THE COLLAPSE OF DECISIONMAKING AND ORGANIZATIONAL STRUCTURE ON STORM KING MOUNTAIN

Ted Putnam, Ph.D.
USDA Forest Service
Missoula Technology and Development Center
February 1995

Stress, fear, and panic predictably lead to the collapse of clear thinking and organizational structure. While these psychological and social processes have been well studied by the military and the aircraft industry (Cockpit Resource Management) (Weick 1990 and Wiener, Kanki, and Helmrich 1993), the wildland fire community has not supported similar research for the fireline. The fatal wildland fire entrapments of recent memory have a tragic common denominator: human error. The lesson is clear: studying the human side of fatal wildland fire accidents is overdue.

Historically, wildland fire fatality investigations focus on external factors like fire behavior, fuels, weather, and equipment. Human and organizational failures are seldom discussed. When individual firefighters and support personnel are singled out, it's often to fix blame in the same way we blame fire behavior or fuels. This is wrong headed and dangerous, because it ignores what I think is an underlying cause of firefighter deaths – the difficulty individuals have to consistently make good decisions under stress.

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

Decisionmaking: A Telling Model

Human thinking and decisionmaking have been studied and modeled. The decision process is essentially additive: A+B+C. For example, a decision to build fireline may be characterized by firefighters (FFa, FFb, FFc, FFd) basing their choice on these factors:

FB	. . .	fire behavior
W	. . .	weather
FL	. . .	fuels
E	. . .	equipment
P	. . .	personnel, experience, skill
S	. . .	safety
M	. . .	expectations of management

Numerous studies show no matter how many factors are important, the human mind normally can handle only about seven factors (e.g., seven-digit telephone numbers). People differ both as to how many factors they use and the value placed on these factors. In this modeling, the first factor is the one each firefighter pays the most attention to with the other factors added in decreasing level of importance.

So the decisionmaking processing leading to fireline building could be modeled:

FFa	=	M+W+FB+S+P+E+FL
FFb	=	S+P+M+FB
FFc	=	FB+P+E
FFd	=	P+E+S+FB+W

Although their decisions were the same, they arrived at them through quite different factor evaluations.

However, in situations that create stress, fear, and panic, minds regress toward simpler, more habitual thinking. This regression could be modeled:

FFa = M+W (Get the work done, weather permitting)
FFb = S (Safety first)
FFc = FB (Fire behavior most important)
FFd = P+E (People and equipment dominant)

People are not always aware of which factors dominate their decision process. Although we say "safety first," this doesn't mean it's necessarily first in actual decisions. Also, people are seldom aware of the few factors they actually are processing so tend to be overconfident in their decisionmaking ability. Although people are unable to use all the available information for decisionmaking, especially when under stress, computers have no such limitation. Computers process information interactively, A x B x C, and can use most of the available information for better decisions. People are very good at determining the state of each factor, the inputs, but not so good at integrating all the factors to make a decision. While computers are of help to incident management teams, normally they aren't available for extended initial attack.

So, when fireline conditions are routine, most people would reach similar decisions becasue they are more aware and take more information into account. When fireline conditions worsen, decisions are more at the mercy of the one or two factors individuals are still processing and their level of experience. In the example above, under stressful conditions even though each firefighter's main factors differ, if they readily communicate as a crew, most of the factors are still present. Although individual decisions are additive, where good communications exist, the group decision can approach the better interactive process.

Studies also show that our linear thinking tends to underestimate hazards, particularly if the hazard is increasing at a logarithmic or exponential rate as can happen on the fireline. An example would be estimating rates of fire spread. A computer would give the better decision in a heartbeat. People would tend to underestimate the rate of spread and have difficulty deciding on an appropriate course of action. And so it is important to understand the limits of how we process information and common types of errors that can occur.

Leadership and Group Behavior

Stress, fear, and panic take their toll at all levels of the wildland firefighting organization. Under stress, leadership becomes more dogmatic and self-centered. It regresses toward more habituated behavior. Groups tend to fragment under stress into smaller units or to stick together and follow their leader without joining the decisionmaking process. Either way, most of the information available for the best decisions is not utilized.

An extensive 12-year study of Forest Service field crews conducted by sociologist Jon Driessen (1990) showed there is an inverse correlation between crew cohesion and accident rates. The study also identified factors fostering cohesion. Driessen found it takes about 6 weeks for good crew cohesion to take affect. So firefighting crews are predisposed toward accidents until they become cohesive units. Unfortunately, this type of information is not normally considered even when sending crews to more risky fires.

An excellent case study of leadership under stress on a smaller scale is Dr. Karl E. Weick's "The Collapse of Sensemaking in Organizations: The Mann Gulch Disaster" (Weick 1993). Although the leadership and organizational structure discussed are based on Norman Maclean's Young Men and Fire, Weick's analysis is thought-provoking. It is also haunting because the "South Canyon Fire Investigation" report shows the human and organizational failures on Storm King Mountain are similar to those he hypothesizes happened at Mann Gulch 45 years earlier.

Risk-Taking in Wildland Firefighting

First, wildland fires cannot be fought without risk. Making decisions while at risk assumes firefighters can evaluate the likelihoods of various states of nature. On larger fires, with structured incident management teams (IMT), specialists, and portable weather stations, etc., the likelihoods are more objective and outcomes are better predicted. An excellent study of leadership under stress on a larger, IMT, scale is Taynor, Klein, and Thordsen's 1987 article, "Distributed Decisionmaking in Wildland Firefighting." They describe the IMT as a very robust organization due to lengthy experience levels, the common experience of working together, excellent communication structure, and well-defined, well-practiced roles. In contrast, on smaller fires, the likelihoods are more subjective,

based on skill and experience rather than instruments. When small fires grow larger and more complex, such subjective estimates become less accurate, and decisionmaking regresses to a reliance on fewer and fewer factors. The result is a failure to keep up with rapidly changing conditions, and people on the fireline are put at greater risk.

Second, risk-taking is subject to perceived and actual rewards and punishments. When we attach a stigma to deploying a fire shelter, we bias firefighters into taking more risks to escape. If there's a stigma associated with dropping packs and tools, firefighters will carry everything while trying to outrun a fire. If a stigma is attached to abandoning a fire or the fireline, firefighters will take more risks to control a fire. The various payoffs associated with risk-taking are not necessarily those managers claim are operating. We need professionals specializing in the study of decision making under stress to interview managers and firefighters, so we can begin to better understand actual risk-taking on the fireline.

Collapse of Decision Making on Storm King Mountain

On the South Canyon Fire the first decision failures occurred at the BLM district level. Although the fire started July 2 in a fire exclusion zone, resources did not reach the fire until July 5. It was the worst fire season in years and local resources were stressed. Holding costs down and making do with local resources dominated decisionmaking. From our earlier analysis, we can predict a tendency to fall back on habituated tactics, i.e., letting the fire go until a local crew is available. Although many crews were available nationally, the district did not request help until July 5. The longer initial attack was delayed, the greater the risk the firefighters faced.

An incident commander (IC) from the local BLM district arrived on the fire the morning of July 5. But because of mechanical problems with their chain saws, the IC and crew left the fire that evening as a load of smokejumpers were dropped onto a nearby ridge. The first person out the door of the jumper aircraft became the jumper-in-charge (JIC). Via radio the IC turned the fire over to the JIC. This situation raises two immediate leadership questions: Why did the IC leave the fire? Was first experienced person out the door the best way to choose the JIC?

The jumpers fought the fire most of the night as it continued to grow in size. In response, the JIC ordered two more type I crews. The IC returned with his crew the morning of July 6. By 10:30 a.m., a second load of jumpers arrived, and the JIC of that plane load became the line scout (LS). The IC and his crew stayed on top the ridge building fireline, while the jumpers began constructing fireline downhill on the west flank. At 12:30 p.m. 10 members of the Prineville Hotshots (PHS), including their superintendent, arrived at the fire. The IC, JIC, and PHS superintendent agreed to send 9 PHS down to help build fireline on the west flank. At 3:00 p.m. the remaining 10 PHS arrived at the fire and stayed up on top of the ridge with their superintendent to help the IC and his local crew.

So the organization structure before the blowup was:

Location	Local Resources	National Resources
Ridgetop	9 BLM District 2 USFS District 2 Helitack	11 PHS
West flank		9 PHS 8 Missoula SJ 4 McCall SJ 2 North Cascades SJ 1 West Yellowstone SJ 1 Grangeville SJ

All the ingredients were in place for a catastrophe: Three local crews (BLM, USFS, Helitack), the Prineville crew split into two groups, jumpers from five different bases lead by two somewhat randomly selected JIC's were thrown together and asked to perform as team under increasingly unstable conditions. Neither leadership roles nor a cohesive organizational structure stabilized before the blowup.

On the west flank, a group of nine smokejumpers split off to construct fireline to the southwest, forming a third group. These three groups began to focus on their own immediate problems and communications among them continued to decline. As the wind picked up after 3:00 p.m. so did fire activity

and firefighter stress levels. And predictably, decisionmaking and organization collapsed inward, with fatal consequences.

From the South Canyon Fire Investigation report and witness testimony, we can find similar signs of collapse that Weick identified in his analysis of Mann Gulch, including:

- Leadership questioned and challenged (for incident commander, jumper-in-charge, and line scout).
- Decisions questioned.
- Most experienced people not consulted and locked out of decision process.
- Poor communication concerning deteriorating conditions, especially among groups.
- Continued fragmentation into smaller groups.
- Decreased talking within groups.
- Failure to integrate vital, available information when changes occurred.
- Failure to act on weight of evidence.
- Underestimating the current and potential fire behavior.

Once the blowup occurred, in the ensuing stress, fear, and panic, people's actions followed classic lines of regressing to more habituated patterns of behavior:

- On the ridgetop all but two people ran out the east drainage, a potential death trap. This was not a matter of thought as much as regression – going back the way you had come in.

- The two helitack refused to go into the east drainage and ran back along the ridge they had been dropped off on, possibly looking for a copter pickup site.

- The west flank SJ and PHS went back up the fireline they had been digging.

- Virtually all the escaping firefighters carried their tools and packs even though it cost many of them their lives (Putnam, 1994).

- Even when yelled at to drop their tools and equipment, no one did. This deeply ingrained response pattern resulted in fatalities.

- Even though their lives were at stake, very few firefighters made any attempt to use their fire shelters, resulting in a higher number of fatalities (Putnam 1994).

- Although firefighter's knew what fire shelters were and how to open them, they clearly did not know how to use them effectively or where they would work best.

Training to Make Decisions Under Stress

Courses such as Cockpit Resource Management train crews to counteract the natural tendencies for behavioral regression. Countermeasures mentioned by Weick and others include:

- Non-stop communication, both verbal and nonverbal is crucial, especially when people first come together.

- Survival goals (threat recognition, escape, shelter use) must be overlearned through repeated practice or they will not be dominate in dangerous situations.

- Cross-train in roles.

- Value wisdom and openness.

- Initiate respectful face-to-face encounters between crew members and between crews.
- Remain curious and observant.
- If things don't make sense, speak up.
- Avoid overconfidence and overcautiousness.
- When situations deteriorate pay more attention to leadership, perceptions, and group interactions. Strengthen ties.
- Group dynamics before a crisis affect survival during a crisis.
- Expect everyone to work safely, communicate effectively, and cooperate.
- Talk to other crew members and crews. Expect them to talk to you. Then listen.
- Be especially wary of accepting increments of worsening conditions. It is deceptive to accept the increments rather than the entire change.

It is apparent from this list that to be adequately prepared requires training, overlearning, and using these skills routinely before a crisis strikes. It is also clear these skills are a necessary prerequisite for effective decisionmaking concerning integrating fire behavior, weather, fuels, equipment, and human factors.

A Start

Within the wildland fire agencies, awareness is growing about the value of cockpit resource management type training and the need to pay more attention to psychological and sociological aspects of fighting fires. Paul Gleason, a seasoned hotshot superintendent, believes that the 10 Fire Orders, 18 Watchout Situations, and 9 Downhill/Indirect Line Construction Guidelines can be information overload for the firefighter on the line. For this reason he believes four of the key factors should be constantly emphasized: Lookouts, Communications, Escape routes, and Safety zones (LCES) as central to safe firefighting (Gleason 1994, 1991).

We know from our previous model that 30+ warnings are an overload under normal conditions (7 is the practical limit) so LCES, while based on the others, is a excellent system because it is manageable in crisis situations. Since LCES is easy to use, firefighters can constantly reevaluate their situation. Gleason concludes that a change in training content is not needed and that we need to better practice what we already know.

However, I'm arguing that a different kind of training is needed to be able to use our existing knowledge in crisis situations, including LCES. To link the human factors involved in firefighting to the classic "Look Up, Look Down, Look Around," we can add "Look Inside." And we could change "LCES" to "I-LCES" where the "I" means Inside, Inner, and Interpersonal.

Patrick Withen, a smokejumper and sociologist has discussed firefighter attitudes and has pointed out (Withen, 1994) that there is not way to "just say no" in firefighting that doesn't carry formal or informal sanctions. The onus is on the individual firefighter not management to justify the decision. Routinely, there is a stigma attached to leaving the fireline.

While looking at the firefighter from psychological and sociological perspectives is encouraging, this idea has not been well received by many in the wildland fire community. When suggested to the South Canyon Fire Investigation Team and the follow-up Review Board as a possible casual factor the suggestion was dropped from further consideration. Their strongest recommendations should come as no surprise: improve fire behavior prediction, improve weather forecasting, develop better fuel inventories, and look at our firefighting institution from the external perspective. These tried-and-true solutions simply fail to deal with a major cause of the fatalities.

We lost firefighters on Storm King Mountain because decision processes naturally degraded. At this time we do not have training courses that give firefighters the knowledge to counter these processes. Both the Investigation Team and Review Board recommended creating a passion for safety but did not acknowledge that this passion is determined by psychological and sociological processes. The type and skill level of investigation team members and review boards (typically they include IMT personnel, a fire weather forecaster, fire behaviorist, fuels specialist, equipment specialist, but no psychologist or sociologist) predisposes them to focus on the traditional inputs, which effectively

excludes other types of input, hence predetermining the outcome. This calls into question the very process and structure by which we investigate fatalities and communicate the results to the fire community. We can and ought to do better.

Discussion

There is no intent here to blame the individual firefighters and managers for what they did or didn't do related to Storm King Mountain. The real issue is that we are not preparing our firefighters and managers to operate with maximal effectiveness under known stressful, risky conditions. The processes and papers cited, when considered in the light of the South Canyon Fire Investigation report, clearly demonstrate that an almost automatic collapse of decisionmaking and organizational structure occurred. It should also be clear that we are not unique in operating under stressful, risky conditions. Other organizations have reduced fatalities through training using techniques with a proven track record. Paying more attention to the psychological and sociological processes of our people is long overdue.

It is clear that even our best crews are not adequately trained in escape procedures and fire shelter use. This is a reflection of the prevailing attitude among managers that if we give firefighters more training and better predictions for fire behavior, fuels, weather, and tactics, entrapments won't happen. So why plan for them? Individual firefighters agree with their managers and also have the attitude that it won't happen to me so why practice for an entrapment. These attitudes caught up with our best and brightest firefighters on Storm King Mountain and were a causal factor in the fatalities.

Since 1990, extended droughts and more severe fire behavior have shortened the time firefighters have to decide whether to try to escape or to deploy shelters. Some 23 firefighters have perished trying to escape uphill carrying packs and equipment. Estimates show most would have lived had they simply dropped their gear and run for safety carrying only fire shelters.

This is why mandatory training for escape, shelter use, decisionmaking under stress, and stress-resistant organizational characteristics should become national priorities.

Everyone agrees our top priority should be reducing the number of entrapments by practicing safety and LCES. But we also need to face the reality that on average 30 firefighters are trapped each season, and that we have not taught them how to escape or to use fire shelters effectively, or the concepts discussed here. Clearly, firefighters need this type of training. Better personal and interpersonal skills will enable firefighters to optimally use all their training and experience under risky, stressful conditions.

Recommendations

1. Implement recommendations in fire shelter training stemming from the analysis of protective clothing and equipment and its use on the South Canyon Fire (Putnam, 1994).

2. Convene a task group of firefighters, fire training and safety officers, psychologists, sociologists, and others who will recommend specific actions for individuals and groups that will maximize their resistance to decision and organizational collapse under stressful conditions.

3. Develop a training program to communicate these new skills to personnel such as Incident Management Teams, type I and II crews, strike team leaders, and others at risk or making decisions under stress.

4. Analyze the organizational structure of initial attack and extended initial attack crews and how these crews interrelate to form an effective organization with optimal leadership and decision making capabilities.

5. Develop professional requirements, best skills mix, and organizational structure for fatality investigation teams and review boards. Form IMT type teams before fatalities occur so investigation teams are trained and ready for dispatch.

6. Consider adding a “Look Inside” component to “Look Up, Look Down, Look Around” and an “I” to LCES. Incorporate an inner check list into the Fireline Safety Reference Notebook.

Literature Cited

Driessen, Jon. 1990. The Supervisor and the Work Crew. USDA Forest Service, Missoula Technology and Development Center, Missoula, MT.

Fireline Safety Reference. 1992. NFES 2243. National Interagency Fire Center. Boise, ID.

Gleason, Paul. 1991. LCES – A Key To Safety In the Wildland Fire Environment. Fire Management Notes. 52 (4) : 9.

Gleason, Paul. 1994. Unprepared for the Worst Case Scenario. Wildfire. 3 (3) : 23-26.

Maclean, Norman. 1992. Young Men and Fire. Chicago: University of Chicago Press.

Putnam, Ted. 1994. Analysis of Escape Efforts and Personal Protective Equipment on the South Canyon Fire. Missoula, MT: USDA Forest Service, Missoula Technology and Development Center.

South Canyon Fire Investigation Report. 1994. NIFC/NFES

Taynor, Janie; Gary Klein, and Marvin Thordsen. 1987. Distributed Decisionmaking in Wildland Firefighting. U.S. Army Research Institute for the Behavioral and Social Sciences. Alexandria, VA.

Weick, Karl. 1990. The Vulnerable System: Analysis of the Tenerife Air Disaster. Journal of Management. 16:571-593.

Weick, Karl. 1993. The Collapse of Sensemaking in Organizations: The Mann Gulch Disaster. Ithaca, NY: Cornell University.

Wiener, Earl, Barbara Kanki, and Robert Helmrich. 1993. Cockpit Resource Management. San Diego: Academic Press.

Withen, Patrick. 1994. Fire Culture. Inner Voice, September/October 1994:12-13.