



# Saddleback Fire

## Learning Review



“The greatest obstacle to discovery is not ignorance – It is the illusion of knowledge.”

Daniel J. Boorstin

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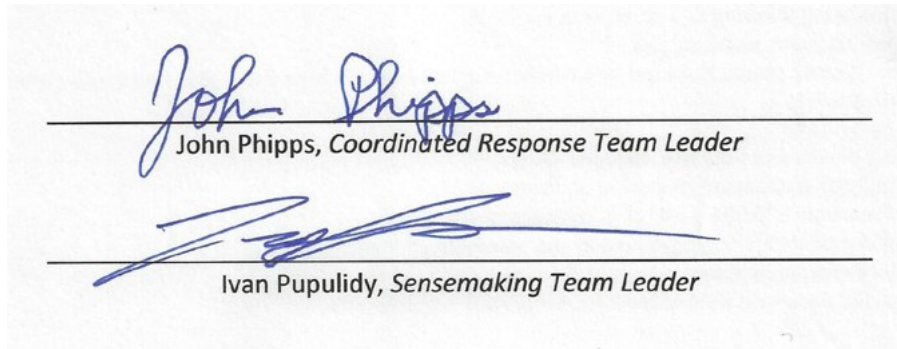
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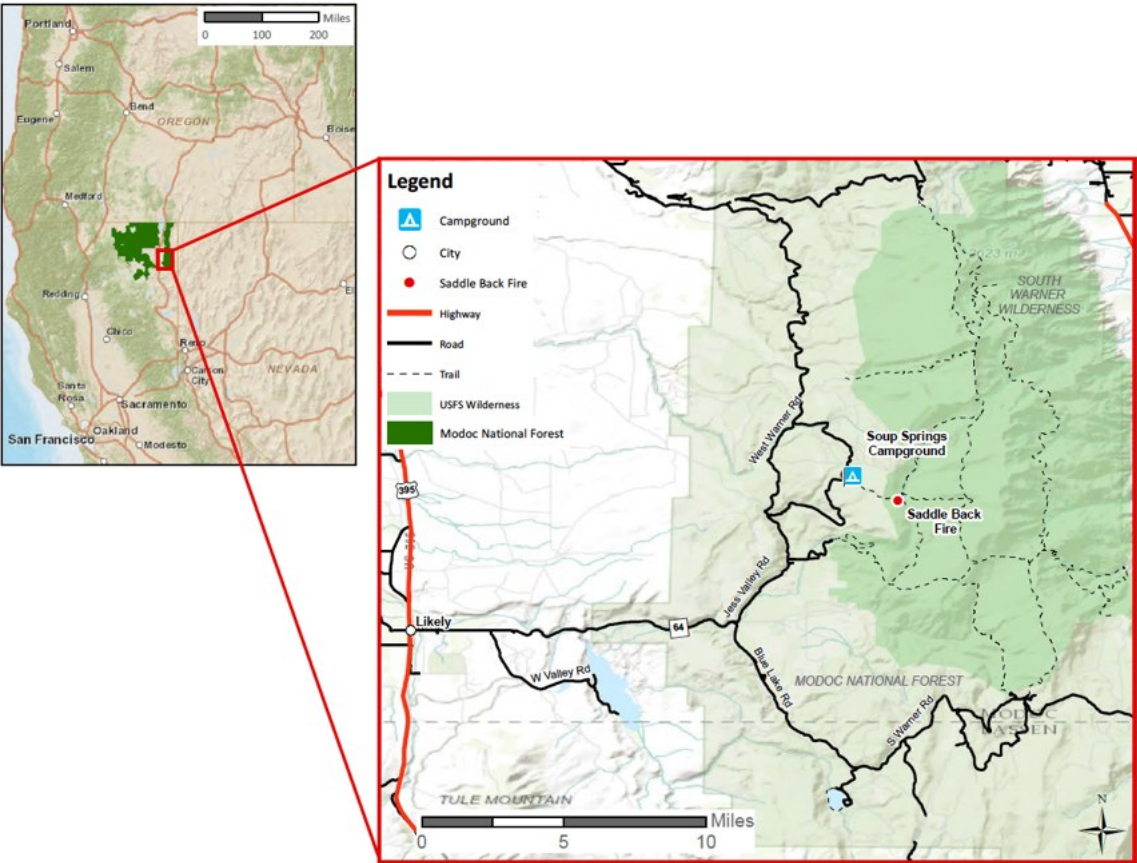
# Introduction

*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.*

## Event Synopsis

On June 10, 2013 three firefighters were constructing a fireline around a tree that had been struck by lightning, within the South Warner Wilderness of the Modoc National Forest, approximately fifteen miles southeast of Alturas, CA. At approximately 1700hrs, a limb fell out of the tree and struck Luke Sheehy, one of the firefighters.

Firefighters on-scene started CPR and called for emergency evacuation. The nearest aeromedical support was 55 minutes flight time and the aircraft landed at the Saddleback Landing Zone at approximately 1819hrs. Luke was transported by helicopter to the nearest hospital in Alturas. Despite all efforts to resuscitate him, he did not survive.



# Purpose of the Learning Review

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## If we don't find fault, what can we do?

The aim of this 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, including an understanding of the pressures faced by all those involved in the incident.

The information gathered by the Data Collection Team was passed to another team, which was convened to make sense of the raw data. This Sensemaking Team (ST) quickly realized that there are concepts, teachings, and stories, which were relevant to this incident and shared throughout the firefighting community. Thus, the ST interviewed firefighters from a wide variety of backgrounds and experience, going beyond the interviews of those directly involved in the event.

Readers are asked to suspend judgment, from the perspective of hindsight, and instead engage as active participants in the process of learning from this event. By coming to understand why it made sense for the individuals, at all levels of the organization, to act the way that they did, we begin to understand what makes the system brittle and what makes it resilient. Resilience involves preparation and the ability to be flexible – to stretch and recover, and even to break and recover, when faced with the uncertain or unimaginable.

This Learning Review will not draw conclusions in the traditional way that reports have done in the past. Conclusions can sometimes close the door on learning, by suggesting that all information has been found and judgments can be made. Judgment is always biased from the perspective of the reader, with the assistance of hindsight. Instead, this Review allows vague and sometimes unresolved concepts to emerge, allowing tension to be created for the reader. This tension can inspire dialogue in the firefighting community and the organization, and encourages sensemaking around the presented concepts. In this way, we hope this Learning Review will become a living document.

The Review will offer Learning Products, which have already been introduced to focus groups within the firefighting community and have shown promise. It will recommend the creation of additional Learning Products, which will take time and resources to develop (e.g. recognition of the lessons learned regarding the incident within an incident). It will also introduce new concepts and language in order to enhance our collective sensemaking capability.

## Note To Readers

The Learning Review Guide recommends the creation of at least two products, one for the field and one for the organization. This Learning Review is designed to meet the needs of the organization, in terms of generating dialogue and inspiring all of us to learn from this event. There is another product designed for the field, as indicated in the 'Using This Information to Learn and Improve' section.

# Field Perspective

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## Typical Mission Flow

*The following process descriptions illustrate how a typical mission would look. Many of these things occurred during the Saddleback mission.*

### **Normal Smokejumper Dispatch to Single Tree Fires**

A fire size up begins in the airplane. The spotter and the first jumper in the door will determine how many jumpers will staff a fire. A small fire will usually be staffed with two to three jumpers (Region 5 is the only Region that uses three, consistently). The jumpers assess elements that can be seen from the air: fire size, distance, access from the jump spot to the fire, trails, roads, terrain features, hazards and natural barriers. Fuel continuity, fuel types, weather, and fire location will also be part of this assessment, in consideration of potential fire spread. These factors are usually discussed between the Jumper in Charge (JIC) and the Spotter before leaving the aircraft and are used to build a tactical model for the operation. This is an example of group sensemaking that naturally occurs in operations. The JIC will receive a resource order, map with coordinates, forest information, and radio frequencies.

Depending on the distance to the fire from where the toolbox lands, a ‘toolbox briefing’ (like a ‘tailgate safety briefing’) may take place, to delineate roles, responsibilities and to discuss tactics.

Once on the ground, the Jumper in Charge will usually tell the next jumper that lands to run the jump spot communications, as the plane delivers cargo. The JIC will go to the fire and see what additional resources are needed and relay information back to the plane, so it can deliver (“kick”) the appropriate cargo. Then the JIC will contact dispatch, establish him/herself as Incident Commander (IC), and give a fire size-up. After the cargo is gathered and everyone makes it to the fire, the IC will inform the other jumpers of observed hazards and the plan of action.

### **Normal Ground Mission**

Once on the ground, smokejumpers employ several tactics to suppress, or monitor the fire. The scene is first assessed for potential hazards. If snags are detected, falling the snags may be the first option considered. If the tree is beyond the capability of the fallers on scene, they may call in a higher rated sawyer, or use other methods to remove the hazard<sup>1</sup>. This is an example of building a larger Margin of Maneuver<sup>2</sup> for safety. Then, a saw line is typically cut around the fire to make a clean path, which enables the diggers to scratch a small line around the perimeter of

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<sup>1</sup> The jump base in Missoula, MT, for example, continues to use Fire-Line Explosives (FLE) as an option for trees identified as hazardous. This option is more difficult to exercise at bases that no longer have FLE.

<sup>2</sup> Margin of Maneuver will be explained in greater detail throughout the Review (See page 14 for more detail).

the fire. This line is dug down to mineral soil to prevent further spread of burning material. The width and depth of this scratch line depends on spread potential and fuel type.

Scene safety is continually assessed and re-assessed. Examples of safety challenges include wind pushing fire over the line, wind shifts, spot fires, topography, and burning snags. Proper prioritization and mitigation of these is important for keeping firefighters safe, as well as containing the fire.

Once key hazards are addressed, the firefighters begin to actively suppress the fire. Suppression techniques might include bone piling (building multiple small burn piles to reduce burning fuels) and potato patching (using the grubbing end of the Pulaski to churn up all the burning material within the fire). In some cases, firefighters can simply wait until the tree burns itself out.

Depending on the fire size and fuel type, this stage could take several days, with the goal being to eliminate all heat and visible smokes. Once all smokes are extinguished, then they will enter the next phase of suppression – cold trailing. To ensure the fire is out, they must line out and go through every inch of the fire to feel for any remaining heat. If heat is found, they stop the cold trail and dig the heat out. Once the Jumper in Charge feels confident that there is no remaining heat, the final phase of suppression is reached – rehabilitation, which includes pulling the perimeter berm and rehabilitating the burned area to specified wilderness standards.



**Photo 1:** The Saddleback Fire

## 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 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 a report of numerous lightning strikes and the jumpers wanted the other IC to be available, in case they were dispatched to a more complex fire.

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

### *WildCAD Incident Card – 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)



**Photo 2:** Smokejumper landing spot

This is Sam and Connor's<sup>3</sup> first operational jump. 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:

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.*

Connor continues to the tree and does an overall 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.<sup>4</sup> 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, there are more ladder fuels and brush outside where he plans to scratch line. Connor gets to work clearing fallen branches.

Sam starts walking over to the tree with the saw. The tree is a big, ugly red fir<sup>5</sup> 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.



**Photo 3:** Lightning strike tree, from the uphill side

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<sup>3</sup> Fictitious names are used in this narrative, with the exception of Luke Sheehy.

<sup>4</sup> 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."

<sup>5</sup> 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.

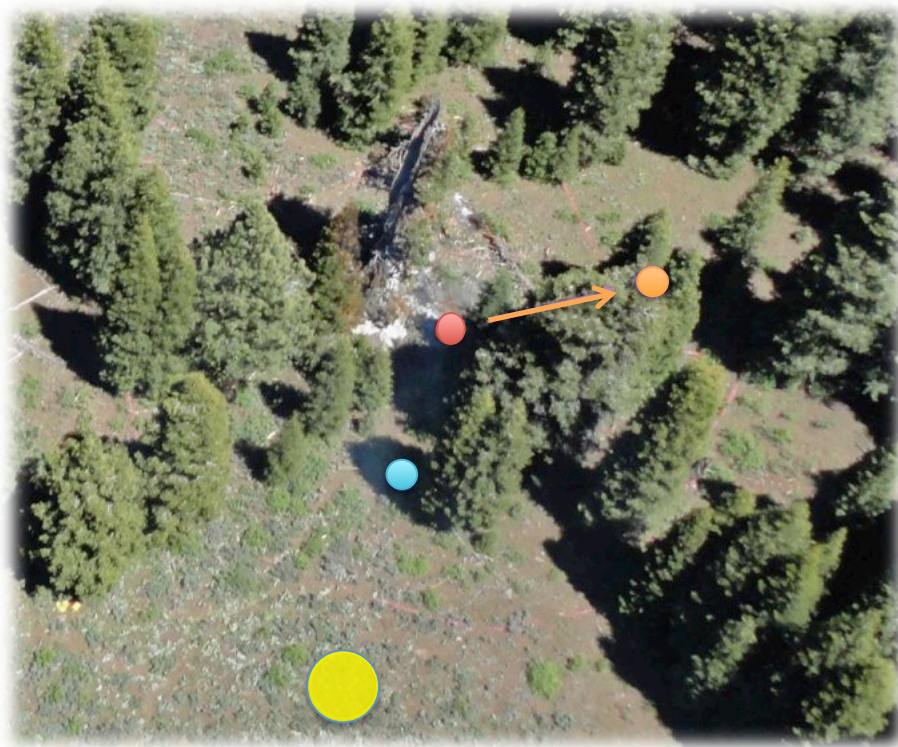


Even from their different vantage points, Sam and Connor sense pretty much the same things - the ground is wet and the fire is probably not going anywhere until the fuels dry out, so there's no need to rush.

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 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."



**Photo 4:** Approximate positions of the firefighters, when the treetop comes out  
Yellow circle = Sam, who is assembling the saw (large circle indicates general position)  
Blue circle = Luke, who is on the radio  
Red circle = Connor, who avoids the falling treetop and runs away from the tree to the orange circle.

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<sup>6</sup> 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.

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.”



**Photo 5:** Illustration of the approximate bend in the scratchline (white areas are ash from the ground fire)  
For another view, see Photo 10, page 27.

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<sup>6</sup> This is how Sam and Connor referred to the tree, meaning they recognized it as a hazard tree.

Suddenly, Connor hears a “Whoosh!” sound. In his peripheral vision, he sees a limb fall and hit Luke, driving him to the ground<sup>7</sup>. 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.”

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!”

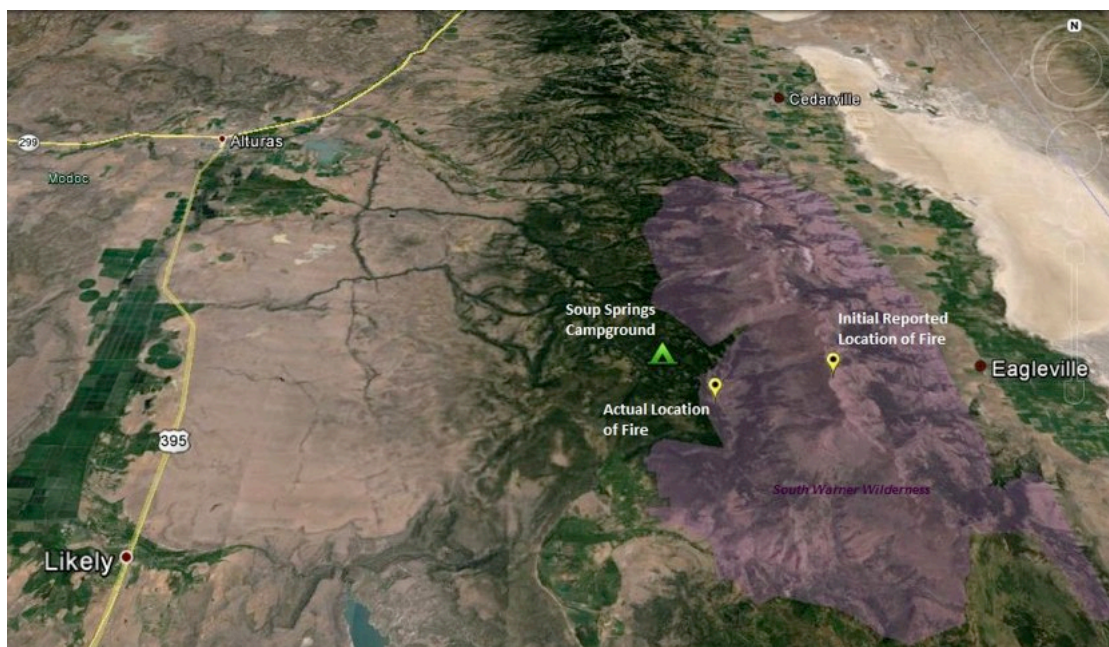
MICC: (Modoc copies) “Could you repeat your identifier?”

Connor: “Redding Smokejumpers, we jumped out of jump 42.”<sup>8</sup>

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.



<sup>7</sup> 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.

<sup>8</sup> The transmission referred to ‘jump 42’; however, the jump aircraft was ‘jump 43’.

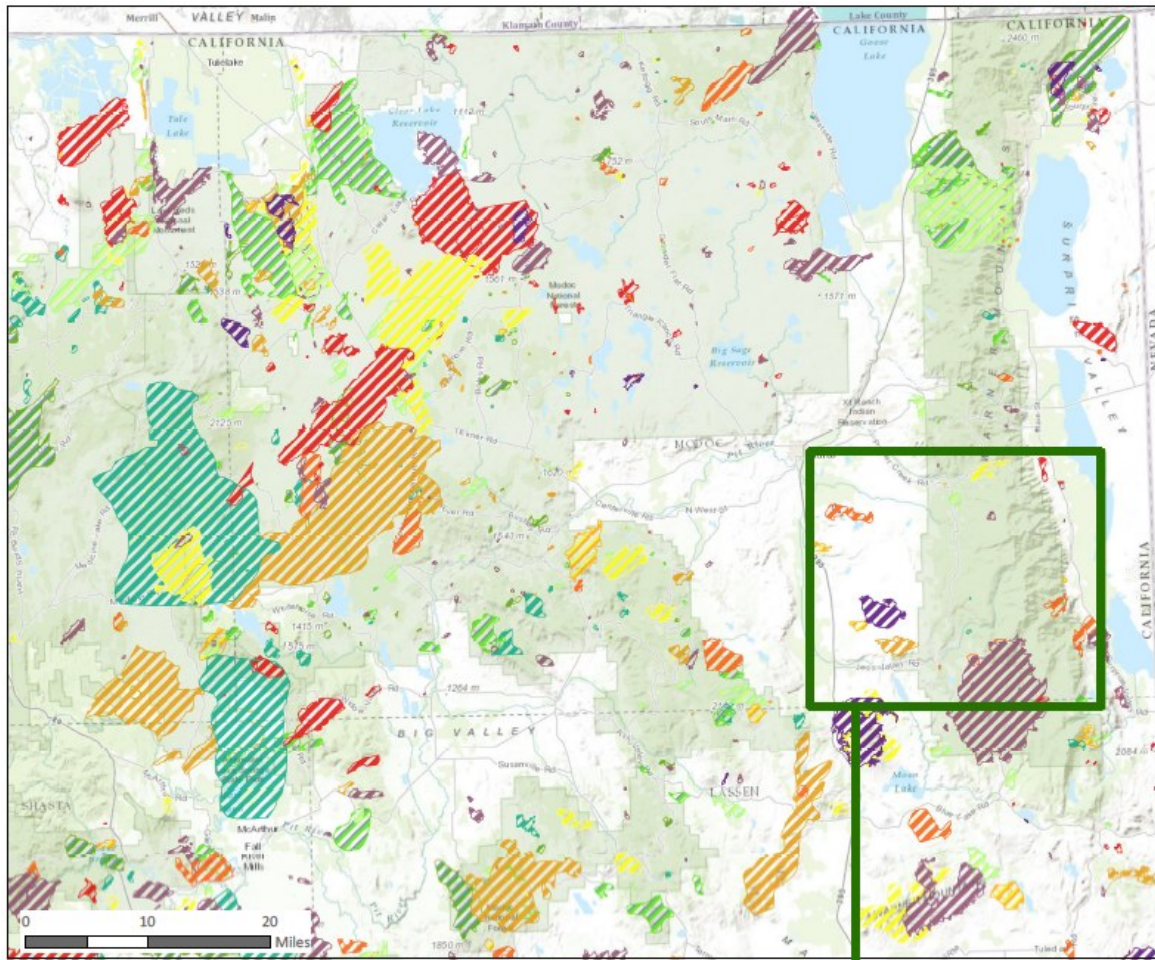
## Organizational Narrative

The Warner Mountain Suppression Fire Management Unit (FMU) direction states: “Suppress all fires using the appropriate suppression response,” regardless of cause. The South Warner Wilderness FMU allows fire managers to “permit lightning caused fires to play, as nearly as possible, their natural ecological role in the Wilderness.” On June 5, due to the Regions dry spring, the Forest Supervisor issued direction that the South Warner Wilderness FMU would “receive the same safe aggressive initial attack as all other Fire Management Units on the Modoc National Forest.” The same letter authorized the use of helicopters, chainsaws, and portable pumps to be in the South Warner Wilderness. The smokejumpers received this authorization from MICC, prior to jumping the Saddleback Fire.

Managing ‘fires for resource benefit’ is still a politically charged issue across the west, due to smoke issues, fear of losing grazing land, the encroaching wildland urban interface, and events such as last summer’s Reading Fire in nearby Lassen National Park. Reading was a ‘fire for resource benefit’ that escaped containment and threatened multiple communities, costing \$15.8 million.

Several large fires have burned in, or near, the South Warner Wilderness including the 2001 Blue Fire, which was an entrapment fire. Most of the wilderness is a fuel type and ecosystem that has long fire return intervals and the upper elevation will only burn under the most extreme conditions (above 98% Energy Release Component, ERC). The Blue Fire stopped because of the fuels in the wilderness, not the weather conditions. Modoc fire staff stated, “Any area on the Modoc could benefit by fire at the right intensity.” See Fire History Map, p. 12.

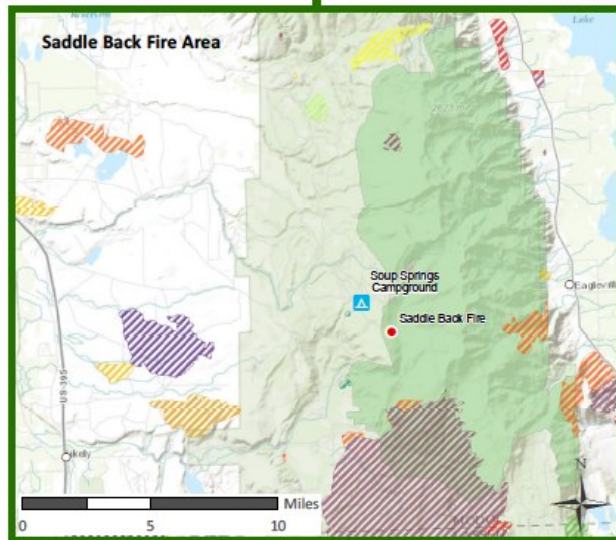
The Zone Duty Officer made the decision to use the smokejumpers based on the information available at the time, including: the reported fire location, resource availability/logistics, and potential future needs. This decision was consistent with guidance and direction.



**Fire History  
Modoc National Forest  
1910 - 2012  
(Fires > 10 Acres)**

**Legend**

- |            |             |             |
|------------|-------------|-------------|
| Campground | 2011 - 2012 | 1950 - 1959 |
| City       | 2000 - 2010 | 1940 - 1949 |
| Incident   | 1990 - 1999 | 1930 - 1939 |
| Wilderness | 1980 - 1989 | 1920 - 1929 |
|            | 1970 - 1979 | 1910 - 1919 |
|            | 1960 - 1969 |             |



# Synthesis, Analysis and Sensemaking

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## Key Concepts and Techniques

*Sensemaking* – There are two views of sensemaking; the first is the individual, or personal view, which is the way an individual makes sense of the situation. The second view is that of the organization (crew, team, multiple individuals), which includes interactions between people to create a coordinated meaning. This organizational sensemaking requires dialogue. When people are distracted or focused on specific plans, decisions, or mental models, it is difficult to create organizational sensemaking.

*Pressures and Filters* – These operate interactively and influence the way people respond to specific situations. External pressures are often static such as Forest policy, budget constraints, and the landscape. Individual filters also exist, including values and beliefs, assumptions, perceived consequences, individual strengths and weaknesses, or the current focus of attention. Individual filters can be static, or dynamic.

*Mindmaps* – These diagrams visually connect concepts to help illustrate their interconnectedness and complexity. These are intended to represent the non-linear nature of thoughts and beliefs, which challenge people involved in normal work (for example, see p. 14).

*Margin of Maneuver (MoM)* – A dynamic technique that describes what many firefighters already do when they recognize changes and adjust to meet challenges and unforeseen hazards. Margin of Maneuver can be seen as the available space in which a crew functions and makes operational decisions. This represents freedom to act, which expands and contracts based on changes in the operating environment and actions taken. Individuals and crews can consciously build MoM, which may give them more safe space for action. MoM can also be affected by external influences such as:

- Operational capability
- Social considerations
- Changes in fire behavior
- Expected/unexpected hazards
- Environmental conditions
- Political constraints

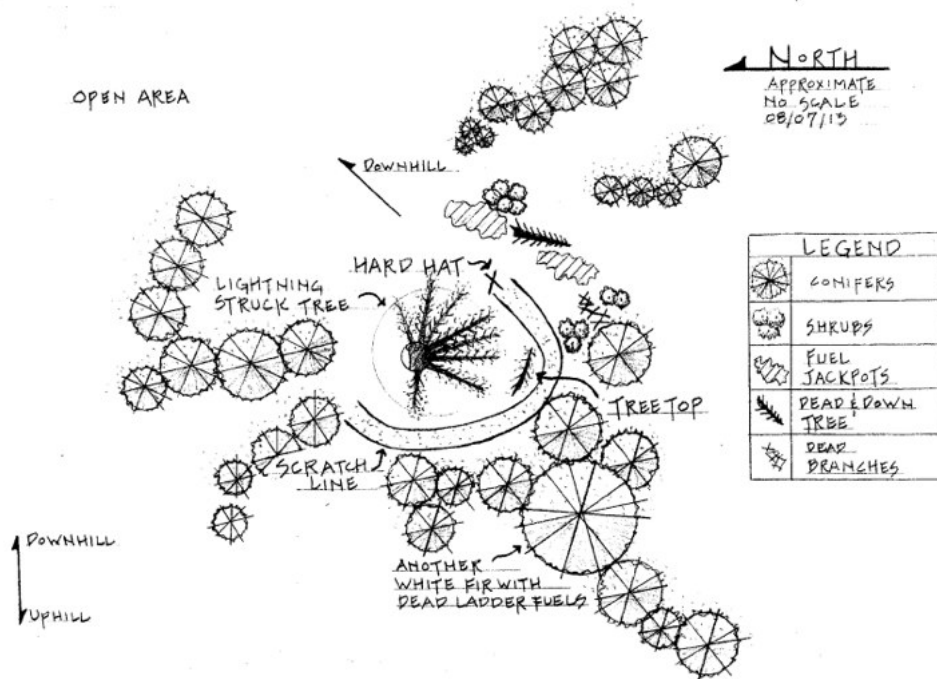
Each of these influences can have positive or negative effects on the ability of a crew to excel in the operating environment. MoM is not defined through quantitative analysis, nor is it defined by positive or negative outcomes. It incorporates the intuitive nature of work (rapid sensemaking), as well as the ability of crews to adjust actions and decisions as they recognize changes in the situations (deliberative sensemaking) and to take action to create margin (enacted sensemaking). This will be further explained in the Review.

## Building Context Around Actions/Decisions

There were a variety of different factors and pressures influencing actions/decisions<sup>9</sup> during the Saddleback incident, which are likely present in many organizations, or work environments. The Learning Review Team interviewed a diverse group of firefighters to develop a list of factors that were present at Saddleback, as well as in normal operations.

During the initial engagement, the firefighters described the “top of the tree coming out” and nearly hitting one of them. Connor reported that he felt the tree had been, “hit hard; there were a lot of green branches on the ground all around the tree.” The lean of the tree was described as being downhill and “it was too hot at the base to consider cutting it down.”

The limb load of the tree was minimal, where they started building line. The tree appeared to have been nearly de-limbed by the lightning strike and the subsequent fire. Looking up from this initial position (the uphill or right side), the upper part of the tree was leaning away (downhill) and there were very few limbs in sight. Sam recounted, “The majority of the limbs were burnt out.” It is possible that the tree ‘rebounded’, after the top came out. This may explain why the ‘treetop’ appears outside of the circumference of the branches.



**Figure 1:** Landscape architect rendition of the site

<sup>9</sup> There were occasions in the Review where the difference between actions and decisions could not be separated, thus the term action/decision was used, as it could have been either one, or a combination of both.

In hindsight, a number of options appear as viable alternatives to building line where they did; yet each had its own set of risks. There were a number of performance influencing factors that may have played a role in both increasing and decreasing the Margin of Maneuver of these firefighters. These seasoned firefighters likely acted simultaneously with deliberation and intuition; however, performance shaping factors may have prevented them from taking advantage of opportunities to increase their Margins.

Performance influencing factors are not unique to the smokejumper community and appear in all operational areas of the Forest, Service in varying degrees. The mindmap diagram below indicates some of the factors and pressures that may influence firefighters’ action/decision to build line where they did and act in certain ways. Start with the center concept and branch outward in any direction to see some complex factors, which may have influenced them. The full mindmap is available in the Supporting Information Section at the end of this Review.



The action/decision was made to engage the fire, by scratching a line around it. We have identified nine key factors:

- *Organizational pressures*, such as the influences and desires of the Forest Service, Forest Direction, and/or Standard Operating Procedures.
- *Training and experience* of the firefighters could influence them with regard to what was acceptable, desired, or possible.
- Providing good *customer service* for key stakeholders and the Forest, which is emphasized in most firefighter training programs and “aggressive safe firefighting” is advocated in the written guidance for the Region.



- *Assumptions* built on expectations of single tree fires, could encourage rapid and routine line construction.
- *Memory items* might include ‘slides’<sup>10</sup> from previous fires and influence how they approach a new fire.
- They may have feel *tactical pressure* to keep the fire small, and put out early season fire starts such as this one and to meet perceived stakeholder expectations.
- Their ability to *detect key signals* may be decreased by focused attention to line construction, and the physical posture required to perform this work. In the case of Saddleback, their heightened arousal associated with the first jump of the season and natural biologic responses associated with the first operational jump and first fire of the season and the location of the fire could have supported a strong desire to engage in the work ‘quickly’. This state of arousal is common to all emergency services and responses to emergent conditions and should not be considered unique to smokejumpers.
- *Cultural emphasis on efficiency* include concerns about how actions are perceived by others, cost containment and other perception of management expectations, these are evident in the culture of the Forest Service. Competition is evident in a number of our operations. Competition can have positive and negative effects.
- *Emotions* might include pride in what they do, their identity as firefighters (which might be enhanced for certain crews who are considered to be “elite” firefighters). At Saddleback, there may have been additional individual performance pressures associated with demonstrating ability and work performance.

These performance-shaping factors are interconnected and may be found in more than one category. This does not represent an exhaustive list and readers are encouraged to think of other factors and look at the supplemental data.

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<sup>10</sup> The reference to ‘slides’ refers to Recognition Primed Decision Making, a model presented to firefighters in both the “S” and “L” series courses (Klein, G. 1989 “Recognition Primed Decision Making”)

## Analysis

### “Treetop falls out”

The auditory signal (the sound of the treetop<sup>11</sup> breaking) and visual confirmation of the treetop falling and almost striking Connor, were detected correctly, perceived correctly, and the response took place rapidly. This allowed the firefighter to quickly move out of the way of the falling treetop.

Connor’s signal detection, expectancy, and flight response were enhanced by his experience. These factors combined and resulted in the successful avoidance of the falling treetop. Connor’s response was time critical and accurate.

### Effects of the Treetop on the Participants

The ‘top’ falling from the tree produced a state of hyper-alertness, as reported by one of the firefighters. It was notable enough that Luke reported this event to the jump aircraft, when it passed back over the fire. Another firefighter interpreted the initial signal differently, “I sensed relief when the top came out, as though a storm had passed”. Expectancy was lowered by this sense of security, based on the belief that a similar event, from the same source, was unlikely to occur. Firefighters interviewed post-incident, supported this assumption. One Saddleback firefighter stated, “it felt like we had good distance around the tree and we had good eyes”.

### Line Construction

Connor and Sam began line construction to the left. Luke’s redirect, to start to the right, represents a signal that perhaps they are not on the ‘same page’. They are all experienced firefighters and it is possible that this redirection made intuitive sense. Once Luke changed the direction of line construction, the firefighters moved toward where the ‘top fell out’ and began work, without dialogue. This may be a form of group sensemaking, which fit their individual interpretations of an unshared plan. Factors they may have considered in their decision include: fire activity on this side of the tree, continuous fuels upslope of this side of the tree (including a large stand of mixed conifers), unburned fuel jackpots on the ground, a desire for efficiency, or a need to ‘keep the fire small.’

Sam and Connor begin line construction on the uphill side of the tree, where there is almost no limb-load. The limb load gets progressively greater as you move to the downhill side of the tree. The scratch line is outside the lateral extent of the limbs when they begin line construction. This gradually changes as the line progresses. They are unaware of their proximity to the tree after they pass the fallen treetop. At this point the line bends sharply toward the limb-loaded side of the lightning struck tree. (See Figure 1)

The question remains, “Why did they believe they were a safe distance from the tree?” The

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<sup>11</sup> The firefighters referred to the ‘treetop’ during interviews, thus the Review also uses this term. However, fir trees can have multiples tops and/or the falling ‘top’ may have been a branch, near the top.

Data Collection Team discovered one place where the lean of the tree could be clearly observed (Photo 5) close to where line construction began. The initial starting point of line construction appeared clear of overhead hazards (this is the de-limbed side of the tree). Firefighters reported that most of the limbs on this side were on the ground. The heavier remaining limb load was on the downhill side of the tree, which may not have been visible from their vantage point. The limb load and lean of the tree, coupled with the lateral growth of the spike tops of the tree (even as observed five days later) extended the hazard area beyond the radius of the lower limbs, which is all that may have been visible from their initial perspective.

Once the firefighters began line construction, visual signal detection was significantly degraded, due to the physical 'bent over' posture that is required to dig line. Assessment of the limb hazard was likely reduced or impeded by the inability to see the fire weakened branches well above them, due to smoke, location, and posture. Therefore, the only signal that could have provided enough warning and elicited another successful flight response was an auditory 'crack' of the limb breaking free from the tree. It is quite possible that the auditory signal was masked by the noise of the chainsaw. Another possibility exists that a sound was never made at all – because the limb was already dislodged from the tree and was hung up in another branch. The wind at the time was light and variable.



**Photo 6:** View looking downhill.  
Luke's perspective of tree, while on radio.



**Photo 7:** View looking uphill.  
Limb load visible from this perspective.

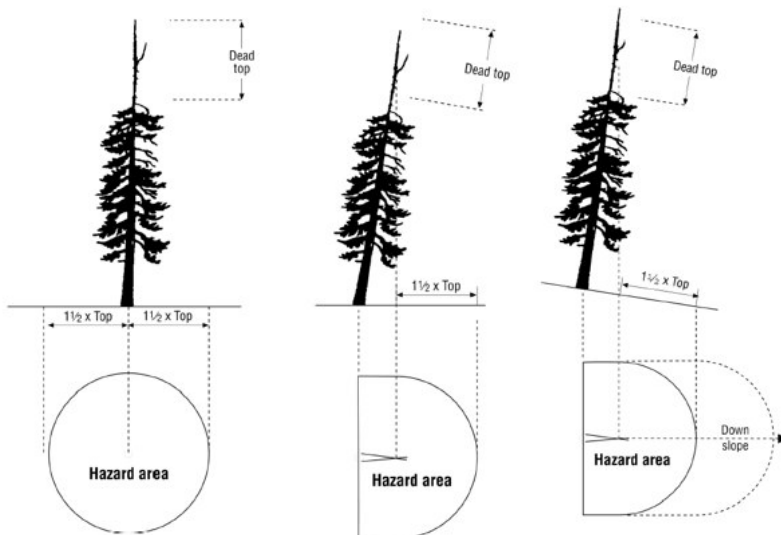
\*\* Yellow arrow indicates the 'treetop' that almost hit Connor.

## Tree Lean

The Data Collection Team studied the lean of the tree and engaged the help of a C Faller. The team noticed that the lower bole of the tree leaned slightly uphill, yet the upper part of the tree leaned downhill, in the direction of the limb load. In addition, a crack in the bole was observed, which was visible on the pictures of the tree taken immediately following the incident. This crack became even more obvious to the team five days later, after the tree had burned. The upper lean of the tree was in the direction of line construction and was consistent with the location of the firefighters, when Luke was struck.



**Photos 8 and 9:**  
Crack in tree



**Figure 3:** Examples of tree lean, showing how the 'top' can extend the hazard area.

Source: Wildlife Tree Committee of British Columbia, "Wildlife/Danger Tree Assessor's Course"

## Sensemaking Discussion

***“Things that never happened before; happen all the time.” (Lee Clarke)***

There are two views of sensemaking: individual and organizational. The individual or personal view, is the way an *individual* makes sense of the situation. The second is *how a group makes sense* of the situation (multiple individuals, such as a crew or team). The second view includes the interactions between people who work to share a common mental model. Both views can be active or passive and sensemaking can be limited by individual assumptions, or mental models. In group sensemaking, people interact to understand, challenge and verify mental models and assumptions – verbally checking perceptions and, literally, building a shared mental model. It is difficult to create organizational sensemaking when people are maximally distracted, or focused on specific plans or decisions.

Group sensemaking was reported to have taken place during Saddleback Fire in the aircraft, between the JIC and the Spotter. Here, seasoned jumpers interacted to develop the initial plan. This interaction was based on mutual trust between individuals, respect for each other’s input, and self-respect enough to honestly voice their concerns. These criteria are required for interactive sensemaking and learning to occur. The same level of interaction and evaluation did not occur once on the ground while on the fire.

We know that the actions taken by this crew do not seem out of the ordinary. Several firefighters interviewed post-incident said they felt like these actions were routine and that they would have done the same thing. This type of fire was described as a “good deal fire”, or “a fire where we can relax” (as compared to a large, complex fire). It is common for people to assume that large events are more complex and small events are simple. This can place people in the mode of ‘believing they know’ instead of questioning for themselves, or checking perceptions with each other. This can result in shortcutting the group sensemaking process.

If I make a decision it is a possession. I take pride in it. I tend to defend it and not to listen to those who question it. If I make sense, then this is more dynamic and I listen and I can change it. A decision is something you polish. Sensemaking is a direction for the next period. (Paul Gleason)

The decision to ‘aggressively attack’ this fire was quite possibly made early in the process, perhaps even before the firefighters were dispatched to the fire. Focus group interviewees indicated that training, reputation, and expectations about single tree fires abound in the culture, especially in the South Warner Wilderness. “This is easy, the dream fire; we all think about single tree fires in the Warners. Just put a quick line around it and wait” (senior firefighter). “There is a sense of routine around small IA – single tree IA. I often feel like I don’t need to be that engaged; I can just put my head down and get to work” (senior smoke jumper).

A mental model is created by training, experience, and stories. Once a mental model is created, it can act like a decision and is difficult to challenge, even in the face of contrary information. Language supports these established mental models. Examples of the language used to describe a mission like the one at Saddleback include, “quick, little check-line”, “efficiency”, “less work”, “reputation”, “this is what we do”, and “control”. The language of firefighting

appears to support routine action (and vice versa).

We often see what we expect to see. Assessments and observations were not enough to challenge the established mental model. Saddleback firefighters said, “We went about that tree about the same way we would go about any tree.” There was significant damage to the tree, “It was hit hard . . . but it was stable, it was a green tree – I could see green branches and the bole was solid.” An experienced firefighter told us, “A *formal* discussion may not be needed; we all know the job and have *group knowledge*.”<sup>12</sup>

Informal interactive dialogue can be an effective way to engage in sensemaking. This gives value to observations and leads to a more substantive challenge to mental models. It is normal for attention and focus to shift rapidly, as hazards are identified. It is equally easy to fall into a routine and not notice changes. When people feel they ‘know’ something, they often stop paying attention to it. The more a person is familiar with a task the less attention they pay to it. To learn, people must stay in a mode of inquiry.

### **Learning at Saddleback**

Development of a plan in the aircraft has the benefit of perspective, resulting from the bird’s eye view (compare Photo 1 with what can be seen in Photo 2). There is a certain richness of detail that ground firefighters will not have available to them. These observations need to be enhanced by “ground truthing” the information, as well as recognizing details not available during aerial observations. The aerial observation can also be compromised by heightened excitement, brought on by pre-jump anticipation. This can maximally distract some individuals, degrading the quality of information transfer during the airborne briefing.

Aerial delivery of firefighters has a great deal of margin of maneuver created in it to allow for safe delivery in most circumstances. A deliberative approach is used for each jump, which is designed to increase margins for those involved. At Saddleback, the system deliberately recognized and addressed the risks associated with the jump phase. The system did not reflect the same intense deliberation, with regard to ground firefighting operations. This may represent a systemic normalization of risk. The jump was conducted flawlessly, according to reports, however the same level of deliberation did not occur regarding ground truthing.

Once engaged in ground firefighting operations, there was individual sensemaking, but there was little effort to create organizational sensemaking (which requires participation and dialogue between crew members). There were well-rehearsed aspects of the mission, which were conducted effectively (e.g. putting the saw together, building line, calling in the size-up). However, there is a need to be continuously adaptive in complex environments, to never assume that this fire is just like any other fire. “The next fire I walk into, I won’t know anything.” (Gary Provansal<sup>13</sup>) The shared dialogue needed to create organizational sensemaking, or a shared mental model, relies on an assumption that no two fires are exactly alike – a recognition

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<sup>12</sup> Additional quotes supporting these observations can be found in the “Firefighter Views” mindmap, in the Supporting Information Section of this Review.

<sup>13</sup> Gary Provansal, Division Chief, San Bernardino County Fire Department; Structure and Wildland Fire, EMS, Disaster Response Specialist, with 30 years experience.

that you have never been on 'this fire'. This reinforces the need to be continuously adaptive.

At Saddleback, there were three related roles that were active at the time the accident occurred: sawyer, swamper and finisher. Transition to leadership roles can be challenging, as one senior jumper stated, "Lead by example and the example is *working*. I want you to work hard, so I have to demonstrate hard work." This can introduce brittleness into the system. Firefighters were very familiar with line construction and operated in a routine way, so they may have felt there was no need for discussion. Each of these roles was conducted professionally and in accordance with training and guidance. Even though they did not actively expand Margin of Maneuver, there may have been an implicit understanding of mission goals and the definition of success. Margin of maneuver was unintentionally reduced by the physical position required for line construction, the lack of dialogue, the normalization of risk, the assumed simplicity of the situation, and the routine approach to the fire. The firefighters at Saddleback performed the way the system had prepared them to and still their line construction drifted toward the tree, without them being aware.

High performance athletes, like firefighters, have to focus on developing skills and/or managing their performance in dynamic and often high-risk environments. In some cases, this can fundamentally conflict with their ability to monitor their own exposure to risk, or situational awareness. This is one reason athletes employ coaches. The responsibility of the coach is to watch for trends, changes in the environment, and changes in the athletes and then adapt to meet the intent. Initial goals and plans may change as the coach learns how the environment is challenging the athlete, or how the opposing team is adapting to defeat their original plan. The equivalent role of coach, in the firefighting environment, might be the leader of the crew involved in the engagement, or any leader on the fire ground. The role of a leader in fire is to learn as much about the environment as possible in order to adapt and meet leader's intent. This can be summed up as, **leading is learning**.



"One of the hardest things to do is to stop 'working', getting my head up and looking around. There are times when I know I have to be the one thinking, but I always feel as if I am not 'working'. I had to learn to step back and become a manager to keep the big picture."  
(Senior smokejumper)

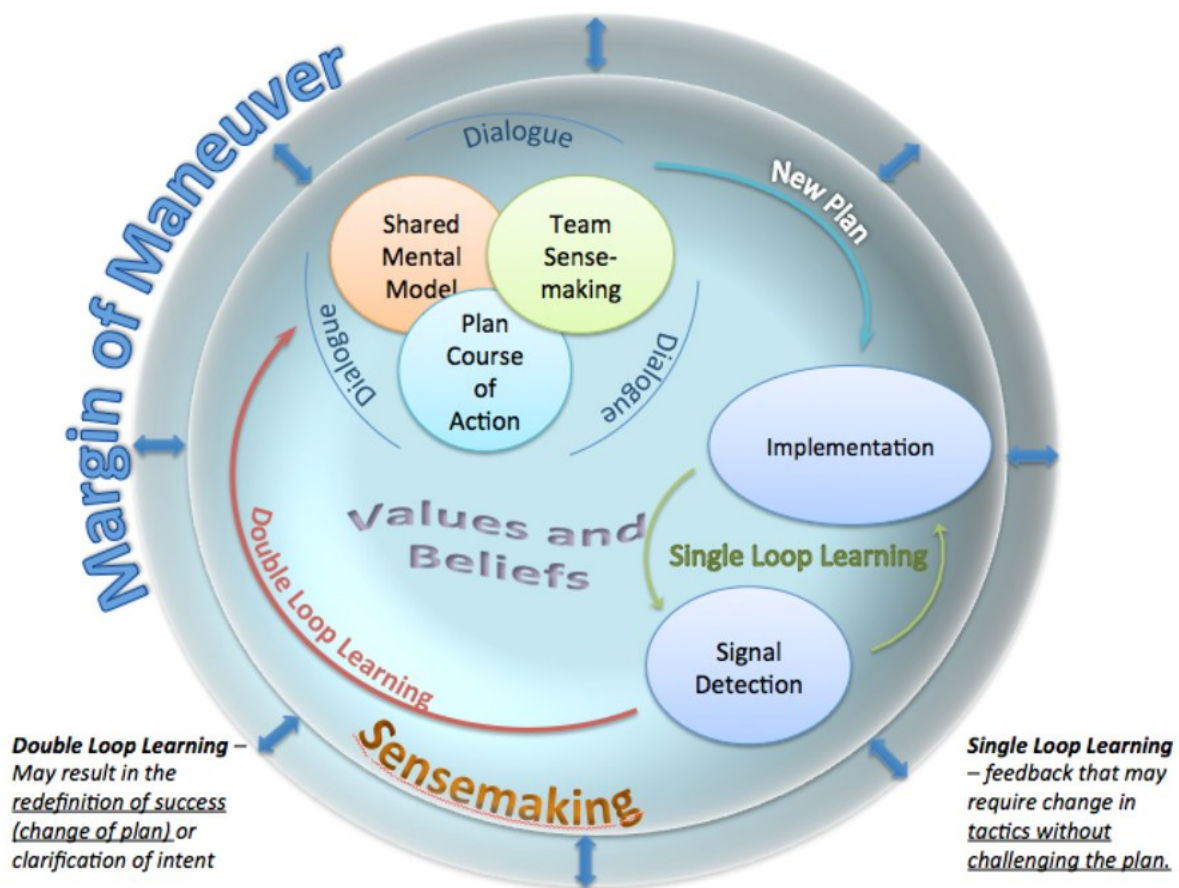
*This image is referred to by some firefighters as "Sup's Rock," evoking the concept that the leader is "heads up" getting the "big picture."*

*Photo courtesy of Alexis Lewis*

## Margin of Maneuver Discussion

Margin of maneuver is closely tied to the interaction between signals and pressures in the existing environment. MoM can facilitate inquiry, once a signal is detected and may result in the user asking, “What just happened to our margin?” Margin of Maneuver provides language to a common way that people naturally deal with recognized hazards. Smoke Jumpers exemplify this technique each time they prepare for a jump. They evaluate the conditions and increase margins according to the information they receive.

In the Saddleback incident, there were timely opportunities to challenge mental models and create group sensemaking; for example, when the participants stated that there was “no rush,” and the “fuels were wet.” The lens of MoM may have helped them reframe their mental model of the situation to include other options for mission accomplishment, or safety expansion through critical thinking.



This depiction represents how Margin of Maneuver fits in a larger framework of sensemaking and critical thinking.

Margin of maneuver is also affected in subtle ways that are often unnoticed by participants. High performing and highly trained, skilled people may not be very good at balancing their aspirations and their exposure to risk. This balance can appear as a sacrifice decision that



forces a trade-off of one goal for another (e.g. mission vs. safety). To use the prior analogy, an athlete without a coach may only know how far to push by going *too* far, getting injured and having to learn from it. In fire, the costs can be far more significant; thus, trying to find the limits without exceeding them is a critical process.

Margin of Maneuver is also affected by our ability to detect and react to stimuli, through our five senses. Alertness and our level of expectation may be coupled with experience and affect signal detection. Signals can be masked by a number of physical and psychological factors, such as fatigue, goal seduction, or cognitive bias. The Saddleback crew may have experienced some cognitive distraction – it was the first operational jump for the rookies and the JIC expressed excitement about a fire dispatch to the Warners. Physiological changes in the firefighters may have led to blocked signals, thereby decreasing Margin of Maneuver.

High performance also contributes to an inability to objectively balance risk exposure. The following quotes represent cultural values, which may influence people to work to the edge of margins. “If you back off too early, you will be seen as weak” (senior firefighter). “We are definitely reluctant to turn down [assignments], but we are willing to do it” (senior smoke jumper). “You are always trying to convince yourself that you can go right back in and get to work” (senior smoke jumper).

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.

(Firefighter, 12 years wildland firefighting experience)

David Woods, a leading researcher in the field of Resilience Engineering, suggests that new concepts, like Margin of Maneuver, be introduced during the After Action Review (AAR)<sup>14</sup> because there is less time pressure following a mission and crews can use hindsight to their advantage. Current research suggests this process may gain more leverage, in terms of learning from the event, if questions are directed toward specific learning moments. Focus groups suggested that firefighters discuss concepts like MoM, decision space, and ‘luck’ during AAR’s (a more complete list of focus group input is listed in the text-box on page 31).

USFS and US Military instructor pilots reframe their mental models or change their definitions of mission success when their margins are large. Large margins give more room to make mistakes, without significant consequences, thereby affording the opportunity to learn from the experience.

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<sup>14</sup> The AAR process is currently explained in the *Incident Response Pocket Guide*, page xii.

## Using This Information to Learn and Improve

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***“Tell me and I forget. Teach me and I remember. Involve me and I learn.” (Benjamin Franklin)***

As part of this Review process, focus groups were introduced to the concept of Margin of Maneuver as a separate learning product for the field. Focus groups consisted of aviation, line officers, fire leadership and firefighters. Mixed groups, in terms of size and composition, seemed to be an effective interaction environment. The group presentations included both verbal and visual representations of MoM, which were followed by a hands-on exercise. This led to an open discussion of how Saddleback, participant experiences, and operating modes can relate to the concept of MoM. (*See below, for further description*)

Two suggestions for further development emerged during this Learning Review:

- A needed improvement to the Hazard Tree Awareness Training, to include SME recommendations (e.g. C Fallers)
- A recommendation to conduct a study of the Saddleback Incident Within an Incident, the rescue and recovery operation.

Learning Review focus groups also recommended:

- Impress the concept of *leading is learning* in all our leadership courses and throughout the wildland firefighting training curriculum. Emphasize this concept in L280 “Followership to Leadership.”
- A review of the current AAR process to determine if the topics of discussion should reflect the recent developments in Resilience Engineering. Several people interviewed during this study indicated a lack of applicability of the current After Action Review (AAR) process. It was suggested that AAR’s might be more effective if they were self-designed.

### **Self-Designing an After Action Review**

*The following questions emerged during focus group interactions, or from interviews with firefighters conducted during this Review:*

- When did we notice Margin of Maneuver changing?
- When did we miss opportunities to improve our MoM?
- When were we ‘lucky’ to get the result we achieved?
- When were we surprised by what we saw or felt?
- How was your plan of action communicated? Was it clear? Could you ask questions?
- How did your leadership respond to questions?
- How did your plan match what you did during the mission? What was different?
  - What helped you notice the difference?
- What surprised you? How did you adapt to the surprises?
- When was luck a factor?
- Overall, what can be done to improve operations at the small unit level, the incident level, the Forest level, and the National level?

## Margin of Maneuver: Application and Focus Group Results

Focus groups engaged the fire community in the evaluation of the concept of Margin of Maneuver. These focus groups were conducted with Forest Service personnel: Line Officers, smokejumpers, District FMOs, hotshot crew superintendents, engine captains, helitack crews, Staff Officers, and Single Engine Air Tanker (SEAT) pilots. During these meetings, the concept and language of Margin of Maneuver was introduced and personnel were engaged in visual and kinesthetic “hands-on” demonstrations through the use of a Hoberman Sphere and an interactive activity.

These techniques helped participants understand MoM in a non-threatening way and apply the guidance to their own experiences. It was noted that participants engaged across hierarchical and position boundaries and seemed comfortable talking about more complex concepts and situations, within the framework of the Hoberman Sphere, and/or MoM. The language of focus groups also expanded to include terms that could be used to describe and apply MoM.



### Hoberman Sphere

A geodesic sphere that is capable of folding down to a fraction of its normal size by the scissor-like action of its joints. This expansion and contraction capability made it useful for describing how Margin of Maneuver can dynamically change.

Individuals reported that, although MoM seemed complex at first, the visual tools made it “easier to think about, things are complex enough – as it is in our lives and jobs.” Further, it was noted that “a visual is always handy...almost a hundred percent of the people (firefighters) are visual.” Having something visual “hit the message home right off the bat.”

The next step is to conduct additional focus groups to validate these early results. Though this is difficult during fire season, participants indicated this concept should be introduced as soon as possible. Some participants even asked for their own Hoberman Spheres, to illustrate the concept to others. A field implementation program is being developed to bring the concept of Margin of Maneuver to the fire community.

## Hazard Tree Awareness and Options

White and red fir trees have a tendency to shed branches, when weakened by fire. A similar event to Saddleback occurred in 2004 during a prescribed fire with the Arrowhead Hotshots. A fire was burning in the top of a white fir and shortly after it was sized up for falling, the top came out and struck Daniel Holmes. There are a number of other investigations that mention tree species with hazardous characteristics (black oak in the Eastern Forests, green cedar, etc.). See the “Tree Strikes” table in the supplemental information section of this Review.

*White fir trees share many of the same features and behaviors with red firs. White firs can be particularly hazardous, as they can have multiple ‘spike’ tops, shed branches, break at the roots, and tend to rot in the middle.*

Research indicates that one possible way to improve the ‘hazard tree awareness’ training product would be to incorporate the expertise of the community of C Fallers and to add a discussion regarding available options regarding options. These highly experienced sawyers may help us learn techniques that would be valuable for other firefighters to know. There are a number of products available to the community, but many are not well known. These products should be assessed and developed into a cohesive product for distribution. Adult Learning Specialists might also be consulted, to help develop additional learning products.

*Would the inclusion of identification training on specific hazardous tree species benefit firefighters and/or the extended community? How can our training about identification and interaction with hazard trees be improved?”*



**Photo 10:** Red arrow points to lightning strike tree. Yellow arrow points to similar white fir ‘sister tree’

## Proposed Study of the Saddleback Incident Within an Incident

This Learning Review covers the Saddleback accident, up to the injury of Luke Sheehy. The consequent medical evacuation, or 'Incident Within an Incident' (IWI), is not covered here. Yet, the medical evacuation presents further decisions and actions, from many levels of the organization, which may result in operational learning opportunities.

A dedicated study is suggested to answer the following question:

“How can we build more resilience into the process of managing injuries and patient extraction in remote areas, like the Warner Wilderness Area?”

A case study approach could include the information gained from Saddleback, as well as other incidents, to develop a deeper understanding of the complexities surrounding these issues. Qualitative and/or quantitative data may build on the existing Dutch Creek Protocols to create a more resilient approach to remote area support and, if needed, extraction.

## Organizational Learning

### **If you can't prevent it what can you do?**

Complex systems change and adapt in predictable or unpredictable ways. Developing a process, matrix, or algorithm will work for simple systems and complicated systems, which are systems with finite answers. However, the complex system can defeat even the best plan. Prussian Field Marshal Helmuth von Moltke, who was credited as having developed Doctrine said, "Planning is everything, but no plan survives first contact with the enemy." This quote demonstrates the importance of both preparation and adaptation. Complex systems are similar to warfare – the enemy will change and learn to defeat the opponent. Nature has the ability to be equally adaptive and unpredictable.

Over 100 firefighters were asked if they had a 'tree story' (a near miss, involving a tree) and all reported at least one. Yet, wildland firefighters have a comparatively low incident rate related to tree strikes. This may be attributable to a high level of expectancy ("if you walk in the woods, tree limbs will fall..."), preparedness (training, having a basic plan of action), or a high degree of alertness (which facilitates recognition and intuitive, skills-based responses). In cases where any of these components are degraded, personnel should consider increasing their Margin of Maneuver in some practical way.

Margin of Maneuver is not a cure all; it represents one of many tools in our toolkit. Perhaps the greatest tool emerges from understanding how safety is created and by developing the skill of critical thinking. There is a belief that safety is created through rules, regulations, policies and procedures (we will call this 'rules', for the sake of brevity). This is true, in the sense that it gives us footing as to how to begin to operate. Rules are the starting point and are especially important for novices; however, experts rarely rely on rules or maxims and instead rely on an intuitive grasp of the situation. Success in complex systems requires the adaptive responses generated by expertise. Yet at Saddleback, everyone was following the rules and something terrible still happened.

Saddleback did not represent an absence of ability; all those involved had demonstrated the skills needed to work with wildland fire. However, the firefighters fell into routine line construction, which seemed to have masked important signals (e.g. the top coming out and the unnoticed bend in their line). We should ask ourselves, "What are the components of our system that supported this kind of reaction?"

We have to consider how safety is created at the point of work, when crews are directly exposed to unanticipated hazards. When crews and individuals create safety, it is often the result of critical thinking and the creation of adaptive responses. This kind of problem solving is commonplace in wildland firefighting operations and is considered by many to be responsible for almost all of our successes.

## The Five Practices

This report embraces the value of learning and, thus, may lead to an expansion of our thinking concerning the five safety practices.

1. **Agreements** (How consistent is my behavior with our agreements?)  
Do we need to develop agreements that consider multiple competing goals and risks?
2. **Strategic Risk** (How confident are we that the proposed work is worth the risk?) Risk assessment is simple in hindsight; however, it is quite different in the moment. Risks are often assessed in multiple frameworks and from multiple perspectives. For example, how is taking no action actually less risk than allowing a fire to burn and to potentially become larger and require a significant increase in personnel and therefore exposure. It is less risk in the moment, but an early season fire could become a multi-million dollar extended attack operation ultimately resulting in significant increased exposure. This is the shortcoming of predicting the future risk, which can only be imagined.
3. **Preparation** (How can we do this work safely?) Are we prepared for the next adverse, unexpected, traumatic event, including both resiliency training and crisis action teams? Certainly, the team that was created after the traumatic event demonstrated the resilience and preparation needed to address the situation. The firefighters at Saddleback were well trained and prepared for this fire. It is not uncommon for Smoke jumpers to fight single-tree fires.
4. **Awareness** (How safe am I now?)  
This is always a challenging question for firefighters, what is aggressive enough and what is safe enough, is often only known after the fact and can only be imagined, based on experience and training, in the moment.
5. **Learning** (What are we learning?)  
Do we have structures and processes in place to facilitate learning from positive as well as negative outcome events?

## Organizational Intent

The uncertainty inherent in complex systems indicates that not all eventualities can be predicted; therefore, no policy or guidance can meet the needs of every possible situation. The ability to respond adaptively, to new or unfamiliar circumstances is the only known way to work in complex, dynamic environments that have uncertainty as an emergent property. It has been shown that adaptive organizations are the most successful at learning and dealing with complexity. As such, organizational intent should be centered on developing and maintaining individual and organizational resilience through the encouragement of adaptive problem solving and critical thinking. This requires a conscious effort on the part of the organization to create corporate language – a system of beliefs and espoused values designed to foster and

encourage complex adaptive problem solving. This may sound like a bid for absolute freedom to do anything; however, more tangible control may emerge from a system based on fostering adaptation. This is the result of greater information sharing and overall knowledge regarding how work is performed.

The US Navy and US Coast Guard understand the importance of both doctrine and rules, yet neither are static in their systems. The following are examples from the Naval Air Training and Operating Procedures Standardization (NATOPS):

NATOPS must be dynamic and stimulate rather than suppress individual thinking. Since aviation is a continuing, progressive profession, it is both desirable and necessary that new ideas and new techniques be expeditiously evaluated and incorporated if proven to be sound. To this end, commanding officers of aviation units are authorized to modify procedures contained herein for the purpose of assessing new ideas prior to initiating recommendations for permanent changes.

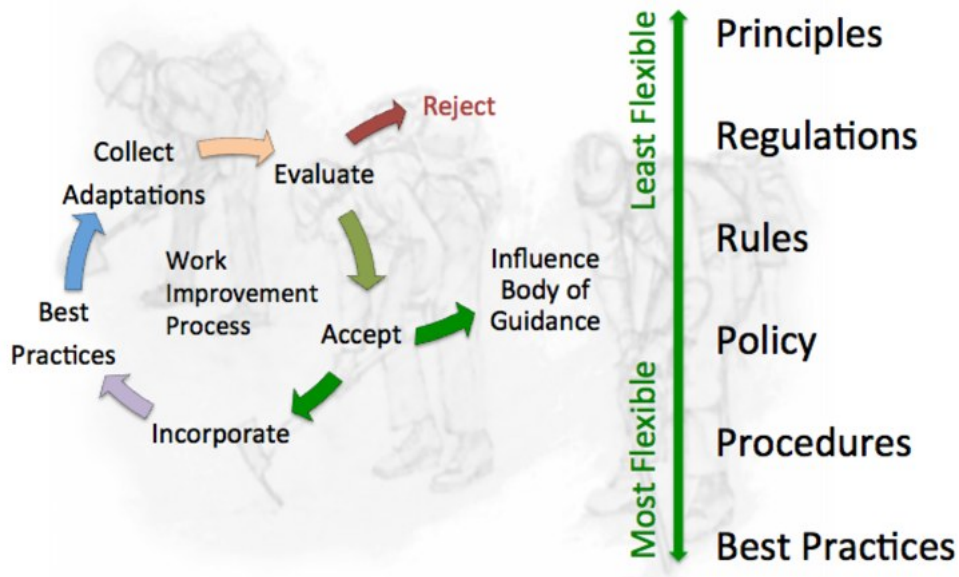
NATOPS manuals provide the best available operating instructions for most circumstances, but no manual is a substitute for sound judgment. Compound emergencies, available facilities, adverse weather or terrain, or considerations affecting the lives and property of others may require modification of the procedures contained herein. Read this manual from cover to cover. It is the air crewman's responsibility to have a complete knowledge of its contents.

Systems that foster innovations (most of which represent work improvements) also need a pathway for these to be recognized, tested, refined, and shared. Adaptations will always occur in complex systems, whether they are hidden from view, due to fear of reprisal, or shared with others for collective learning and improvement.

A resilient organization exhibits qualities of trust and mutual respect. These qualities are reflected in open dialogue and feedback. If there is no avenue for the dialogue and evaluation of innovations, unwanted processes can develop and become part of 'common practice' without the organization being aware of them. If adaptations can be identified as unacceptable, they can be removed from the system before they result in undue exposure to risk. Innovations that are acceptable, and enhance the system, are called 'work improvements;' they represent ways the system can change, from within, through innovation. These can be identified, if voiced, and then incorporated in 'best practice' and they can be shared throughout the community of practice. In this way, 'best practice' also retains its dynamic nature.

In order for this to be effective the organizational model should facilitate, coordinate, assess and institute changes. Below is a conceptual model that represents the approach suggested during Office of Learning focus groups, held around the USFS last fall and spring.





Bureaucracies tend to drift toward static operating models, which can adversely affect their ability to adapt and can degrade resilience. Gifford Pinchot introduced doctrine to the USFS, at least in part, because he recognized the challenges of trying to manage complex ecosystems. Principles, or Doctrine, are foundational and are followed, in order, by Regulations, Rules, Policy, Procedure and Best Practices. All of these components should be considered to be dynamic, with the least amount of change occurring at the ‘Principle’ level and the most at the level of ‘Best Practices’.

Doctrine incorporates principles that form the foundation of human judgment, decisions, action, and behavior. It is authoritative but flexible, definitive enough to guide specific operations, yet adaptable enough to address diverse situations. Far from eliminating firefighters’ standard rules of engagement, Doctrine empowers people to use their own judgment “at the sharp point of the spear” where accidents most often occur.

Tom Harbour, Director, Fire and Aviation Management, USFS

## Glossary

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*Big, ugly tree* – (shared terminology) A tree that looks hazardous; a hazard tree.

*Black* - The “Black” is where a fire-front has burned all fuel or vegetation in that area. These spots are many times marked as safety zones for firefighters, because there is nothing left for the fire to burn. Further, “taking black with you” means that a firefighter or fire behavior, on its own, is making an area clear of fuels.

*Brittleness* – Opposite of resilience (see below)

*Check-line* – A temporary fireline constructed at right angles to the control line and used to hold a backfire in check as a means of regulating the heat or intensity of the backfire.

*Community of practice* – A group of people who share a craft and/or a profession. The group can evolve naturally because of the members' common interest in a particular domain or area, or it can be created specifically with the goal of gaining knowledge related to their field. It is through the process of sharing information and experiences with the group that the members learn from each other, and have an opportunity to develop themselves personally and professionally.

*Complex system* – Complex systems are dynamic networks of interactive, interconnected and diverse components. They also display the additional characteristic of adaptation, in that the system can learn or adapt, can change on its own, or change when influenced. These changes are not fully predictable and result in uncertainty, which is an emergent property of complex systems.

*Counterfactual* – Expressing what ‘could’, ‘should’, or ‘might’ have happened, even though it did not happen.

*Dirty burn* – an area that although burned over, still contains combustible fuel.

*Direct Line* – Any treatment applied directly to burning fuel such as wetting, smothering, or chemically quenching the fire or by physically separating the burning from unburned fuel directly adjacent to the “black”.

ERC – Energy Release Component.

*Faller Designations* – Class A – Inexperienced Operator, limited to felling and bucking material under 8 inches in diameter. Class B – Trainee Faller, limited to felling and bucking materials under twenty-four inches in diameter. Class C – Fully Qualified Faller, ‘Journeyman’, skilled in felling and bucking material over twenty-four inches in diameter.

*The “Green”* – Unburned fuel

*Green into green, black into black* – Burning material is thrown into the black pile, unburned material is thrown into the green pile.

*Ground Truthing* – The process of sending technicians to gather data in the field, which either complements, or disputes data collected while airborne.

*Heads-up* – To maintain situational awareness, pay attention, or to physically keep your head up and not look down at the ground.

*Helitack Crew* – A crew of firefighters specially trained and certified in the tactical and logistical use of helicopters for fire suppression.

*Hindsight Bias* – Hindsight can reflect a ‘perfect vision’ of a past event, by using knowledge that can only be known now, to create judgment. Hindsight bias can limit the information that a person gathers on an event by artificially narrowing what is seen as relevant. Hindsight bias can prevent us from being objective, once we know the result of an event. Kierkegaard said, “Philosophers say life must be understood backwards, but they forget the other proposition, that it must be lived forwards.”

*Hoberman Sphere* - is a geodesic sphere that is capable of folding down to a fraction of its normal size by the scissor-like action of its joints. This expansion and contraction capability made it useful for describing how Margin of Maneuver can change.

*Hotshot Crew* – Intensively trained fire crew, who are used primarily in hand line construction (Type-1).

*Incident Commander (IC)* – This Incident Command System position is responsible for overall management of the incident and reports to the Agency Administrator for the agency having incident jurisdiction.

*Indirect line/Indirect Attack* – A method of suppression in which the control line is located some considerable distance away from the fire's active edge.

*Jackpot* – A bunch of fuel on the ground, which might make the fire larger.

*Optimistic bias* - is commonly defined as the mistaken belief that one's chances of experiencing a negative event are lower (or a positive event higher) than that of one's peers....Other terms representing the same construct include "unrealistic optimism," "illusion of invulnerability," "illusion of unique invulnerability," "optimism bias," and "personal fable." (National Cancer Institute)

*Pulaski* – A special hand tool used in wildland firefighting, which is useful in constructing a firebreak.

*Resilience* – *Resilience is a parameter of a system that captures how well that system can adapt to handle events that challenge the boundary conditions for its operation. Such challenge events do occur (a) because plans and procedures have fundamental limits, (b) because the environment changes, and (c) because the system itself adapts given changing pressures and expectations for performance. The capacity to respond to challenge events resides partly in the expertise, strategies, and tools that people use to prepare for and respond to specific classes of challenge.*

*Retrospective* – Reactions arise from our ability to look back on a sequence of events, of which we know the outcome.

*Scratch line* – An unfinished preliminary control line hastily established or constructed as an emergency measure to check the spread of fire.

*Single Loop vs. Double Loop Learning* – Single loop learning is a reactive response in the moment, a repeated attempt at the same problem, with little variation in method or questioning of the goal. Double loop learning is an inquisitive response in the search of innovative ways that often result in the redefinition of the goal. In double loop learning, we make connections between our existing mental model and new information, our knowledge base changes, and new options can be developed. A key factor in the success of this method is the active participation of individual, or the team in the learning process.

*Smokejumper (or 'Jumper')* – A specifically trained and certified firefighter who travels to wildland fires by aircraft and parachutes to the fire.

*Snag* – A standing dead tree or part of a dead tree from which at least the leaves and smaller branches have fallen. Often called a stub, if less than 20 feet tall.

*Swamper* – A worker who assists fallers and/or sawyers by clearing away brush, limbs and small trees. Carries fuel, oil and tools and watches for dangerous situations.

*Tree bole* – The trunk of a tree.

## List of Appendices

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A – MTDC PPE Report

B – Letter of Delegation

C – Performance Shaping Factors Diagram

D – Weather

E – Dispatch

F – Resource Orders

G – Qualifications

H – Coroner's Report

I – Dangerous Tree Work Book

J – USFS Hazard Tree Alert