

The 2&7 Tool: A Human Factors Tool for Wildland Firefighters

Brad Mayhew

Abstract

Recent years have seen an increased recognition of the role of human factors in wildland fire tragedies. The challenge is to organize and present this information in a useable format for firefighters at all levels. At the heart of preventable wildfire tragedies are two key errors—two ways that situational awareness and decision-making break down. Contributing to these errors are seven key barriers to situational awareness and decision-making. These fundamentals—2 Errors, 7 Barriers—can be presented as a useable training tool. Though this 2&7 Tool aims at completeness, it is still a work in progress.

Introduction

The mission is to design a human factors tool for wildland firefighters. Right now, our training and fatality case studies seem to focus disproportionately on tactics and fire behavior while underemphasizing human factors and the causes of decision errors and lapses in situational awareness. We need to develop a training tool to give firefighters the skills to notice, identify, and mitigate breakdowns in decision-making and situational awareness. This tool must be complete, systematic, simple and useable. It must be relevant to preventable wildland fire mishaps and appropriate to the target group at all levels.

Here is a working model of what that tool might look like:

TWO ERRORS:

- 1-Underestimating hazards, and using inadequate safety measures (i.e., inadequate LCES)**
- 2-Failing to notice changing conditions and adjust tactics accordingly**

SEVEN BARRIERS:

- 1-Inexperience**
- 2-Getting Too Comfortable**
(eg. Complacency, Inattention, False Sense of Security, Autopilot)
- 3-Distraction From Primary Duty**
- 4-Priorities Out Of Order**
- 5-Social Influences**
(eg. Groupthink, Peer Pressure)
- 6-Stress Reaction**
- 7-Physical Impairment**
(From Fatigue, Carbon Monoxide, Heat Stress, Medication, etc.)

© 2005-2008 Brad Mayhew

This Fireline Factors Article is available at: www.firelinefactors.com

Last revised 3 January 2007

Originally appeared as “A Human Factors Tool for Wildland Firefighters,” in: Butler, B.W and Alexander, M.E. Eds. 2005. Eighth International Wildland Firefighter Safety Summit: Human Factors - 10 Years Later; April 26-28, 2005 Missoula, MT. The International Association of Wildland Fire, Hot Springs, SD.

The Two Errors

Two key decision-making errors lead to tragedies on wildfires:

- **1-Underestimating hazards, and using inadequate safety measures (i.e., inadequate LCES)¹**
- **2-Failing to notice changing conditions and adjust tactics accordingly**

Each of these errors arises from human nature: 1-Optimism: We assume that nothing bad will happen, that things will work out, and 2-Inertia: Once we form an interpretation of our situation and choose a course of action, we tend to stick with it.² Usually, optimism and inertia are appropriate, even beneficial, but sometimes they get in the way of sound decision-making.

How do we make decisions? Early theories held that we weigh options, analyze relevant factors, and then choose the most appropriate course of action. “Recognition-Primed Decision Making,” is a more current model: when we look at a situation, our minds search for a similar situation from the past, and we react to the current situation based on our past experience—we go through “slides” in our head, pick out the one that most closely matches current conditions, and act on that.

Tragedies occur when 1-You pick the wrong slide, or 2-Conditions change, but your slide stays the same. But why does this happen? Nearly every fatality came with numerous clear early warnings. So why didn’t people notice? Human optimism and inertia don’t explain it all: in hindsight, the warnings *seem* so loud that they should have been enough for any seeing, thinking person. People must have missed the warnings because they weren’t seeing and thinking clearly—something must have gotten in the way.

The Seven Barriers

There are seven key kinds of barriers to situational awareness and decision-making:

1-Inexperience

- Don’t have the “slides”
- Don’t know what to focus attention on and what to filter out (don’t know what’s top priority and what isn’t)
- Don’t recognize the severity of warning signs (haven’t developed the emotional triggers—the “gut reactions”)

2-Getting Too Comfortable

- Get so used to things working out that you think nothing bad will happen
- Get comfortable taking risks because they’ve worked out so far, and nothing bad has happened yet

¹In order to make this applicable to a wider range of mishaps, Error #1 can be stated more broadly: “1-Misjudging hazards and using inappropriate or inadequate safety measures.” Underestimating is just one way of misjudging. For our purposes, I think the specific term (“underestimating”) is more useful. If we want to apply the tool to other kinds of mishaps, the more general term (“misjudging”) might be more appropriate.

Underestimating hazards would include overestimating personnel.

LCES stands for Lookouts, Communications, Escape Routes, and Safety Zones—these are the basic safety measures for wildfires.

² You might say that, by nature, humans are chronic underestimators, and that we’re generally blind to change.

- Get so used to an activity that your brain goes on **autopilot** and you become **less attentive**
- Key terms: false sense of security, complacency, inattention, letting your guard down, automaticity, a sense of invulnerability, Russian Roulette, normalization of risk, mindlessness

3-Distraction From Primary Duty

- You can only focus fully on about ONE thing at a time, and you can only juggle about FIVE things in your brain.
- When you try to track too many things, vigilance suffers.
- Distractions can be external (eg. Heavy radio traffic, panicking public, etc.) or internal (eg. Conflicts, personal concerns, etc.)

4- Priorities Out Of Order

- We have all kinds of priorities, desires and motivations. Safety is one of the things we care about, but other things matter to us, too.
- Here are some examples of other motivations:

-accomplishing the mission	-competition
-saving acres, structures, dollars	-staying comfortable
-not letting people down	-getting along
-getting a thrill	-ego
- So we have a variety of motivations that we base our decisions on, and they're constantly moving up and down on our mental priority list throughout the day. While this is going on in our heads, we're usually not aware of it. It's easy for other priorities to get ahead of safety—to forget what's most important when the pressure's on.
- The idea is not that there's something *wrong* with any of these other priorities. The point is that we get can get into trouble when we base our decisions on this secondary stuff above safety.
- Saving structures, accomplishing the mission, and not letting others down, for example—these are good priorities. But they can be counterproductive when they get ahead of safety.³
- Motivations and desires also affect how we see the world—we see what we want, and we block out what we don't.
- We filter and interpret information based on our priorities and desires. This can lead to wishful thinking and avoidance.⁴

³ What we call “Hazardous Attitudes” seem to result mostly from Priorities Out Of Order. Getting Too Comfortable (Barrier #2) and Social Influences (Barrier #5) can also play a role. All these factors are just an ordinary part of being human. “Hazardous Attitudes” and “Priorities Out Of Order” are just unsafe versions of attitudes and motivations that are usually normal, useful, and mostly unchangeable. Competitiveness, for example, can cloud decision-making. But it also makes people work harder; it's often appropriate and productive, and it's widespread. You can't get competitive people to stop feeling competitive, but you can train people to be aware of their strengths and weaknesses, and to base decisions on safety and effectiveness above other motivations.

⁴ An eighth barrier might be appropriate – a special case of how desire and motivation affect perception – **Avoidance:**

- We tend to avoid information we don't want to hear, especially when we've already made a commitment (we avoid warnings that we've made a poor choice), or we feel stuck with something we don't like, or we don't see any better alternatives.
- Hostility and frustration often come with avoidance. Resignation is another result.

5-Social Influences

- Social influences affect how we view the world. As our brains try to figure out what's going on, they pick up on clues and hints about what other people are thinking. As our brains read the people around us, we trust most of what we get from them. So we “pick our slides” based on what others seem to be thinking. And we do most of this without realizing it. Usually this works well—usually what other people seem to be thinking really *is* correct. But not always. So sometimes social influences get in the way.
- One familiar form of social influence is peer pressure. Peer pressure can be powerful even when it's unspoken.
- **Groupthink** is another example of how social patterns can get in the way. In groupthink situations the group mind locks onto a slide, and group members stop thinking as individuals; members of the group don't question the group opinion. Here are some of the characteristics of groupthink that Irving Janis identified; these sound strikingly similar to what we find in fatality reports. In groupthink situations:
 - Group members stop thinking for themselves
 - Group cohesion takes priority over other objectives.
 - Group members don't notice warnings that contradict the group's slide.
 - Members explain away warnings they do notice.
 - Members don't speak up; if they do, they're ignored or silenced by other members.
 - Groups have an illusion of invulnerability, and take irrational risks.
- This isn't to say that all group decision-making is dangerous. Groupthink is just a way that group decision-making can go wrong.

6-Stress Reaction

- Stress triggers our fight-or-flight survival mechanism. This is a physical, chemical change in the body and brain.
- Heart rate and breathing speed up as you get ready to respond immediately to threats and challenges.
- As the stress reaction builds, the rational “thinking” part of the brain shuts down, and the emotional “reacting” part takes over. When this happens:
 - Your mind locks into a course of action and you fixate on a goal.
 - You lock into trained behaviors.
 - When you “lock in,” you block out new information.⁵
 - Communication breaks down.
- This extreme stress reaction is powerful if you have to react quickly and fight hard or run fast. But it's not helpful for thinking clearly or seeing the big picture. And it can cause you to do things that “don't make sense.”
- Key terms: getting too focused, hot cognition, tunnel vision, action tunneling, mission fixation

(see comments by Janis and Mann 1977 on Defensive Avoidance and Wishful Thinking, pp. 64,71,74,95-133)

⁵ You become physically less able to take in and process information. Consider, for example, tunnel-vision studies showing that our visual field narrows under stress.

7-Physical Impairment

- Physical factors like fatigue, Carbon Monoxide, heat stress, alcohol or drugs bog down and interfere with your ability to perceive, think, and respond.⁶

Non-fire Applications

This tool also works for non-fire decision errors, and I think this versatility is an added bonus.⁷ A friend wrecked his car a few months ago on the I-80 driving to Lake Tahoe during a snowstorm. Before the accident, he considered spending the night in town and finishing the drive the next morning. He also considered snow chains (even though the vehicle was 4 wheel drive) or letting one of the passengers drive. Any of these choices probably would have turned out better. So why did he keep driving? Well, just after the accident, while he was standing there in the snow, he ran through this tool in his head; here's what he came up with:

This was Error 1 -- Underestimating the hazard and using inadequate safety measures (He underestimated the ice, and overestimated his ability to deal with it. He could have taken further precautions, but didn't think they were necessary).

The Barriers were:

- 1-Inexperience (he hadn't driven icy roads much)
- 2-Getting Too Comfortable (he had a false sense of security and didn't fully appreciate the danger)
- 4-Priorities Out Of Order (he wanted to get to Tahoe that night, didn't want to spend the night somewhere else and finish the drive in the morning; also, he wanted to keep his passengers happy, and they wanted to get to Tahoe that night—nothing wrong with these priorities by themselves, but they may have gotten in the way of playing it safe)
- 5- Social Influences (he wanted to keep his passengers happy, and they wanted to get to Tahoe that night; also, everyone seemed pretty comfortable with the situation, which reinforced the perception that it was a good plan)
- 7-Physical Barriers (possibly Fatigue: the accident happened at about 1:30 am, he probably wasn't as alert as if it were 10:00 am).

Distraction (3) and Stress (6) were probably not major factors.

Another example, offered by one of the UCSB Psychology professors: SCUBA Diving mishaps. Usually it's a diving instructor who dies, usually because he didn't follow his checklists. So this is Error 1: underestimating the hazard and using inadequate safety measures. Skipping the checklist is due to Barrier 2: Getting Too Comfortable/False Sense of Security (based on past experiences when everything worked out). Under water, your body doesn't use O₂ as efficiently, and this makes critical thinking difficult. You're also likely to panic when things aren't working out. So under water, Barriers 6 and 7 come into play: Stress (Panic), and Physical Impairment (O₂ deprivation).

⁶ "Recent research (Lamond and Dawson 1998) points out that the loss of even a single night's sleep (25.1 hours of wakefulness) impairs decision-making and vigilance to levels comparable to a blood alcohol content of .10." Thirtymile Fire Investigation Report (Furnish et al. 2001, p. 80).

⁷ For certain other kinds of mishaps, might re-word a couple of things, but the principles are the same.

In addition to auto and SCUBA accidents, I've also run this model for decision errors in other fields, and it's worked pretty well so far.⁸

Final Thoughts

Human factors are more subjective than tactics and fire behavior. They're harder to deal with—it seems like there would be a lot of guessing if we try to figure out *why* people do what they do. We know we have to go beyond *what* went wrong, we have to get to *why*. But going from *what* to *why* always involves speculation and inference. So if we try to incorporate this tool into our case study process at the crew level, one constant annoyance will be that you can't really get absolute final answers. For example, if you're looking at stress, you'll probably never know *exactly* how stress affected decisions on a mishap; there'll always be some ambiguity. It's the same for the other barriers. Nevertheless, it's still worthwhile to run through the process because the intent is to bring out the lessons of human factors.

Most of this stuff is already intuitive for experienced firefighters, so what's the point? Even though many experienced firefighters already understand this stuff, most younger firefighters are not familiar with the issues. So this is a teaching tool. It's a system for looking at mishaps and finding the fundamental reasons things go wrong. For some people, this is already intuitive and they don't need a system. For many of us, though, it isn't intuitive yet. So this tool is a way to systematically address the key issues.

There will have to be some supporting document, or set of documents, or website, or *something* that explains the tool more fully. Part of the challenge with these topics is that most of the research is not written in useable language. So the supporting document for the tool will have to be in useable language. I'm working on this. It will also include resources for instruction—brain maps that show how drastically your brain changes under stress, stories, references to current literature, etc.

Finally, this 2&7 Human Factors tool is a work in progress. I'm aiming for completeness, simplicity, precision, and usability. This is an ongoing project—a model to build on, and I welcome any feedback.

References

Janis I, Mann L (1977) 'Decision Making: a psychological analysis of conflict, choice, and commitment'. (The Free Press: New York) pp. 64,71,74,95-133

Furnish J et al. (2001) 'Thirtymile Fire Investigation Report'. USDA Forest Service.

⁸ Surfing, skiing, investing, etc. also fit the model.