OPERATIONALIZATION OF A SYSTEMIC AND HUMAN PERFOMANCE ANALYSIS FOR SERIOUS ACCIDENT INVESTIGATION –

US FOREST SERVICE PANTHER FIRE FATALITY INVESTIGATION

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ABSTRACT

This Thesis answers the question: *Can Human Performance and Systemic analysis of accidents be formally accepted in an organization which has traditionally focused on the "Root Cause" model of accident investigation and will this type of analysis have the potential to be incorporated in future accident investigations?*

Accident investigations have historically followed a model based on the assumption that 'human error' caused the mishap. Investigators have been instructed to focus on the personnel closest to the mishap and to find "causal and contributing factors and ultimately the root cause of the accident". Epidemiologic analysis models move this focus to the organization, yet still seek cause. The Human Performance and Systemic analysis does not make this presupposition; instead errors are looked upon as decisions. This new analytical approach identifies decisions, and then places the decisions in context. The decisions, in context, are then analyzed to determine the conditions which supported the decisions. This represents a more realistic representation of what the individuals were experiencing as the incident unfolded and why it made sense to them to do what they did; thereby avoiding hindsight bias and another residual effect of the causality model, counterfactual arguments. The Panther Fatality Investigation is an example of an investigation conducted in this new method. Panther demonstrated that modern Human Performance and Systemic analysis accident investigations could replace causal or epidemiologic based investigations. Panther also passed the same stringent review processes imposed on previous investigation reports, establishing precedence and formally indicating the viability of this approach.

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THESIS MAIN BODY

Introduction

For more than thirty years the United States Forest Service (USFS) has followed the 'root cause' model of accident investigation, which focused on human error or failure. Over that period of time there has been no observable change in the wildland fire accident rate. The method of analysis, selected in the Panther Investigation, is markedly different in its philosophical approach and is based on the most modern theory available, as described by Professor Dekker in "The Field Guide to Understanding Human Error".

The Panther fire investigation represents a qualitative analysis of a fatality fire entrapment[1], which occurred on the Klamath National Forest in California. The Panther investigation intentionally departed from current United States Forest Service (USFS) Interagency guidance, the Serious Accident Investigation Guide (SAIG). The SAIG requires the investigator to determine *Error, Cause* and *Root Cause*. The ascription of error to a decision can only be made once the outcome of that decision is known and found to be undesirable. This outcome is, of course, unknown to the participant, otherwise they would have taken another course of action.

Cause, when viewed in hindsight, is easily identified. This resulted in numerous USFS accident investigations, which quickly identified causes such as a "Loss of Situational Awareness" and "Negligence". This method also resulted in the organization blaming the victims. These accident investigations, which named individuals as negligent, were misused and the organization took administrative or, in some cases, criminal action against personnel. This was devastating to the individuals involved in the incident, or to their survivors, as it pointed out, unrealistically, that a simple course of action would have saved the victims. Often, the bad feeling results in some form of litigation, with little chance of benefiting the people involved. These reports clearly identified that change was needed.

Attempts have been made to change the model described by the SAIG. The Accident Prevention Analysis (APA) is the most successful of these. The APA relies on the epidemiologic model of accident investigation derived from Professor James Reason's "Swiss-Cheese" model. The effect of using this approach met the intent of removing blame from firefighters in the field. However, blame was simply shifted from the individual to the organization. The APA is currently used exclusively for the evaluation of ground incidents classified as near-misses and therefore it has not been applied to serious accident investigations.

The Panther Investigation was the first human performance and systemic analysis-based investigation to be conducted in the USFS. The concept of human failure analysis, used in previous

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[1] Entrapments are situations 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. These situations may or may not result in injury; and include near misses.

reports, was avoided because there is rarely a firm definition of what baseline performance is or what a correct decision looks like. This is due, at least in part, to the complexity of modern wildland firefighting operations.

Panther approached the narrative section differently than previous reports. The SAIG allows for a variety of approaches to the narrative section. Traditionally, reports have focused on a single perspective to tell the story. This section of Panther was designed to tell the story from multiple perspectives (Dekker, 2002). Telling the story from multiple perspectives was recognized by the organization, as a tool to enhance lessons learned. The Interagency Lessons Learned Center Director stated, "Panther is the definitive report for lessons learned and should be used as a template for reports whose purpose is prevention. The report was written so that field personnel could make their own judgments and draw their own conclusions – this alone challenges other investigators to write like this for the field."

The Panther Investigation was formally accepted by the Forest Service through a process called the Accident Review Board (ARB). This board is convened by the Deputy Chief of the Forest Service. The ARB accepted Panther with only minor changes[2], which demonstrated that this new innovative approach, based on analysis of human and system interaction, could be formally accepted by USFS Leadership. It also demonstrated that an accurate social construction of the conditions, which supported the decisions made by those most closely involved, could be accomplished. Of equal importance, decisions, not errors, could be placed in context for analysis. Panther proved that emotionally charged terms like error, cause, fault and blame were unnecessary in the evaluation of complex accidents and implied importance of language in the writing of an accident report.

Philosophy of Human Error Analysis:
Generally, human error analysis has been approached in one of two ways. The first method assumes that the system is safe and "bad" people commit egregious acts that render the system unsafe. This belief results in a philosophy focused on preventing error prone individuals from making mistakes. The processes employed include developing taxonomies of error types, tabulation of error, counting errors by type, error classification, estimating likelihood of errors, and error trending. Some organizations choose to implement additional procedures, add regulations, or develop technology or automation designed to reduce error frequency. Accident investigations performed using this approach frequently cite "error" as a root cause and generally stop the investigation upon making this judgment.

The second philosophy describes the system as being unsafe and maintains that people create safety through individual action(s). This concept relies on people in the system to avoid accidents and accepts that errors will exist in complex environments, especially when people are subjected to pressure and/or conflicting goals. This philosophy considers the identification of error as the starting point of the investigation (Cook & Woods, 1994) (Dekker, 2002).

Historical Accident Analysis:
The focus of accident investigations has historically been to identify what happened and to establish a causal model. When applied in a human context, this frequently resulted in blame being placed on

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[2] Strong References to the limitations of an Interagency guide were toned down and three recommendations were removed by the Accident Review Board.

the principle actor. The process of finding cause was created through a successful history of evaluation of mechanical failures in the aviation industry in the 1960's and early 1970's. Many of the accident investigation formats and guides are based on what we learned from these evaluations.

During these early years of aviation accident investigation, mechanical accidents were considered causal in as much as 80% of the accidents. The investigation processes developed at that time focused on finding the failed component and developing trending data to predict similar failures and ultimately established remove and replacement cycles to avoid catastrophic failures in flight. The language of accident investigation developed around the concept of failure and terms such as 'cause' and 'root cause' dominated reports. Even the language of the investigation evolved, as exemplified by investigators talking about "Finding the golden B-B."

A recently proposed accident investigation Directive[3] detailed a similar prescriptive policy and stated, "The objectives of safety investigations is to improve safety by identifying what happened, when it happened, why it happened, and what should be done to prevent recurrence of similar incidents. Six key questions should be answered: who, what, when, where, why, and how. To do so requires determining the proximate and root cause/causes based on the findings of fact, supported by the causal factors and developed into conclusions that result in viable recommendations."

This approach oversimplifies the complex nature of wildland fire and has resulted in reports that mistake 'error' as the ultimate cause of the accident. For example, if an individual makes a decision that results in an accident, then the organization frequently identified the *failure of the individual to follow established guidance* as the cause of the accident. Recommendations from reports like these addressed symptoms and reflected the organization's lack of understanding of the complexities faced by wildland firefighters. When the Storm King Mountain Accident occurred, the Chief of the Forest Service stated, "The Ten Standard Firefighting Orders" and the "Eighteen Watch-out Situations", "We don't bend them, we don't break them."

Many firefighters argued that the "10 &18", as they are referred to, cannot always be followed and doing so would reduce firefighting effectiveness to zero. Jenifer Thackaberry, discussed this issue in "Blaming the Dead" (Thackaberry, 2006). In this chapter, she describes the frustration in the field with a compliance based approach to a complex and rapidly changing environment when firefighters are faced with an order that reads, "Fight fire aggressively, having provided for safety first." This clearly demonstrates the goal-conflict created by this direction.

Field frustration with the causal model, coupled with a recognition that humans do not fail the way machines do, resulted in the development of the Accident Preventions Analysis (APA) and Facilitated Learning Analysis (FLA). Although some people refer to these processes as "work-arounds", these products were developed to tell another side of the story. Ideally, this perspective does not ignore the erroneous nature of human action, rather, it draws attention to the system and organizational issues that contributed to the incident or accident. Findings from this type of analysis are fundamental to establishing meaningful recommendations designed to prevent the type of accident from re-occurring. These processes follow the epidemiologic model of accident

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[3] USFS Directives are designed as direction to the field and allow little interpretation. Guides are used to allow the field latitude to use judgment in the evaluation and completion of a specific task.

investigation and have resulted in reports which have shifted the focus of blame from the individual to the organization.

The current USFS accident investigation guidance, "Interagency Serious Accident Investigation Guide" (SAIG), still reflects this history of mechanical evaluation of accidents. The most recent attempt to update the guide resulted in the development of an even more draconian Directive. Several groups within the USFS have challenged this Directive and met with little or no success until the acceptance of the Panther Report by the ARB.

<u>Organizational Realization:</u>
Reporting Culture, Flexible Culture, Just Culture and Learning Culture (Reason, 1997) have been recognized by the USFS at many levels and there has been a considerable investment in cultural change to meet safety needs. The organization has recognized an inextricable link between these cultures. For example, if workers perceive the organization to be unjust, they will not provide information. The loss of this information will adversely affect the ability of the organization to learn from near misses or mistakes and, therefore, the ability of the organization to prevent accidents. In an effort to affect change at the cultural level, many members of the organization have turned to High Reliability Theory. This movement, within the Forest Service, followed Karl Weick's recognition that the USFS demonstrated the traits of a High Reliability Organization (Weick, 1996). High Reliability Organizations rely on decisions being made at all levels of the organization to avert disastrous outcome, (Rochlin, Roberts, & La Porte, 1987) describe the decision made by the lowest rated person on the flight deck as an "obligation to suspend flight operations" if he/she felt safety was compromised. In this discussion, they describe the process by which these decisions are reviewed, "Although [this] judgment or decision may be reviewed or even criticized, the individual will not be penalized for being *wrong* and will often be publicly congratulated if [she/he] is *right*". This is an example of how an organization can encourage reporting and actions to support safety.

The organization's willingness to accept concepts within the HRO model provided an opportunity to garnish support for a new model of accident investigation. Using this opening, the Panther Fire Entrapment report departed completely from the SAIG model and evaluated the conditions that existed when key decisions were made on the fire-line. This recognition of HRO and the associated need to evaluate decisions in context, as opposed to error, have resulted in the organization's willingness to look at alternative approaches to accident investigation processes.

The Narrative, Human Factors Analysis, Findings and Recommendations of the Panther Fire Accident Analysis are included in the next section of this document. These sections set the stage for understanding the complexity of wildland firefighting operations and demonstrate the departure from traditional accident investigations. References contained in the report are in the format recommended by the SAIG and have not been altered to meet the APA guidance.

Accident Investigation
Report

Panther Fire Entrapment

Klamath National Forest, Happy, CA
Region 5, Happy Camp Ranger District
Happy Camp, CA

July 26, 2008

Accident Investigation
Final

<u>Foreword</u>

This accident investigation report reflects statements willingly made by individuals involved in the incident. These individuals should be rewarded for their candor, honesty and willingness to communicate with the Investigation Team. They demonstrated deep concern for their fellow firefighters and it became clear that this concern was a fundamental reason for talking to the team. Without this level of cooperation, accident investigations would be impossible and our ability to reduce the reoccurrence of this type of accident, through accident investigation, would be removed.

Complex living systems, like fires, develop their own communication and structure, unique to both the individual participants and the conditions on the fire. As a result, normative processes cannot be applied - what is normal for one fire may not be normal for another. The multiple perspectives of the participants must be considered to understand the "sense-making" that took place when decisions were made. Perhaps of greater importance, is an understanding of conditions which permitted, or even fostered, the decisions. These conditions are manageable and are often common from one fire to the next. One example of a condition which is common to many fire investigations is "assumptive behavior"[4]. Assumptive behavior was manifest in this accident as "**Fairly common Klamath Wisdom**" that escape routes are more heavily emphasized than safety zones. This "Klamath Wisdom" is an important aspect of firefighting guidance; one that, while not exclusive to the Klamath National Forest, is certainly worth discussion.

This condition can be identified and systematically addressed as a formal change to the way we conduct safety briefings. Many Forests have similar unwritten safety techniques and policies (quotes from previous discussions).
- "**Because I am so familiar with this issue, I am sure others are aware of it as well**," or,
- "**I have been assigned in a leadership role, so how can I ask a fundamental question without looking bad**." and,
- "**They were two really senior guys – I figured they knew what they were doing**."

These are the type of assumptions which block communications. This also supports the "Myths about Safety" section of the latest DIALOGOS report; Myth #1: "**People at the top (or somewhere else) will take care of it**."

> This Myth Raises Questions for Reflection[5]:
> - What is it about the culture of the Agency that made it acceptable to not speak up when they suspected or even anticipated this disastrous outcome?
> - What would it take for people in the Agency to speak up more often in circumstances like the ones above?

The identification of these conditions indicates that a modification of our accident investigation guidance should be considered. The new goal for accident investigations, which are not exclusively attributable to mechanical failure, should be to understand the dynamics of human performance in complex systems, and to describe the function or dysfunction of each. This new approach will shift the focus from "*Blame*", to understanding why the complexity, structure or culture of the activity, organization or system prevented an accident-free outcome. This level of understanding will enhance our ability to prevent the reoccurrence of accidents and incidents.

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[4] Identified in the Panther investigation and referenced in this report as an impediment to communication.
[5] June 30, 2008 Dialogos Report to the USFS "Taking Steps Toward Change", Page 17

Executive Summary

The Panther fire was located and identified on July 23, 2008. Initial attempts to contain this fire were made by a Type 4 incident command organization. Due to an increase in fire size and complexity, it transitioned to a Type 3 incident command organization within the next operational period.

By the evening of July 25th, the Type 3 Incident Commander 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 complexity of the fire. The District Fire Management Officer agreed the increase in overhead 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.

On the 26th, two Division Group Supervisors (DIVS 1&2) representing the incoming Type 1 organization arrived at the Panther Fire. Their mission, as directed by the Siskiyou Complex Branch Director, was to scout the fire and develop a plan for the next day. The two DIVS drove separately to DP16 to meet with the Panther IC. Upon arrival at the fire, DIVS 1&2 received a briefing from the Type 3 Incident Commander (ICT3) and the ICT3 Trainee. Most of the Panther crews were withdrawn to DP16 as a precaution and remained staged there during the briefing.

Following this briefing the DIVS scouted the road system in the fire area. DIVS 1&2 then returned to the initial briefing area. By the time they returned to the briefing location, crews were reengaged. The ICT3 and ICT Trainee were managing a logistics issue at another location. The DIVS parked their vehicle and began reconnaissance of the line where the initial attack crews were working. DIVS 1&2 made initial contact with both of the assigned crews.

While conducting a reconnaissance of the fire line, the Panther Fire made a major run and rapidly overtook the ridgeline where DIVS 1&2 were located. They attempted to escape but found their escape routes cut off. At that time DIVS 1 elected to deploy his fire shelter. DIVS 2 chose to evade the advancing fire by escaping downhill through heavy unburned fuels.

Although DIVS 1 had fully deployed his new generation fire shelter, the intense heat of the fire and its residence time exceeded the capability of the fire shelter. 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 accident investigation team attempted to use the methods recommended in the Serious Accident Investigation Guide, but they realized it did not fully or fairly represent the individuals involved in the incident. The team unanimously agreed that an in depth emphasis on the analysis of Human Factors was required to present the information discovered as well as to propose recommendations that would be meaningful to the safety culture of the Forest Service.

Narrative

The narrative is a sequential presentation, which begins with the initial discovery of the fire and progresses from event, to event, and ultimately to the accident. Multiple perspectives are presented to provide the needed background information to facilitate a thorough understanding of the conditions which supported the decisions made by the participants. To address the wide experience level of the readers of this report, text boxes are used to present detailed information, needed for some readers, without adversely affecting the readability of the report for others. The entire narrative is included in the appendix.

July 22, Tuesday:

A lightning strike started the Panther Fire at approximately 0021 hours (based on observed lightening activity).

July 23, Wednesday:

An infra-red (IR) survey flight identified a new heat signature in the vicinity of what later became the Panther fire. The District Fire Management Officer (FMO) dispatched an Incident Commander[6] Type 4 (ICT4) and a ten person module (partial crew) to conduct a reconnaissance of the area (organizational structure for ICT4 structure is depicted in Figure 1). The weather in the area was dominated by an inversion, which reduced visibility and prevented lookouts from seeing the fire due to a solid layer of smoke. When the inversion lifted lookouts and the Initial Attack module personnel were able to locate the fire.

> Crews initially assigned included: One Interagency Hotshot Crew (IHC); half of a Type 2 Initial Attack qualified crew (10 person module); 10 smokejumpers and helicopter support.
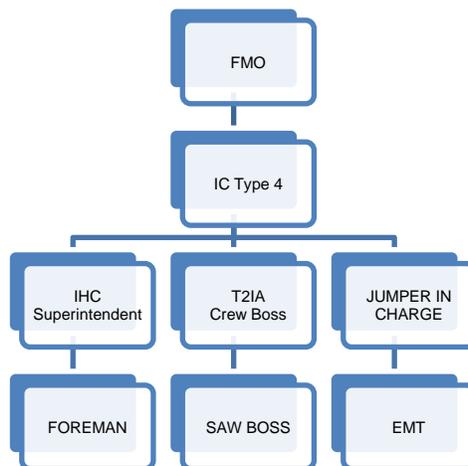

Figure 1. Panther Fire Organizational Structure July 23, 2008. (Note the foreman position is referred to as a captain in California)

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[6] IC will be used in place of Incident Commander hereinafter

Shortly after they arrived, the Type 4 organization personnel located the fire. The IC asked for air support and additional crews. Air Attack from the nearby Siskiyou Complex[7], verified that a single fire was burning and estimated the size of the fire to be 45 to 50 acres and directed an available group of smokejumpers to the Panther.

During the day the fire made a passive short duration crown fire run up the steep slope, finally holding at a fresh retardant line along the ridge top (Fig. 2). The fire run created an area of "good black" later to be used as a safety zone. The peak temperature was 77 degrees with a minimum relative humidity of 39% and the eye level winds were up slope at 1-3 mph.

Figure 2.   Panther Fire after first day, hand crews anchored at mid point on the left flank of the fire and constructed fire line toward the ridge top. Airtankers were used to put a retardant line across the top of the fire on the ridge line and partway down the right flank. Retardant was also used below the crews on the left flank. Helicopters concentrated water drops below on the lowest part of the fire along the left flank.

The ICT4 employed a direct attack strategy and used available resources to construct fire line along the left flank of the fire. Recognizing the need for additional support he requested four Type 1 airtankers, helicopters, smokejumpers and four Type 1 or Interagency Hotshot Crews (IHC).

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[7] The Siskiyou Complex was a group of fires on Klamath National Forest that came under a single Type I management team.

The According to the District Fire Management Officer (FMO), the district FMO determined that the fire complexity warranted a Type 3 organization and ordered a qualified Type 3 Incident Commander (ICT3) through dispatch.   This statement was challenged by the Forest Duty Officer and Acting Forest FMO, who indicated that this recommendation originated with the Forest, not the District.

July 24, Thursday:

The official transition to a Type 3 incident command structure (Figure 3) occurred at 0900 hours and the ICT4 officially transferred command to the ICT3. The ICT4 was assigned as an ICT3 Trainee (hereinafter referred to as Trainee).

The Trainee and ICT3 held a briefing for all personnel assigned to the Panther Fire. This briefing included basic fire line safety, organizational structure and the day's assignments. The safety briefing also included a description of the safety zone used by the smokejumpers and crews started calling it the "high knob." The high knob (Fig 4) provided a good vantage point to observe the left flank of the fire. It had easy access to a large area of burned terrain that served as a good safety zone, "good black" (witness statements).

Smokejumpers were assigned to continue construction of fire line along the ridge. The T2IA crew continued constructing fire line downhill from the end of the previous day's line. Helicopters held the fire below the crews in check at the lowest point of the fire.

New crews arrived: Two Task Force Leaders (TFLs), a dozer, and 3 Type 2 crews (T2). TFLs were assigned to assess the flanks of the fire that they would be responsible for the following day. T2 crews were to cut and improve a personnel access line (P-Line) from Drop Point 16 (DP-16) along the ridge toward the first knob. The dozer was used to improve the 14N05 Road west of DP-16

The fire was mapped via GPS and estimated to have tripled in size to 175 acres (compared to the ATGS estimate completed early on the 23rd). Fire activity and lateral fire spread resulted in a decision to start constructing indirect fire line[8] (left flank). The crews continued work from their mid-slope anchor point with quick access to the "good black" as their safety zone. They were still without an anchor point[9] at the bottom of the fire due to fire behavior, heavy fuel loading and steep rough terrain. A firefighter described the fuel during his interview, "**God, a person could get claustrophobic in here because it was like walking through a tunnel.**"

Two Task Force Leaders were newly assigned to Panther and given the responsibility of Divisions on the fire. They performed scouting functions until the 25th when Division E and Division Z were formally created and included on the Incident Action Plan (IAP).

Three Type 2 (T2) crews, from outside the Region were new to the fire and the area. They did not possess the capability in these fuel conditions and steep terrain to be effective in direct attack. Nor did these assigned crews match what was requested by the Trainee (as ICT4, July 23, 2008).

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[8] Indirect Fire Line – Any line that is not directly against "black" or active perimeter – Direct line provides fire fighters with a safe, already burned, area (firefighters say "The only safe line is a black line.").
[9] Anchor Point – A strategic and safe point or area, usually a barrier to fire spread, from which to start construction of the control fire line (BLM Aviation Policy Compilation, page 133)

The fire behavior, which included a short duration crown fire run the previous day, changed into a backing fire configuration with 1 to 3 foot flame lengths. Visibility was poor most of the day due to an inversion. The inversion trapped smoke and prevented effective aerial support. The weather forecast and conditions were very similar to those observed the previous day.

By the end of the day crews had not established an anchor point below the fire, "**there was limited success with line construction on the west side and no anchor point was established on the bottom of the fire**" (ICT3 Statement).

July 25, Friday:

The Trainee conducted the morning briefing at 0700 hours. The briefing included basic fire line safety and the continued priority of line construction on the left flank of the fire. Division breaks were identified and the fire was split into two divisions: Div E (left flank); and Div Z (right flank). (Figure 4)

The ICT3 and Trainee recognized that their efforts to this point had yielded limited success. They met with the FMO in Happy Camp at 1930 hours and together the FMO, ICT3 and Trainee agreed to transfer command of the Panther Fire into the Siskiyou Complex. During the drive back to the Panther Fire the Trainee and ICT3 decided to change the tactics for the next day. Fire suppression efforts would now shift to the right flank of the fire, indirect at the ridge line.

The spot weather forecast indicated that little change was expected from the previous day's conditions.

Crews still could not establish an anchor point at the bottom of the fire. Reconnaissance indicated a strong potential existed for the fire to become established in the unnamed drainage below the saddle in Division Z (right flank, Fig 4). This presented a condition where the fire could come into alignment with the slope and a slope driven fire could transition to a crown run fire. Crews on the left flank were continuing downhill fire line construction which was becoming more and more indirect. The risks involved were discussed among the Panther Fire leadership.
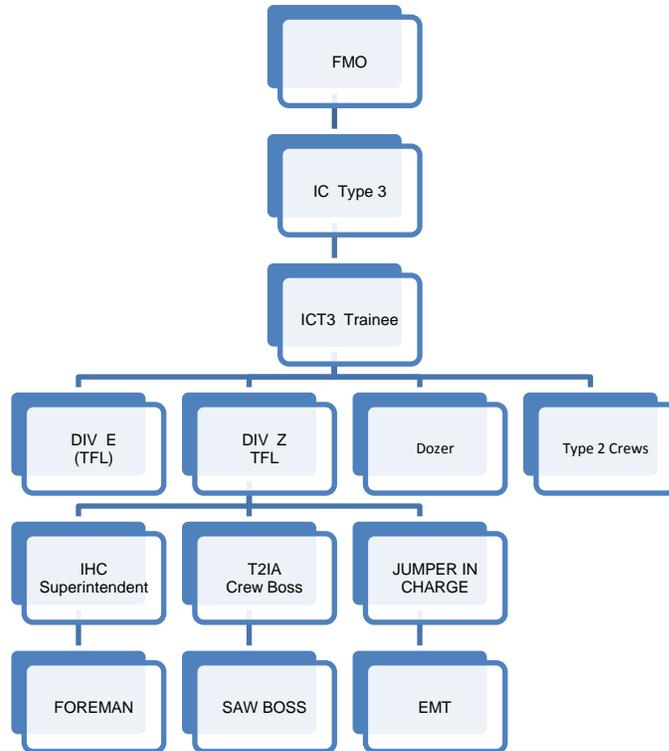
Figure 3. Organization Table for the Type 3 Incident Command Structure in effect from July 24th until the entrapment occurred on July 26th. (Note: the equivalent position to Foreman in the California system is Captain)

Figure 4. Map showing Division Z and Division E and the relationship of the 'High Knob" to the "good black". Uncontained fire line is depicted in red with hash marks, ")(" indicate division breaks. The escape route from the Saddle is depicted in green.

Figure 5. Post fire photo across the unnamed drainage toward the high knob.

July 26, Saturday - Day of the Accident:

At 0600 hours the Trainee conducted the morning briefing. The briefing included basic fire-line safety and informed the crews that Siskiyou Complex would be sending people over to scout the fire in preparation for the inclusion of Panther in the Siskiyou Complex, scheduled for the next day. During the briefing, the ICT3 and Trainee discussed changing the tactical approach due, at least in part to the forecast weather.

Particular attention was given to the weather forecast, which called for lower relative humidity and afternoon winds becoming westerly and increasing to 6-12 mph with gusts up to 20 mph. This forecast represented a significant change to the weather observed over the previous 3 days. The Trainee realized the forecast wind change could have a significant and adverse effect on fire behavior and discussed this recognized increased risk with his crews.

> The Branch Director (Branch) officially assigns DIVS 1&2 to the Panther Fire at 0630 hours as part of the Type 1 organization. They were sent by the Siskiyou Complex Branch Director to Panther Fire with the intent of conducting a reconnaissance of the fire to orient themselves to the terrain, fuels, staffing etc. so that they could prepare a strategy for the following day.

They planned to establish an anchor point on the bottom of the fire and to focus actions on the right flank (Fig. 4). They considered the possibility of crossing the black to get to the bottom of the fire to get the anchor point established.

The Trainee directed the IHC Superintendent (Supt.) to scout the right flank of the fire to validate the plan, concerned about how much the fire burned overnight. This reconnaissance of the fire indicated that the initial plan would not work because the fire had crossed the unnamed drainage to the east Division Z (Fig.4). Any action would now have to consider that the fire might make a crown fire run similar to the one observed on the first day.

The Trainee recognized and discussed the danger of having people on the indirect line above the fire. This information, coupled with the weather forecast, caused the Trainee to abandon his initial plan of going direct, which had been discussed at the morning briefing. Personnel assignments were made to reflect this decision and crews started to engage by widening the P-line at approximately 1030 hours. The Trainee also briefed crews to react to the identification of changes in fire behavior and activate escape routes early, in order to mitigate the potential risks associated with the increase in fire behavior.

At almost the same time as the Panther Fire morning briefing, the Siskiyou Complex assigned two Division Group Supervisors (DIVS 1&2) to recon the Panther Fire in preparation for the takeover. They arrived at Orleans Base Camp[10] the night before and were on their first day of this fire assignment. During the morning briefing, at Orleans, they met the Branch Director (Branch) and they were assigned to the Panther Fire as Division Group Supervisors. DIVS 1&2 left for the Panther Fire each in their own vehicle.

At 0930 hours, while on their way to the Panther Fire, DIVS 1&2 met the District FMO along the 15N17Y road. During this impromptu briefing, the FMO pulled out a map of the District and provided information about fire history, steep terrain, and the fire behavior common to the Klamath National Forest. The FMO expected the fire to increase in size and advised DIVS 1&2 that Panther would likely cross Ukonom Creek.

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[10] The Siskiyou Incident Command Post (ICP)

The briefing also covered general safety issues, the crew's work and their successes and the inability of the 14N05 road to hold the fire if it made a significant run. The briefing took approximately 40 minutes.

DIVS 1&2 arrived at the Panther Fire Drop Point 16 (DP-16) each in their own vehicle. At 1000 hours, they were briefed by the Trainee regarding events from initial attack through the present. The Trainee covered the lack of progress, the inability to establish an anchor point on the bottom of the fire and the fact that they were forced to build indirect line. He also voiced his concern about the fire making a crown fire run. This concern was based on the information gleaned from the reconnaissance and the forecast weather. Additional topics discussed included the Incident Action Plan (IAP).[11] This briefing also emphasized the difficulty the terrain posed to line construction and the difficult travel through the heavy fuels. The Trainee also indicated that three of the assigned T2 crews could not effectively build fire-line due to terrain and fuel type. The briefing included a basic fire-line safety briefing, which focused on known hazards.

Figure 6. Example of typical fuel along the P-Line from DP-16 to the Saddle. This picture was taken from the first knob looking Northwest toward the saddle and the high knob

The Dozer was also not effective in this terrain and was only used to widen the 14N05 road and in support of the T2 crews building indirect line in advance of the fire. The crews and equipment available to the Panther Fire appeared, on paper, to be much more capable than they actually were and were below the type and number of resources requested by the ICT3 or Trainee. DIVS 2 recalled being told, **"…only two crews were able to get on the fire. The other three from the East were not able."**

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[11] The IAP addresses resources (personnel and equipment) assigned to the fire, the intended plan for the T2 crew, smokejumpers and IHC crew.

The Branch Director (Branch) from the Siskiyou Complex arrived at the Panther Fire after the first briefing. The Trainee gave essentially the same briefing again for the benefit of Branch. The DIVS 1&2 remained and listened to this briefing. Figures 5 and 6 show the type of terrain and vegetation facing the crews.

During this briefing, the fire activity increased with a "poof through the inversion" as reported by the T2IA lookout. This increase in fire activity was enough to cause the IHC and T2IA crews to withdraw from the indirect line and pull back to DP-16. The crews arrived back at DP-16 while the Trainee was still conducting the briefing with Branch and DIVS 1&2.

The Branch departed at approximately 1200 hours. He gave DIVS 1&2 instructions to scout the fire and develop a plan for the next day, Sunday. Crews were waiting, staged, at DP-16 pending a change in conditions before re-engaging on the fire-line.

The Trainee and ICT3 recalled telling DIVS 1&2 to limit their reconnaissance to the 14N05 road rather than going up the fire-line and noted that crews were disengaged. The Trainee and ICT3 reported that the warning, not to go on the line was clearly communicated. However, DIVS 2 stated that this was not understood to be a warning and did not remember this conversation.

Following this exchange, DIVS 1&2 departed DP-16 and scouted the 14N05 road. While the Trainee and ICT3 departed DP-16 for DP-15, to resolve a logistics issue at DP-15.

While the DIVS 1&2 scouted the 14N05 road to its end, the IHC and T2IA crews reengaged on the indirect line. The T2IA crew started work widening the P-line directly from DP-16 with the intent of improving the P-line into indirect fire-line. The IHC crew hiked down the 14N05 road to a point just below the saddle where they had constructed an escape route extending from the road to the saddle. They planned to continue widening the indirect line on the ridge above the road.

As DIVS 1&2 were returning from their reconnaissance mission, they met the IHC crew on the 14N05 road as the crew was hiking toward the escape route. DIVS 1&2 had a brief discussion with the Supt. which ended with DIVS 2 saying, "**We'll tie in with you on the line**". The fact that the crews were reengaging led DIVS 1&2 to assume the fire-line was safe for them to continue their reconnaissance. This assumption is supported by DIVS 2 statement, "**But they had reengaged all of the resources back on the line and so it seemed like a natural thing for us to do, was to go out and assess the crews and see what is going on.**" The comment made about *tying in on the line* may have been considered by DIVS as an adequate method of informing the Panther leadership of their intent to go up the fire-line. This information was not communicated to the TFL acting as Division Z, the ICT3 or Trainee.

DIVS 1&2 then drove back to DP-16 and at approximately 1400 hours, they conducted a radio check with each other and started to hike the indirect line (P-line) that connected DP-16 to the saddle and which ultimately led to the high knob at the division break. Based on their briefing, DIVS 1&2 understood that the division break was a safety zone with "good black" (Fig. 4).

At 1415 hours, DIVS 1&2 met with the Saw Boss from the T2IA crew. They conversed with crew members in order to understand the mood and capability of the personnel they were assigned to supervise the next day. DIVS 1&2 moved away from this crew and toward the Saddle where they expected to find the IHC constructing hand line.

At nearly the same time the T2IA lookout warned the IHC crew on the tactical frequency about "**increased fire activity below the indirect line**". This report triggered the Supt. to again withdraw his crew back to DP-16. According to the Saw Boss DIVS 1&2 had just left his position when his own crew received instructions to withdraw. DIVS 1&2 continued along the indirect line towards the saddle and the IHC crew location.

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 withdraw. It also substantiated what the crews had been concerned about and discussed during the morning briefing. Crew supervisors 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 going to limit their reconnaissance to the 14N05 road.

1400 – DIVS 1&2 start to walk up the indirect line (formerly the P-line)
1430 – Report of increase fire behavior and Trainee establishes contact with DIVS 1
1500 – DIVS 1&2 depart the saddle
1510 – Supt. sees fire making a run and exits the fire line via the escape route
1515 – DIVS 1&2 realize they are cut off from the escape route and start to deploy shelters. DIVS 2 chooses to escape.
1520 – DIVS 2 is found on 14N05 Road
1530 – Deployment is communicated and first rescue is attempted from the high knob.
1537 – Trainee orders ATGS
1552 – ATGS requests helicopter support
1613 – Helicopter start bucket drops
1650 – Rescue team locates DIVS 1

Meanwhile, the Supt. verified the report of increased fire activity. Upon hearing the radio transmission between DIVS 1 and the Trainee, he transmitted to the IC that DIVS 1&2 were with his crew. The Supt. directed his crew to prepare to withdraw.

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 along the improved P-line. (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**." DIVS 2 indicated that he thought the Supt. proceeded toward the fire as they left the saddle.

As the Supt. returned to the saddle, from his reconnaissance, he looked for DIVS 1&2. Recognizing that the fire was making a run and that DIVS 1&2 had departed the saddle, he 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".

Figure 7. Individual in the distance is standing at the deployment site.

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 dramatically and their position was in jeopardy, DIVS 2 asked DIVS 1 "Up or down?" (Fig. 8)

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."

> The fire run which led to the entrapment was a result of a topographic slope reversal. Neither a significant change in the fire weather or fuel conditions contributed to this run. As the fire changed orientation from backing spread to head fire alignment the fire activity increased substantially. This type of fire behavior had not been seen on the incident since early in the operational period of July 23rd.

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. This realization caused them to reverse direction again and they started back up the indirect line heading toward the Division Break.

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Figure 8. Location of DIVS 1 and DIVS 2 after 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 deployment would not be survivable. 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.

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 and he was actually 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. He conveyed during interview that during his escape he felt that he might have made the wrong decision.

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 on the high knob. The Trainee was aware that the DIVS 1&2 had been on the fire-line and was also concerned about their location. As the Trainee drove past the established escape route, used by the IHC, (about 1520 hours) he encountered DIVS 2 on the 14N05 road (Fig. 8).

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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 drove back to DP-16, they looked for DIVS 1 on the road hoping to find him.

Within seven minutes of picking up DIVS 2, the Trainee called Air Attack and ordered air support to cool down the area they presumed to be the deployment site. Air Attack initiated water drops from the Division Break down to the saddle with seven helicopters. At this point all parties were using their best estimates of the deployment position.

The Supt. notified his Assistant Superintendent (Asst.) that DIVS 1 was missing. The Asst. was at the Division break (the high knob) with the Smokejumpers. They developed a plan to initiate a grid search to try to locate and, if possible, rescue DIVS 1. At 1542 hours, the rescuers were forced to pull back due to the extreme heat of the fire and by requests from Air Attack to clear area for bucket drops. The temperatures experienced by the rescue crew were hot enough to actually melt some of the knobs on the crew handheld radios. Water drops now concentrated on the area indicated by the rescue team.

Air Attack reported at 1642 hours that he thought he saw something that might be the shelter. DIVS Z requested that Air Attack stop bucket drops to allow the rescue party to resume search and rescue. At 1650 hours the rescuers located a deployed shelter and informed the ICT3 and Trainee that DIVS 1 did not survive the deployment. The Trainee immediately notified the FMO of the shelter deployment and fatality.

At 1650 the Trainee directed all fire personnel to Independence Bridge. By 1845 all personnel were withdrawn and staged at the bridge.

Human Factors Analysis

People do not set out to make mistakes, nor do they break like machines. These statements are at the core of any successful human factors analysis. The motivation of the human factors investigator is, therefore, different than that of an investigator who sets out to determine the source of a mechanical failure. The key question in a human factors or system analysis shifts from what caused the "error", to <u>why</u> an incident or accident took place.

Professor James Reason stated, "Rather than being the main instigators of an accident, operators tend to be the inheritors of system defect created by poor design, incorrect installation, faulty maintenance and bad management decisions. Their part is usually that of adding the final garnish to a lethal brew whose ingredients have already been long in the cooking."[12] He also wrote, "We cannot change the human condition. People will always make errors [sic]. But we can change the conditions under which they work to make these unsafe acts less likely."[13] The result of a successful human factors investigation or analysis

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[12] Reason, J. T. (1990). *Human Error*, Cambridge, UK: Cambridge University Press, p 173.
[13] Reason, J. T. (2002), *Managing the risks of Organizational Accidents,* Burlington, VT, Ashgate, p. 153-4

should therefore be to determine the conditions which supported the incident so they can be managed in a way to prevent reoccurrence.

Professor Charles Perrow, a recognized expert in human interaction in complex systems, wrote, "Formal accident investigations usually start with an assumption that the operator must have failed, and if this attribution can be made, that is the end of the serious inquiry."[14] Human factors analysis begins when the point of failure is identified.

These scholars demonstrate that human error is a *consequence* and not a cause. The search for cause is the stated goal when addressing mechanical failure. Applying the same approach in human factors incidents, will almost always result in blame. The analysis of decisions made by the front line individuals who were involved in incidents or accidents, also leads the investigator down the same path toward the assignment of blame. Assignment of blame can prevent the recognition of more significant findings that would lead toward far reaching solutions. This approach goes beyond simply correcting symptoms identified in the investigation and toward positive cultural change within the organization.

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 and conditions exclusively related to the personnel involved.

The following analysis will illustrate the conditions which supported the final outcome and will put the reader in a position to determine <u>why</u> the accident occurred. The result of this multifaceted analysis will lead to meaningful recommendations predicated on the analysis of those conditions.

The Human Factors Analysis defines the relationship between the operational structure and conditions that existed and how the stage was set for the accident. Incidents unfold in terms of events in perceived time, as opposed to a chronological manner. The people involved in the incidents predicate their decisions on their perception of those events and evaluation of signal that they recieve. For this reason, it is very difficult to imagine the thoughts they must have had or the complexity that they understood as the circumstances evolved. 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 the participants 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 organized as follows:

- Command
- Control
- Management
- Communication
- Personnel

Conclusions are then drawn from this analysis, and labeled "Findings". The findings form the basis of the recommendations.

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[14] Perrow, C. (1986). *Complex Organizations: A critical Essay*, Third Edition, N.Y.: Random House, p. 146.

Command[15] Related Analysis:

Condition 1: Management did not clearly provide strategic guidance to the ICT3 and Trainee. This resulted in no specific articulation of goals for an extended attack strategy. The Trainee recalled that 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**". The Deputy District Ranger's policy was to discuss the options available and when necessary he would 'make the decision'. During these discussions the Deputy District Ranger assumed that the Trainee understood that "**he was not to take any unnecessary risk**". This exemplifies that within the fire organization there is no clear definition of necessary risk, allowing for a variety of interpretations of acceptable risk. The Deputy District Ranger acknowledged that it was possible for the Trainee to draw the conclusion he did based on the lack of specificity in conversations they had. The ambiguity and misperception was never challenged by either the Deputy District Ranger or the Trainee. This indicates that neither was aware of the difference in perception. (see discussion about assumptive behavior later in this analysis).

There was clear recognition among most of the Panther Fire leadership that the fire was not likely to be caught using the employed direct attack strategy. The quantity of resources on hand was not adequate to accomplish the mission and the likelihood of receiving additional resources appropriate to the required tasks was very low. The Trainee recognized the need for additional crews and requested 4 Interagency Hotshot Crews (IHC). He also clearly stated, due to the complexity of the terrain, fuels and difficulty establishing an anchor point, the IHCs were justified. He did not feel any extermal pressure to keep the fire small, but was clearly driven to do so because of the realization that the fire would "**go big**" otherwise.

Strategic planning and risk assessment were supplanted by tactical goals in a reactive posture on this fire. The Type 3 organization's focus remained reactive and became a series of tactical actions, essentially in an initial attack posture or mind set. Tactics were predicated on the lack of successes or minor successes of previous actions. This series of initial attack actions never evolved into a strategic plan. The decision to continue in an initial attack posture may have been influenced by previous successful actions, which contained a fire, on the same district, earlier in the season.

The opportunity to intervene in the decision process using input from the WIldland Fire Situation Analysis (WFSA) was not possible. The WFSA was being drafted as the Panther Fire went into extended attack. Due to the time required to prepare a WFSA and the approval process, the WFSA was not available until August 3rd. Once available the signed WFSA recommended an indirect containment strategy. There is no reason to suspect that this determination was influenced by the accident, although sections of the WFSA referenced the accident investigation team.

On the afternoon of the 25th, the FMO stated to the Trainee, "**…you need to make sure to let me know what your long-term prognosis is. We need to have discussions and make a plan by this evening. [Sic] I was wanting to know what he saw happening as opposed to fighting it day by day.**" (FMO statement) These comments illustrate that the IC and Trainee were doing their best to "keep the fire as small as possible" while still thinking about long term goals. On the 24th the District Ranger, FMO, ICT3 and Trainee discussed rolling the Panther into the Siskiyou Complex. On the evening of the 25th the Trainee and ICT3 met with the District Ranger and FMO, at Happy Camp, during this meeting, the IC and Trainee discussed three alternatives:

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[15] **Command:** Describes leadership's communication of vision, intent, guidance and direction.

- Keep the fire at the District level and lose all support from Siskiyou Complex,
- Continue on with existing resources with the current IC and Trainee or
- Transition the fire over to the Siskiyou Complex under the management of a Type 1 Team.

The IC and Trainee recommended that the fire be rolled into the Complex. They recognized at that time that the chances for success were limited and chose the best alternative available to them. The Acting Forest FMO and Forest Duty Officer, had already prepared for this decision and had arranged with the Type 1 Team to take the panther fire. The transition was scheduled for the 27th at 0600 hours.

The DIVS arrived on the fire as representatives of the Siskiyou Complex. Following their briefing and initial assessment of the conditions they disagreed with the tactics and strategy employed by the Type 3 organization and sensed "doubt". "**I sensed some anxiety and doubt from all those folks (ICT3, ICT3 (Trainee), Type 1HC, Type 2HC). They had been trying to go direct for several days and had met with nothing but a lack of success so there was still some anxiety about trying to make that work.**" (DIVS2 Statement).

DIVS1&2 recognized the need to alter the strategic approach to the fire. After receiving the initial briefing from the Trainee, they had concerns. "**So the other reason we were heading out here was to evaluate, you know, what they were proposing to do the next day…we were talking about how we were going to propose that we go in different directions.**" "**To me it was, pushing a bad position**" (DIVS2).

Condition 2: The existing decision support tools for strategic analysis and assessment are not considered to be useful by many mid-level fire commanders. These tools are ambiguous and limited in their ability to provide meaningful guidance. They are more frequently used to support a decision that has already been made, as opposed to providing meaningful assessment of the conditions to facilitate an appropriate response. Furthermore, there is no risk benefit analysis process available to determine total risk, which would serve to guide incident commanders through a risk versus probability of success (or benefit) evaluation. "**I did one in my mind, not the one in the book**" (ICT3 Statement).

This demonstrates that the use of the Operational section of the Incident Response Pocket Guide (IRPG) was conducted by memory. The fact that incident commanders generally engage in these critical evaluative processes by use of personal evaluation criteria, without reference to the IRPG, indicates a limitation associated with the complexity and risk analysis processes described in the IRPG[16].

A lack of analytical tools to determine the probability of success valued against the level of risk, prevent all but the most experienced of ICs from understanding the level of risk that has to be mitigated and then what level must be accepted to meet mission objectives. The result is often an over cautious decision-set, or one that is so bold that it has been considered to be an example of "at risk behavior".

Control[17] Related Analysis:

Condition 1. DIVS 1&2 were qualified to be assigned as Division Group Supervisors. They were assigned to complete a mission which was external to the IAP and as a result they were not formally assigned to any of the Panther Fire leadership. Chain of command and responsibility were not clearly articulated during the

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[16] More than twenty incident commanders polled supported this observation.
[17] **Control**: Establishes limits or boundaries on behavior and provides structure to personnel and organizations.

transition process. DIVS 1&2 truly were newcomers to the fire. Their chain of command had a direct tie to remote leadership at the Type 1 IC level and not under the Type 3 leadership that existed at the fire.

The ICS organization lacks specific guidance and structure with regard to incoming overhead during transitions. This condition is also observed when unassigned personnel[18] enter the fire area and affords the opportunity for individuals to be in "harm's way" without a suitable level of responsible oversight.

The successful egress of the fire-line by all personnel formally attached to the fire indicated that sufficient and effective risk exposure mitigations were in place for the assigned firefighters. When the trainee realized that DIVS 1&2 were in the saddle he assumed that DIVS 1&2 would leave the saddle with the IHC crew.

Condition 2. One of the purposes of scouting the fire is to gain information regarding the distances between escape routes and safety zones. Due to the fact that DIVS 1 & 2 had not been on the fire before, they did not have a sense of how far they were from the safety zone at the high knob division break. The investigation team has deduced that when DIVS 1&2 turned around to egress downhill, they were less than 154 meters from the Division Break and the "good black" where the smokejumpers were gathered[19].

As they had never been on this fire-line, they had no empirical data to determine the time required to reach the Division Break (high knob) and safety. The decision to turn around was at least in part due to their lack of specific knowledge of the distance and terrain. DIVS 2 stated, "**This was a pretty steep knob going up there…I figured it would catch us in a heartbeat if we tried to go up to the black. We were too far away. It's a lot farther than you think**." The decision to escape downhill follows common firefighter knowledge that usually fire can move faster uphill than a firefighter can run.

Condition 3. Safety briefings were routine in nature and content, therefore they did not emphasize conditions unique to the District. Local management pointed out that part of their standard briefing to incoming resources is to "**stress [sic] escape routes over safety zones. That's a fairly common Klamath wisdom. [Sic] Because of the long residence time of fire in heavy fuels and the density of fine fuels and live fuels, it's very difficult to find a place big enough to shelter from the flame lengths and the intensities that we can experience on the Klamath.**" (FMO statement) This is a common fuel characteristic in many Western timber types.

Complete knowledge of circumstances can result in people assuming that others hold the same level of knowledge. It becomes extremely important, with regard to safety information, to ensure that tacit knowledge is made explicit. In essence, people often take for granted that others know what factors are considered to be most critical and therefore they can be overlooked.

Safety briefings form a final barrier by preparing individuals for the actions expected during the period of time covered by the briefing. These form the basis of preparation of a mindset which should identify unique circumstances and/or conditions expected to be encountered. The briefing should emphasize the specific conditions which predicate action and the specific actions to be taken in order to mitigate the identified risks.

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[18] See appendix
[19] this is based on the location of the deployment site 154 meters from the division break

<u>Management[20] Related Analysis:</u>

<u>Condition 1</u>. The Trainee had no Command Staff support, therefore the ICT3 position retained responsibility for all command functions (operations, safety, planning and/or logistics). The US Forest Service does not support duties external to fire duties for ICT3 positions[21], as they are perceived as a distraction to critical duties. However, retention of collateral command functions is not excluded, according to policy. The ICT3 and Trainee left DP-16 for DP-15 to perform logistics duties at, what turned out to be, a critical moment. During their absence, DIVS 1&2 were able to leave their vehicles and hike up the indirect fire-line, unnoticed.

Type 3 organizations frequently demonstrate the need for additional staff support. As incident complexity increases or is expected to increase from Type 4 to Type 3, the IC needs additional organizational support in operations, safety, planning and/or logistics.

Ninety seven percent of fires are caught in initial attack. Most of the remaining three percent transition rapidly into large extended attack fires with a variety of complexity. This complexity can be varied in scope and source. Some large fires are operationally simple and logistically difficult. Others have operational challenge, but require limited planning and logistical support. Events with increasing operational complexity, in all areas, are high-risk low-probability events that easily overwhelm the span of control of a Type 3 incident commander with minimal organizational support. Accidents are more likely to occur during periods of increasing complexity, in conditions where reactive processes are not working and when operational capability is limited.

<u>Communications[22] Related Analysis:</u>

<u>Condition 1</u>. There is a system wide absence of standard communication or phraseology in wildland firefighting. This absence provides the opportunity for miscommunication of safety critical information. This is especially evident during transitions[23], where newly assigned personnel are not privy to the full meaning terms used by those who have been working side by side for days. Equally significant is, there is no

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[20] **Management**: This aspect is external to the ICS system and focuses on overriding planning, organization, resource allocation and budget constraints.

[21] Interagency Standards for Fire and Fire Aviation Operations, 2007 page 11-3, lines 25-31
  ICT3s are required to manage the incident. They must not have concurrent
  responsibilities that are not associated with the incident, and they must not
  concurrently perform single resource boss duties. It is important to note that not
  all Type 3 complexity incidents require a full complement of individuals at the
  command and general staff positions. A Type 3 Incident Commander (ICT3) is
  expected to exercise their authority and establish the appropriate organizational
  structure for each incident as based on complexity, and span of control.

[22] **Communications**: Functionality of transfer of information throughout the organization or system; clarity of message sent as compared to message received.

[23] This is not a unique phenomenon and has been instrumental in numerous accidents (see Avianca flt. 052)

established challenge/response phraseology. As a result, assumptions, impressions and expectations replace factual verification, which results in a lack of understanding of significant critical safety communications or actions.

DIVS 1&2 missed the importance of two critical radio transmissions regarding increased fire activity from a posted lookout. They undervalued the lookout's messages, compared to the crews who clearly understood the warning given by the lookout and acknowledged the danger associated with hearing "**increased fire activity below the indirect line**". This is an example of what is referenced in major industrial accidents as "*inadequate cue utilization*"[24]. Proper cue utilization is a function of the clarity of the cue, the ability to understand the significance and meaning of the cue, an understanding of the actions that are required upon perceiving the cue and the ability to react in time to the cue. An alarm such as "*Engine Fire!*" on an aircraft would be an example.

The ability to react to a cue is also a function of expectancy. Briefings should therefore serve two purposes. First, they describe to the participants what the area(s) of concern is(are) and what the warning should sound like, by reviewing the expected cues to enhance the level of expectancy and preparation. Second, briefings should inform the players of exactly what action is expected to be taken when the cues or signals are transmitted.

As a result of culture and time spent together, all organizations develop communications and a "shared mental model or understanding"[25] specific to their profession. The nature of firefighting operations readily lends itself to the development of such language. This propensity, coupled with the fact that the crews on this fire had worked together for 3 days, resulted in unique emphasis being placed on specific phrases. Words and phrases became more significant in the context of the fire. Therefore, the transmissions sent by the lookouts received different, or in this case greater, weight by the group than the "outsiders".

DIVS 1&2 continued from the saddle to the Division Break (good black) because they perceived they had the time to do so. The lookouts messages were more meaningful to the crews assigned to the Panther Fire, who took more expeditious action to withdraw from the fire. This conclusion is supported by witness statements and how the assigned crews addressed trigger points for disengagement. When asked about trigger points for withdrawal, the ICT3 stated, "**But yeah, not like it was ever said if it does this, then it's time to come off the hill. We had trigger points for other things, but you know, the quality of the [sic] crews that were up there with their own lookouts it was understood between us that if it did get established in that drainage that everybody would be leaving.**"

When the lookout reported "**increase in activity**" and, "**column breaking through the inversion**", this verbiage was received and acknowledged by the crews who had been working on the fire for 3 days. Upon hearing this message, the Supt. quickly verified the reports and immediately withdrew his crew to DP-16, "**pack-it-in and get off the hill. That's enough.**" (Supt. transmission on crew frequency). He then contacted DIV Z who concurred that crews should withdraw to DP-16.

The Trainee was alerted by these transmissions and, to his credit, called the Supt. to inquire about the whereabouts of DIVS 1&2. DIVS 1 responded to the Trainee "**yeah, we are here with your crew [IHC in the saddle]**" (DIVS 2 statement).

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[24] N. Meshkati, 2008
[25] N. Meshkati, 2008

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Aircrews overcome cultural, regional and even personal issues through developed and defined communications protocols established through standardization and training in Crew Resource Management (CRM) styled techniques. The wildland fire system of communication lacks specific structure or defined vocabulary to communicate critical elements, hazards or required actions. A simple example of this type of ambiguous language is - we "deploy" shelters in an emergency and "deploy" crews on an operational assignment.

Confusion during transition from one incident command organization to another, was demonstrated when DIVS 1&2 arrived as newcomers to the organization at a critical time. Signals clear to the Type 3 organization, went unrecognized by DIVS 1&2 and were not challenged, or clarified. This was exemplified on the Panther Fire as DIVS 1&2 undervalued the importance of the lookout's warnings. When asked during an interview, if he had heard any warnings, DIVS 2 said, "**No**."

The decisions made by DIVS 1&2 were complicated by this unique language and mixed signals regarding the value of the signals sent and received. One example of a mixed or diluted signal occurred in the saddle as the DIVS were deciding to proceed to the division break and good black or withdraw with the IHC crew. The crew did not leave the saddle in a hurried manner, at least in part due to the planning on the part of the Panther Type 3 organization (including the Superintendent). This un-hurried withdrawal suggested that there was time available to reach the high knob. This assumption was supported by the action of the Superintendent to scout the advancing fire as opposed to withdrawing with his crew[26]. The complexity of this communication was not challenged or clarified by anyone directly associated with the Panther Fire because, to them, there was no need. To them the meaning and value of warnings were clear. This is reflected in the fact that all the Panther Fire crews successfully exited the fire-line, to their pre-determined safety zones. DIVS 1&2 had to make sense of the ambiguous signals. (See Figure 9, next page)

Figure 9 is used to depict the nature of the mixed signals. A scale is used to emphasize the need to weigh the value of information and that there is no simple conclusion that could be drawn giving the information that the DIVS has and their desire to complete their assigned mission. The perception of the individuals making the decision causes the scale to tip, either toward withdrawal or plan continuation. These decisions are also affected by the time available to weigh this information. It is easy for most of us to clearly look back at these decisions, knowing the outcome, and determine a better course of action. The reality is that there were many factors that had to be considered in a time dependant in nature and time unfolds quite differently for those experiencing unfolding events. Clock, or chronologic, time does not represent real or perceived time and the associated emotional or physical stresses which can result in a variety of time distortions. As the events unfolded for the DIVS 1 & 2, they experienced less and less time to process a large amount of information (see Figure 10, Decision Factors and Complexity Analysis).

In this incident the same basic decision was made 4 distinct times. The first three decisions were identical. The last decision (to shelter or escape) differed, due to experience and training. However, neither decision was "wrong". There were survivable areas within meters of the deployment site and the surviving DIVS

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[26] Note: Unhurried is the recommended way to withdraw from the fire and the superintendent's actions were not unusual or unwarranted, in fact, unhurried withdrawal is considered exemplary. Information about the progress of the fire would be valuable to support his conclusion that they were 'done for the day'.

stated that during his egress he questioned his decision to escape, "**On the way down I thought I made a mistake, if I had fallen or broken a leg, I would have been [killed]**". This further demonstrates the need to understand conditions and avoid the desire to analyze decisions or perceived errors.

Figure 9. The Critical Decision in the Saddle: In a complex system multiple factors must be weighed. The following diagram illustrates some of the factors which were evaluated in the saddle. Many of the same factors had to be weighed at two more critical decision points before the deployment, with substantially less time available to reach each decision.
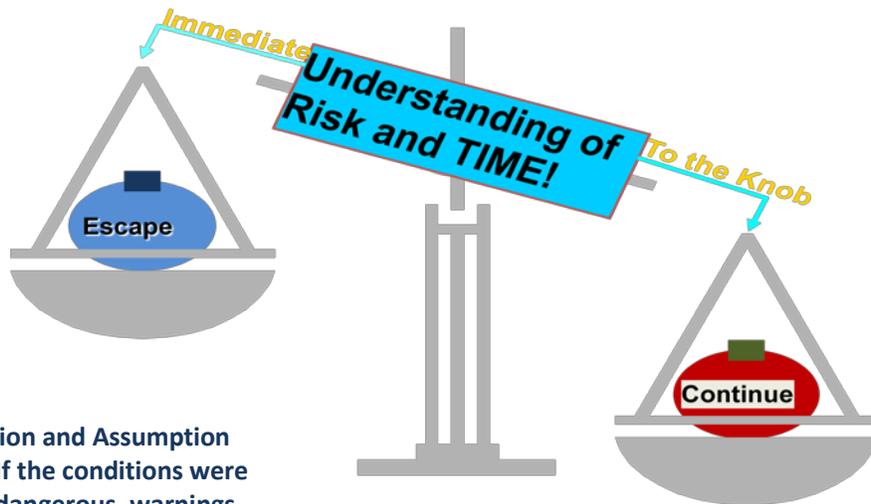
Expectation and Assumption
- **If the conditions were dangerous, warnings would be clear and specific**
- **If it becomes dangerous, we will notice it in time to take action**
- **We have time to make the division break ("*a couple of hundred yards**" uphill to a reported safety zone)**

Objective – Goal
- **Scout the fire to prepare for suppression efforts the following day**
- **Validate observations regarding the current strategy and lack of success**

Mixed Signals - Ambiguity - Uncertainty
- **Crews engaged and disengaged, but nothing happened earlier in the day**
- **Forecast weather change had not occurred as predicted**
- **Crew gathered in saddle not reacting as if dangerous, "take your time, we won't be coming back today"**
- **Perception that the Supt. leaves saddle and heads in direction of fire**
- **Without corporate knowledge the warnings from the lookouts seemed ambiguous**

"We are going to continue westward on this hand line location to the black area and we are going to stage up there."

(DIVS 2 Statement)

* Quote from DIV2 Statement

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<u>Personnel Related Analysis:</u>

<u>Condition 1</u>. Assumptions and expectations replaced verification, which resulted in a lack of understanding of significant critical safety communications. Examples of assumptive behavior included:
- Crews assumed that DIVS 1&2 did not require additional warning
- DIVS assumed that warnings would be clear
- 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
- IC assumed that the 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.

<u>Condition 2</u>. Personnel qualifications and work/rest histories were evaluated and no discrepancies were found.

<u>Condition 3</u>. Safety briefings that focused on specific issues unique to the identified hazards and expected risks were too general in nature. As a result, the opportunity to emphasize or highlight specific conditions was not fully taken advantage of. Individuals were placed in a position where a large amount of deliberation and assessment had to be done with less and less time available.

The final decision to escape or shelter had markedly different outcomes. A focus on human error would cause us to evaluate these decisions and perhaps even judge them. Judgment is usually based on hindsight bias and frequently a function of outcome. Like the famous 'Monday morning quarterback' we can all look back and say if this or if that the outcome would have been different. This does nothing to affect the outcome of the current situation and little to prevent re-occurrence.

The following diagram graphically presents the complexity and type of factors involved with four similar decisions on this fire – each one of the factors listed has either bearing on the value of the information or a bearing on the outcome. It is not intended to be a complete list, simply a reflection of the major factors identified by the investigation team. Additionally, people bring their own perceptions, training and experience to the table. The diagram presents the volume of information which must be assigned a value and then processed by an individual, in a critical phase of the operation. This diagram focuses on the decision to escape vs. continue and escape vs. shelter and is designed to simply illustrate the volume of material that must be considered in what seems to be a simple decision. (See the Decision Factors and Complexity Diagram, Figure 10, next page) Risk assessment processes could reduce the volume of information that must be evaluated when time is limited, by addressing critical areas prior to engagement.

Decision Factors and Complexity Diagram

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.

<u>Findings</u>

These findings represent the conclusions of the Serious Accident Investigation Team (SAIT) based on the human factors analysis, recorded or reported events, factual data, professional knowledge and good judgment. Sources are referenced below each finding in parentheses. These findings are presented in categories as recommended by the Serious Accident Investigation Guide:
- HUMAN
- EQUIPMENT
- ENVIRONMENTAL

<u>Human</u>

1. This incident command organization had no command or general staff support. The ICT3 and Trainee retained all responsibilities for these functional areas. (Command)
    (SAIT Deliberations, Witness Statements)

2. The Type 3 organization's focus remained reactive. Strategy and tactics were not altered to match assigned resources. The ICT3 and Trainee implemented a series of tactical actions that never coalesced into a strategic approach. (Command, Management)
    (SAIT Deliberations, Witness Statements, Narrative)

3. The decision support tools in the Risk Management Process and Complexity Analysis (IRPG) were not found to be useful in making GO/NO GO staffing decisions, or in the development of a long term strategy. (Management)
    (SAIT Deliberations, Witness Statements, IRPG)

4. The Type 3 organization recognized the need for increased crews and made the appropriate requests. The fire did not receive requested resources. Type 3 organizations are not considered at the GACC level in the allocation of scarce resources. (Management)
    (SAIT Deliberations, Witness Statements, Resources requested vs. those assigned, IAP)

5. No formal mechanism exists to integrate incoming overhead into an existing incident organization. This situation is exacerbated during transitions. DIVS 1&2 were not assigned to the Type 3 organization and therefore no single individual had direct responsibility for their safety. (Control, Management, Communications)
    - Incoming DIVS 1&2 were operating outside the existing IC Type 3 management structure.
    - DIVS 1&2 go on fire-line without informing the IC.
      (SAIT Deliberations, Witness Statements)

6. Strategic oversight and guidance provided to the Type 3 Incident Commander and the Trainee was minimal. There was no clear articulation of goals expressed by District leadership after transition to extended attack. (Management, Command)
    (SAIT Deliberations, Witness Statements)

7. Critical communications were ambiguous. Specific language had more meaning to personnel assigned to the fire. This language was undervalued by DIVS 1 & 2, who were external to the Type 3 organizational structure. All personnel formally assigned to the fire were able to safely

egress the fire area after the warnings were broadcast. DIVS 1&2 made individual decisions regarding shelter deployment versus escape.

Error frequency is increased when communications of intent are ambiguous. Firefighting incident organizations must overcome this ambiguity in their language, which transcends multiple levels of the organization. Presently, they are able to overcome this level of ambiguity through trial and error, only after one party recognizes that the message sent is not the same as the message received. The closer the parties are in proximity, background and experience, the faster this ambiguity is resolved. A significant barrier and opportunity for misunderstanding arises when new members are added to the organization. The new members do not possess the same "common" understanding or shared mental model and can easily misinterpret or miss critical communications, which are easily understood by the seasoned members of the organization.(Communications, Control, Personnel) (SAIT Deliberations, Witness Statements)

8. Safety briefings were non-specific in nature, only identifying standard firefighting hazards. These briefings were not tailored to emphasize critical trigger points, risk assessment and mitigations specific to the location, topography and fuels.

A formal review of existing risks allows the participants to make key safety decisions prior to engaging in operations. This is at the core of Risk Benefit Analysis processes used by organizations who routinely engage in high tempo, high risk missions. This process eliminates the need to weigh the value of signals and factors perceived to be important by the person at the time the decisions need to be made. If more time is available, then more factors can be evaluated. Correspondingly, if less time is available fewer factors can be evaluated. Investigators frequently categorize this as a failure on the part of the individual, called "Loss of Situational Awareness".   In reality it is a function of preparation and emerging conditions.(Communications)
(SAIT Deliberations, Witness Statements)

9. Assumptions and expectations (assumptive behavior) replaced verification and follow-up by fire leadership. This resulted in a lack of understanding of critical safety communications and positive feedback from all fire-line personnel.
   - SENDER $\rightarrow$ verification $\leftarrow$ RECEIVER   (Communications)
(SAIT Deliberations, Witness Statements)

10. DIVS 1&2 did not check in with the TFL assigned to Division Z acting as Division Group Supervisor prior to going on the fire-line in Division Z. The only communication indicating this intent was with the IHC Superintendent during a conversation that took place on the 14N05 Road.

11. There was no Delegation of Authority.

Equipment

12. DIVS 1&2 were appropriately equipped with Personal Protective Equipment (PPE).
(Witness Statements, Equipment Examination)

13. DIVS 1 was fully deployed inside a New Generation fire shelter.
(Witness Statements and Equipment Examination)

14. The fire shelter was subjected to direct flame contact and high temperatures. These conditions exceeded the limitations of the fire shelter.
(Timeline, Witness Statements)

Environmental

15. Energy Release Component was at the 77th percentile for the day of the deployment. Even though the Klamath had been experiencing a very active season up until this time period, this particular fire danger index was not extraordinarily high. (Fuels)
(FireFamily Plus[27])

16. The 1000-hour fuel moistures were measured at 4% on July 16 at the Oak Knoll sample site. The Klamath National Forest Pocket Card identifies 1000-hour fuel moistures below 15% as a threshold for increasing fire activity. (Fuels, Fire Behavior)
(Klamath National Forest Fuel Moisture Sampling Data, Witness Statements, FireFamily Plus)

17. Live fuels were not a significant contributor to fire activity and in some cases acted as a heat sink or partial barrier to fire spread, especially when the fire was spreading out of alignment with either the slope or wind. (Fuels, Fire Behavior)
(Witness Statements)

18. No significant weather events or conditions occurred to change the observed or predicted fire behavior on the incident. (Weather)
(SAIT Meteorologist, Witness Statements)

19. A slope reversal occurred in the unnamed drainage on the east side of the fire. This caused the fire to change from a backing fire to a head fire, with a short duration crown fire up to the saddle. (Fire Behavior)
(SAIT Fire Behavior Analyst, Witness Statements)

20. The unnamed drainage had been identified as a point where fire behavior would significantly change, once fire was established on the east side of the drainage. Lookouts had been established to monitor fire activity in this area. Smoke and fuels limited the ability to observe fire behavior. (Fire Behavior, Weather, Communications)
(Witness Statements)

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[27] "FireFamily Plus" is a corporate trademark for USFS owned and developed software

<u>Recommendations</u>

1. Submit the task of evaluation of the Safety Management System (SMS) to the National Safety Council and to Research and Development with respect to the following:
   a. Forest Service Wide implementation of SMS
   b. Just Culture
   c. Inclusion of standard HF analysis in all accident investigations
   d. Establishment of Doctrine (Leader's Intent) in Forest Service Manual Systems
   e. System Safety
   f. Organizational Risk Management

   (Findings 1, 3, 5, 6, 7, 9)

2. Solicit Forest Managers to develop a safety briefing procedure for newly arriving personnel that personalizes the safety briefings used in high risk operations. Establish a working group to assess the current forms of communication of safety information transmitted through briefings. This group should produce guidance to reflect actual conditions facing the firefighters on the line and prepare them for the hazards unique to the specific conditions that crews are likely to encounter. The briefings should address safety considerations and procedures unique to the assignment, based on thorough risk assessment.

   (Findings 2, 7, 8, 9)

3. Develop a policy to fully evaluate and, if indicated, develop a system which standardizes communication of safety critical information and Crew or Team Resource Management for ground firefighters. If indicated, include this language and CRM training for personnel engaged in high risk operations.

   High Reliability Organizations know that odd things can occur and want their people to be on the lookout for these odd or unusual things instead of assuming that they don't matter or are not important[28]. They train their people to look for anomalies and recognize decoys and most importantly to decouple systems when problems are discovered and then empower employees to act. This was absent as evidenced by the assumptive behavior observed on this fire and common to many fire and aviation accident investigations. Recent investigations have identified this as the "Need for upward voice".[29] An example of a successful briefing used the phrase, "Let me know if you see anything Dumb, Different or Dangerous."

   (Findings 3, 7, 9, 10)

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[28] Karlene Roberts conversation with the chief investigator, October 13, 2008
[29] Conversations with Jim Saveland USFS

Conclusion

<u>Demonstrated Departures from the SAIG</u>

Panther departs from the normal, SAIG recommended, report in both content and structure. Human Factors analysis, for example, is considered in the SAIG, but only as a minor section relegated to the appendix. The SAIG recommends using a modified Human Factors Analysis and Classification System (HFACS) model developed for wildland fire accident analysis[30]. Accident investigations, that have used this method, have been drawn into a failure mode analysis. Once the analysis is complete, the accident investigation team recognizes conclusions of failure on the part of specific systems components. HFACS focus on error results in teams being faced with a decision to include judgmental assessments of blame or disregard the human factors analysis altogether. Most teams rarely include human factors in their reports. The HFACS process was not considered for use in Panther.

The Panther narrative tells the story of what happened leading up to the incident from multiple perspectives and considers the days leading up to the incident as conclusive. The Incident Management Team's perspective for the days leading up to the arrival of the DIVS is important to understand the nature of the interaction between the DIVS and the Type 3 organization and how that affected communications. This is a departure from the standard report. USFS reports, generally focus on the time immediately prior to the incident and only on the personnel directly involved with the mishap.

Panther Narrative also explains multiple points of view, telling the story from different perspectives. Contradictions in participant statements and recollections vary. This is expected, and the various contradictions are included in Panther. This allows the reader to understand what military experts refer to at the "Fog of War". Previous reports told only the perspective(s) that supported the conclusion made by the investigator and the conflicting reports were ignored[31]. The truth of any accident in wildland firefighting is that many assumptions are made during the course of operations. They are often unchallenged and, as a result, become the memory of the individuals and the way that they perceive the event to have occurred. By including these contradictions, the assumptive behaviour is identified and can be discussed as a condition which supported decisions.

The Human Factors Analysis is the cornerstone for the evaluation of the fatality accident. Until Panther, reports relied on "Findings of Fact". Several reports were even titled "Accident Investigation Factual Report", which is a process recommended in the SAIG. The result is that the only facts that can usually be determined by a non-systemic human performance-based analysis are violations of policy and procedure. These are exemplified in reports that examine the inadequacy of individuals, the organization or equipment. The SAIG recommends that this analysis be divided into Human, Environmental and Material. The approach used in Panther considered these categories too restrictive. As a result, Panther used a decision point analysis process that first determined the decision points, and then looked at the conditions which supported those decisions. Key indicators were: assumptions that went unchallenged,

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[30] The source of this analysis is unknown – It is published in the SAIG and not referenced, which may be an indication that it was developed by agency personnel. It appears to be based on HFACS, as described by Weigman and Shappell.

[31] These conflicting statements can be read in witness statements only available to USFS Safety Management personnel.

ambiguous communication, absent information or briefings, information that was in contradiction and the volume of information presented to the DIVS who were new to the fire.

29 Code of Federal Regulations 1960.29 requires that the accident investigation determine "causal factors". This is an Occupational Health and Safety label, which applies to environments where there is an expectation of predictability, such as factories, industrial applications, construction, and the like. The firefighting environment is less predictable and prone to sudden changes. Causality is less definite in firefighting operations. The conclusion of the accident investigation team was that "Causal Factors" has to be defined in a modern Human Performance context. The term was therefore defined as, "conditions which supported decisions". This conclusion was supported by management and will be included in the next investigation guide as follows. "Causal factors, in a human performance context, are best be expressed the conditions which contributed to or supported the decisions made, which ultimately resulted in the undesired outcome." This seems like a subtle difference, however, it is predicated on the concept of avoiding hindsight bias and ascription of error.

Panther included many traditional segments, as recommended by the SAIG. For example there is a large section of the appendix dedicated to fire behaviour. This segment is important to show the supporting conditions which drove many of the decisions made by individuals on the fire-line. The conclusions drawn from this information are explained in the narrative. This is a segment of the report that will be evaluated to determine if there is a better way to include it in the main body of the report.

The SAIG is prescriptive about the determination of *cause*. In most reports the *causal factors* are colorful and use terms like 'inadequate', 'failure', 'failure to comply', 'failure to recognize', etc. This language is very subjective and may be seen as the creation of the investigator. By clearly understanding the outcome, it is equally clear to determine the cause. The SAIG defines a *causal factor* as, "*a given act, omission, condition or circumstance which, if corrected, eliminated or avoided would prevent the accident or mitigate damage or injury.*" This places the accident investigation team in a position where the search for counter-factual findings is a requirement. The team then looks for the things they wish had happened and develops a prevention strategy based on "if they had done this, then the accident would have been avoided (Dekker, 2002). The resulting investigations have done little to prevent accidents and USFS accident rate has remained unchanged for decades.

Panther sought global solutions for the problems identified during the investigation. Concepts such as communication dysfunction, assumptive behaviour and ambiguous or weak signals became the focus of the investigation. These were specific conditions discovered during the investigation that effected decisions. This perspective facilitated recommendations which were quite different from previous reports, most of which recommended increased vigilance or greater compliance with regulations. Panther recommendations included: organization-wide examination of the development of risk evaluation tools and a system-wide safety program designed on risk management, as opposed to compliance. The human performance and systemic method of analysis appears to provide deeper insights into the functions and interactions of systems involved in wildland firefighting.

The SAIG requires that "*recommendations are to be based on causal factors*", leaving little latitude for global application, as the definition of causal factors was error based and directed at individual failure. These recommendations usually focused on the violation of the "!0 and 18". This refers to the "10 Standard Firefighting Orders and the 18 Watch-out Situations". These are memorized by all wildland firefighters, with the intent of increasing situational awareness. They have limited

success meeting this intent instead they frequently present goal-conflicts to firefighters. When asked, firefighters almost unilaterally agree it is impossible to meet mission goals and comply with the "10 and 18" in most circumstances.

STANDARD FIREFIGHTING ORDERS

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

WATCH OUT SITUATIONS

1. Fire not scouted and sized up.
2. In country not seen in daylight.
3. Safety zones and escape routes not identified.
4. Unfamiliar with weather and local factors influencing fire behavior.
5. Uninformed on strategy, tactics, and hazards.
6. Instructions and assignments not clear.
7. No communication link with crew members or supervisor.
8. Constructing line without safe anchor point.
9. Building fireline downhill with fire below.
10. Attempting frontal assault on fire.
11. Unburned fuel between you and fire.
12. Cannot see main fire; not in contact with someone who can.
13. On a hillside where rolling material can ignite fuel below.
14. Weather becoming hotter and drier.
15. Wind increases and/or changes direction.
16. Getting frequent spot fires across line.
17. Terrain and fuels make escape to safety zones difficult.
18. Taking a nap near fireline.

Figure 11 "The 10 and 18" as depicted in the Incident Response Pocket Guide carried by all wildland firefighters.

Panther did not evaluate any violations of the "10 and 18". Shortly after the acceptance of the Panther Report, the "10 and 18" were redefined as indicators of increased danger as opposed to 'rules or regulations' to be followed. The Panther analysis was made based on the assumption that all the participants were working within their scope of duties and with the intent to meet agency Directives and policy.

Panther Accident Report Acceptance and Resulting Organizational Changes

The Panther Accident Investigation Report has been challenged by both formal and informal review. The first was the formal acceptance of the report by the Accident Review Board. This board consisted of several members of the US Forest Service Senior Leadership including the Associate Chief of the Forest Service, the Deputy Chief of Business Operations, the Director of Fire and Aviation Management, two Deputy Regional Foresters, a Regional Director of Fire and Aviation Management and the Forest Service Director of Safety and Occupational Health.

The board has the opportunity to review the report in advance and prepare questions for the Chief Investigator (Ivan Pupulidy). The Chief Investigator has the opportunity to provide additional information as needed, to support conclusions made in the report. The board will then vote to accept it 'as is', reject the report, or accept the report following specific changes or recommendations. Panther fell into the last category – the board requested that 3 recommendations be either removed or merged into one. They also required clarification about the forest's use of the Wildland Fire Use Analysis. These were completed and the report was approved in the format included in this document.

Two informal reviews followed the acceptance of the report. The first was a Washington Office-level review conducted by the Director of Safety and Occupational Health, members of the Risk Management and Human Performance (RM&HP) Group, RM&HP Research and Development and the Lessons Learned Center. The second was a review for Forest Staff and field personnel involved in the Panther incident. There is no USFS guidance which mandates either of these reviews, yet they were conducted prior to the release of the report to ensure accuracy and to enhance the opportunity for use of Panther as a preventative tool. Both reviews identified Panther as an example of how accident investigations should be done. The member of the Director of Ground Safety for RM&HP stated, "We need more of this!"

The results of the first informal review were far reaching. As a direct result of the Panther fire investigation, the organization has recognized the need to evaluate the proposed new accident directive. The first step forward was a meeting with the chief investigator of Panther and senior Forest Service safety leadership, which resulted in a suspension of the Directive and an agreement that the organization would re-write the Directive. Sections of the Directive which pertained to methods of investigation were completely removed.

It was agreed that a new "Safety Investigation Guide" would be created, which will describe the methods of investigation to be used, including the processes used in the Panther investigation. The Chief Investigator of Panther has been assigned as the principle developer of the new guide. The Directive was completely re-written and all references to Root Cause were removed. Federal Law requires that agencies conduct investigations to determine "causal factors". As a result, leadership agreed that the term should be fully defined in the context of modern, systems and human performance investigation theory.

The Interagency Lessons Learned Center Director stated, "Panther is the definitive report for lessons learned and should be used as a template for reports whose purpose is prevention. The report was written so that field personnel could make their own judgments and draw their own conclusions – this alone challenges other investigators to write like this for the field."

The Director of Safety and Occupational Health would not let go of the concept that errors occur, yet he agreed to a revision of the *concept of error*. Error will no longer be discussed in reports without a corresponding discussion of the context in which the error occurred. The term

error will also be defined as a value placed on a decision resulting from an unfavorable or undesired outcome.

The Chief of the Forest Service signed another Directive, which states that information and conclusions discovered during a Safety Investigation cannot be used for any purpose other than prevention.

Aside from the additional work of re-writing or creating a new Safety Investigation Guide, stakeholders, such as USFS interagency partners, must be educated with regard to the new method of analysis. To facilitate this, a meeting was conducted with the Department of the Interior Safety Manager. This initial meeting was very successful in gaining support for the new guide. It also identified members of the organization who will resist the process. This is an anticipated part of the process of change and will be met with an array of training, presentations, recommended readings and discussions.

The Panther Investigation also identified another weakness in the prescribed method of accident investigation, which was not addressed by the report. Timelines are common additions to accident investigation reports. This type of depiction can be beneficial, however, timelines can also give a false impression depending upon the perspective of the reader. For example, having 2 minutes to make a decision could seem like a lot of time to one person and very little to another. In addition, timelines suggest a linear nature in accident occurrence and there is an implication of events in sequential order. This can oversimplify or ignore factors which have a significant impact on decisions, such as: the relationship between events and the strength or weakness of warning signals. Decisions depicted on timelines rarely include any context or conditions. As a result they are viewed as isolated events, which can be "cherry-picked" for examples of failure modes. "Finding real or imagined evidence is almost pre-ordained because you come looking for it from a backward direction." (Dekker, 2002)

The individuals who are living the experience may not perceive it in terms of chronologic time. Rather, time passes in terms of events, one to the next. Chronologic time does not consider the perception of compression and extension of time asserted by many accident victims.

To better represent the way events unfold, a new method of timeline depiction is needed. The method under consideration is one that initially places the events in chronologic order and then identifies decision points. These decision points are then analyzed to understand the context of the decision. The context is depicted on the timeline to help the reader understand the complexity of the moment. This new timeline could form the basis of a simple method to standardize the approach to Human Performance Analysis and will be evaluated during the development of the guide.

The timeline is the weakest point in Panther and yet it may have the greatest potential for improvement of the entire process. Most accident investigators have been trained in a very linear approach to assessment. Timelines currently depict events sequentially over time, however, they also easily identify decision points. Most Forest Service investigators are quite adept at recognizing errors based on hindsight bias. The re-definition of cause and error afford the opportunity to use the timeline to identify the decision points and then, analyze them in terms of context and conditions. In essence, the timeline could become the starting point for the investigation and remain consistent with one of the foundational blocks of current training. This supports a recommendation made by the Director of Safety for the Department of the interior, "The first steps in the new guide should be evolutionary, not revolutionary."

The Panther fire investigation report challenged the essentialist view of accident investigation held by some leaders in the Forest Service. The highest level of the organization has accepted the Panther investigation as a representative model of future accident investigation. This positively answers the question: *Can Human Performance and Systemic analysis of accidents be formally accepted in an organization which has traditionally focused on the "Root Cause" model of accident investigation and will this type of analysis have the potential to be incorporated in future accident investigations?*

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