shappell, S. A. (2003). *A human error approach to aviation accident analysis: The human factors analysis and classification system,* Burlington: Ashgate.

Wiegmann, D. A., & Shappell, S. A. (2001). "Human Error Perspectives in Aviation," *International Journal of Aviation Psychology*, 11, 341-357.

Wiegmann, D. A., Rich, A. M., & Shappell, S. A. (2000). *Human error and accident causation theories, frameworks and analytical techniques: An annotated bibliography (Technical Report ARL-00-12/FAA-00-7),* Savoy, Illinois: University of Illinois, Aviation Research Lab.

Wilde, G. (1976). "The risk compensation theory of accident causation and its practical consequences for accident prevention." Paper presented at the annual meeting of the Österreichische Gesellschaft für Unfallchirurigies, Saltzburg, Austria.

Wood, R. H., & Sweginnis, R. W. (1995). *Aircraft Accident Investigation*, Casper, Wyoming: Endeavor Books.

Woods, D., Dekker, S., Cook, R., Johannesen, L., & Sarter, N. (2010). *Behind human error*, Burlington, Vermont: Ashgate Publishing Company.

Young, R., & Obrien, M. (2010, February 9). *Flying Cheap: Is air travel safety being compromised,* Frontline and American University School of Communications Investigative Reporting Workshop. Video. Distributed through Public Broadcasting Service, PBS.org.

Appendix

Tree Strike Accidents and Incidents, 2000 – 2014 (Including Saddleback)

Incident / Accident	Year	Injury / Fatality	Highlights of Lessons Learned & Recommendations
Cowles Bog Accident, IN	2013	Injury Root ball gave way	• Remove dead and down prior to operations • Be aware of weather conditions such as a freeze-thaw cycle
Saddleback Fire, CA	2013	Fatality	• Hit by snag while building line • Learning Review pending
Deschutes NF, OR	2013	Fatality + injury	• Two fallers hit by snag. One injury, one fatality • Contract firefighters • Report pending
Florida Training Exercise	2012	Injury	• Trainee hit by snag during training felling field exercise
Circle Meadow Prescribed Fire, CA	2012	Injury	• Jumped out of way of falling snag and injured ankle • Analyze risk-to-reward • Consider tactical pause; beware of tactical fixation • Consider how/when to protect special 'named trees' (which have become important to the public)
Gold Pass Fire, ID	2012	Injury	• Hit by snag during mop-up • Firefighters should never assume that "all" snags have been removed from an area after a felling procedure
Lockheed Incident, CA	2012	Injury CAL FIRE Greensheet	• Inmate firefighter struck by felled tree • Ensure that no one is within two times the tree falling length

Incident / Accident	Year	Injury / Fatality	Highlights of Lessons Learned & Recommendations
Marble Yard/Daniel Boone Forest Incidents, KY	2012	Injury (FLA)	• During mop up phase, one firefighter hit by snag • Suppress activities during high wind events • Be aware of timing (such as if the fire has had time to burn longer/smolder in trees)
Sunflower Fire Incident, AZ	2012	Injury (FLA)	• Hit by tree during hazard tree felling • Always have adequate personnel when doing falling operations
Chips Fire, CA	2012	Injury (FLA)	• Contract faller hit by limb, while felling a tree • Minimize pounding on snags with overhead hazards • Ensure sawyers practice on the ground risk management to avoid unnecessary exposure. • Consider alternative methods to hand falling snags in high risk situations
Steep Corner Fire, ID	2012	Fatality	• Hit by falling tree, while building line • Biggest concern on fire were hazard trees a "common" foe
Bagley Fire, CA	2012	Injury	• Hit by 'tree debris' • Even 'safe' locations can present a hazard
Scotts Chapel Road Fire, KY	2011	Fatality	• Firefighter hit by burning snag • Follow hazard tree SOP's
Buckhorn Tree Felling, CA	2011	Injury (CAL FIRE Greensheet)	• Sawyer struck by falling limb while felling tree (inmate firefighter)
Chittenden Felling Operation, MI	2011	Injury (FLA)	• Sawyer struck on head by tree, while exiting along escape route • Learn about tree species and characteristics
Hastings Fire, AK	2011	Injury (FLA)	• Hotshot struck by tree during mop-up • Risk can only be managed, not eliminated
Northern Region Occ.	2011	Injury	• Sawyer hit by bole of tree during felling

Incident / Accident	Year	Injury / Fatality	Highlights of Lessons Learned & Recommendations
Safety & Health Fire (?)			
Crystal Lake Felling Operation, CA	2011	Injury (FLA)	• Sawyer hit during tree felling • The instructor/leader needs to take control of the operation when it goes beyond a learning environment • When feeling anxious or stressed take a tactical pause to reevaluate the situation
Snow Gate, OR	2011	Injury	• Firefighter struck by burning snag while constructing line • Empower individuals to voice concerns and communicate hazards
Sequoia National Forest, CA	2011	Injury (FLA)	• Hit by tree during felling • Learn tree species and recognize tree characteristics before cutting • Do not assume your size-up is flawless
Project Work Tree Strike, CA	2011	No Injury (FLA)	• Hit by tree during felling • Sawyers need to take command of their area of operations
Birthday Fire, MT	2010	Injury (BIA)	• Firefighter struck by a limb
Pat Creek Fire, AK	2010	Injury	• A gust of wind blew over one tree, which hit another, then the third tree – which struck the firefighter • Crews cannot assume that all hazard trees have been removed after felling activities • Only 72 hour report available
Crandall Felling Accident, WY	2010	Injury (APA)	• Sawyer struck by snag during tree felling
Jesse Fire, ID	2010	Injury (FLA)	• Firefighters hit by snag during line construction • This injury occurred just after a briefing that identified snags as a problem in the area – Banner Fire incident had happened the day before

Incident / Accident	Year	Injury / Fatality	Highlights of Lessons Learned & Recommendations
			• Recommendations suggested updating existing training material on snags
Banner Fire, ID	2010	Injury (FLA)	• Firefighter struck by snag during fire management
Meadow Creek Fire, CO	2010	Injury (APA)	• Firefighter hit by tree
Freeman Reservoir, CO	2009	Fatality	• Firefighter hit by section of tree, during training exercise
Little Grass Valley, CA	2009	Injury (FLA)	• Firefighter hit during tree felling operation
Dark Ridge Tree Felling Incident, KY	2009	Injury	• Tree fell on firefighter during felling • Only 72 hour report available
Bull Run, OR	2009	Fatality	• Firefighter hit by snag that may have been knocked over by helicopter rotor-wash
Volusa County Fire Services, FL	2008	Fatality	• Sawyer cut tree, swamper hit by tree as it was falling
South 1 Fire, NC	2008	Injury	• Snag hit firefighter during mop-up • Only 24 hour report available
Rattle Fire, OR	2008	Injury (HRO Review)	• Sawyer hit by snag from a different tree than he was falling • Pay attention to weak signals
Lime Complex, CA	2008	Injury	• During tree felling, a snag broke into multiple sections and one piece rolled into two National Guardsmen
Camel Hump Incident, WA	2008	Injury (FLA)	• Rappeller struck by snag that had been cut during falling operation • Focus on hazard tree risk management SOP's
Dutch Creek Fire, CA	2008	Fatality	• Firefighter struck by tree during felling operation • Crew was assigned to cut trees outside their falling qualifications

Incident / Accident	Year	Injury / Fatality	Highlights of Lessons Learned & Recommendations
Trapper Ridge, ID	2007	Injury	• Hotshot struck by hazard tree that fell as they were constructing fireline • Only 24 hour report available
Rombo Fire, MT	2007	Injury (FLA)	• Hotshot struck by snag after he felled a green tree • Do not engage in the fire, unless necessary • Before cutting the target tree, look around for other trees/hazards that may affect current operations/safety and clear the workspace first • Design sand table exercises around tree falling accidents/training
Stanley Accident, TN	2006	Fatality	• Forestry technician struck by falling tree, which was pushed over during dozer line construction
Missouri Ridge Fire, ID	2005	Injury	• Sawyer struck by snag, which broke while he was cutting it
Powerhouse Fire, CA	2004	Injury	• Swamper hit by falling limb • Only 24 hour report available
Holmes Hazard Tree Fatality, CA	2004	Fatality	• Firefighter hit by snag as he transitioned from tree size-up to hose relocation • Falling snag was from a white fir tree • Confusing policy surrounding hazard tree mitigation needs to be rectified in S-212, the IRPG, and the Fireline Handbook • Fire policy including SEKI JHAs are not adequate to provide firefighter safety for hazard trees
Inyo National Forest, CA	2003	Fatality	• Dead tree fell and struck victim, who was sleeping in tent • Only 24 hour report available
Borrego, NM	2002	Injury?	• No reports available
Missionary Ridge Fire, CO	2002	Fatality	• Faller was struck from behind by an aspen whose root system had been weakened by

Incident / Accident	Year	Injury / Fatality	Highlights of Lessons Learned & Recommendations
			fire, while walking in woods • Only 24 hour report available (very sparse)
East Fork, WY	2002	Injury?	• No documents available
Labor, MT	2001	Injury?	• No documents found
Holyoak Accident, UT	2001	Injury	• Hit by falling snag during burn project • Sparse 'letter-style' report
Poplar Log Fire, KY	2001	Injury	• Snag hit firefighter, while he was building fireline • Develop training for individuals not familiar with Eastern Tree Species when coming from the West to the East • Have qualified personnel scout for snags prior to constructing line
Whitley County, KY	2000	Injury?	• No documents found
Concow fire, CA	2000	Injury	• Firefighter hit by falling snag