

Integral Leadership and Signal Detection for High Reliability Organizing and Learning

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Abstract

In the last ten years, the fire management community has made significant advances in firefighter safety and leadership development. Yet, there is no discernible downward trend in entrapment fatalities. While the complexity of the job and exposure of an increasing number of firefighters to increasingly severe situations has surely increased over that time frame, the best we can say is that the trend is not increasing. This paper explores the question, how can we make significant advances toward reducing the likelihood of future firefighter fatalities? Signal detection theory provides a mechanism to facilitate sensemaking, learning and the exploration of deeper causal models. Signal detection theory can help focus attention on detecting weak signals (and so provide a means for high reliability organizing) and learning from errors (and so provide a means for organizational learning). To make progress toward organizing for high reliability and learning, leadership is required. Some of the vast literature on leadership development is summarized. A critical facet of leadership is creating an environment “where the truth is heard and brutal facts confronted.” Signal detection can also be deployed to help create such an environment. The paper concludes with some suggestions for possible next steps.

Introduction

Between 1933 and 2003 there were 329 wildland fire entrapment fatalities. A little over half (171) are Forest Service personnel. The total average is 4.6 entrapment fatalities per year. Average statistics for temporal periods, especially short temporal periods can be misleading. The data does not suggest any downward trend (figure 1). While the complexity of the job and exposure of an increasing number of firefighters to increasingly severe situations has surely increased over that time frame, the best we can say is that the trend is not increasing. (See pages 94-98 in Paulos (1988) for the development of a more meaningful safety index). Each year, there is only a 20% chance that we will make it through the fire seasons without one or more entrapment fatality. There is roughly an equal chance (18%) that we will have nine or more entrapment fatalities (figures 2 and 3). So how can we make significant advances in the prevention of firefighter fatalities? This paper adds to the growing body of knowledge about the importance of how people make meaning. Our sensemaking capability is critical. The paper will suggest how looking at the world through the lens of signal detection theory can move our organizations toward high reliability and learning. The paper will then discuss the importance of leadership to transforming organizations by creating an environment that fosters individual and collective development.

Causal Models and Practical Drift

Following the South Canyon wildfire in 1994 and the first wildland firefighters human factors workshop (Putnam 1995), investigations of entrapment fatalities have progressively improved, incorporating more and more human factors and increasingly recognizing the

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importance of situational awareness. But there is still more that can be done. An excellent example of an investigation is the Columbia Accident Investigation Board (CAIB) report (<http://www.caib.us>), especially chapters six (decision making) and seven (organizational causes). The introduction to chapter seven is particularly appropriate:

“Many accident investigations make the same mistake in defining causes. They identify the widget that broke or malfunctioned, then locate the person most closely connected with the technical failure: the engineer who miscalculated an analysis, the operator who missed signals or pulled the wrong switches, the supervisor who failed to listen, or the manager who made bad decisions. When causal chains are limited to technical flaws and individual failures, the ensuing responses aimed at preventing a similar event in the future are equally limited: they aim to fix the technical problem and replace or retrain the individual responsible. Such corrections lead to a misguided and potentially disastrous belief that the underlying problem has been solved. The Board did not want to make these errors. A central piece of our expanded cause model involves NASA as an organizational whole.” (p. 177)

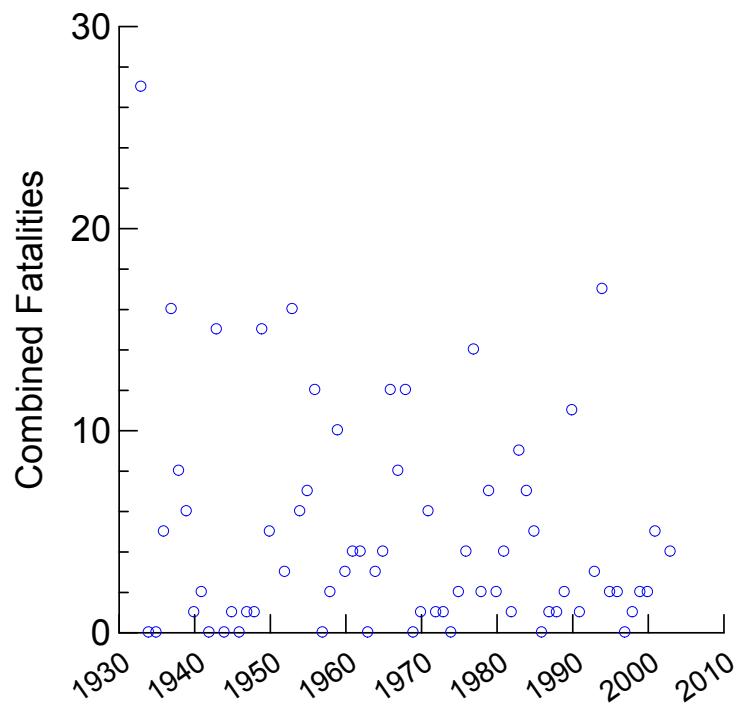


Figure 1. Annual variability in entrapment fatalities.

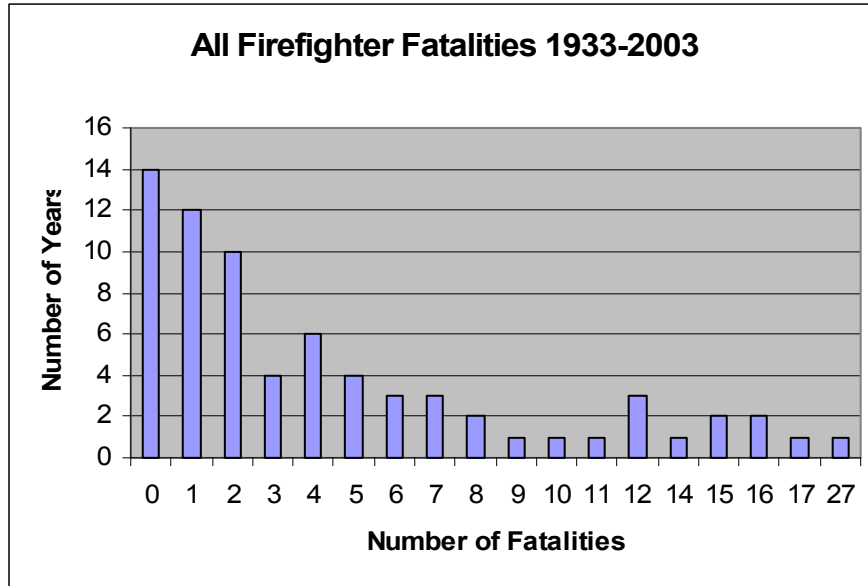


Figure 2. Frequency of entrapment fatalities.

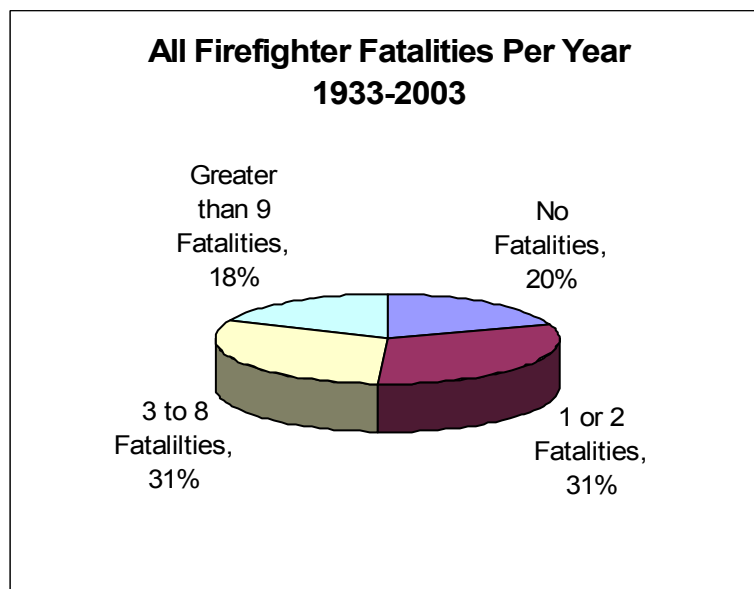


Figure 3. Percentage distribution of the number of entrapment fatalities.

The fire entrapment causal model has been limited, primarily looking at the world through the lens of the Ten Standard Firefighting Orders and the 18 Situations That Shout Watchout. It is increasingly recognized that “we don’t necessarily believe what we see; instead, we see what we believe.” The ten and 18 are a lens which we look through to see the world. The notion that someone is to blame and must be held accountable is another lens we look through to see the world. There are times when we need to examine the lenses through which we see the world. While excellent training tools and a basis for operational procedure, the ten and 18 present a limiting causal model as described above by CAIB. In other words, the fire entrapment causal model has been “limited to technical flaws and individual failures.” An excellent example of a more complete causal map is on page 21 of Snook’s (2000) book, Friendly Fire. Snook’s in-

depth analysis of *individual psychology, group dynamics, and organizational culture* is pointing the way for a more in-depth and robust analysis of human factors. The fire management community has taken only baby steps in that direction to date. The concern that Snook (2000) expresses for not finding deeper root causes mirrors the fire management situation:

“Near misses like this F-111 incident should sound organizational alarms... Even if the F-111 incident had been recognized as an important indicator of the organization’s health and even if it had been raised to the highest levels and examined in some detail, I am still doubtful that the right lessons would have been learned, that appropriate action would have been taken. Given the organization’s response to the eventual tragedy—treating it as a potential crime instead of as a safety mishap and then heaping stacks of new rules on top of the old ones—I am not confident that this near miss, even if it had come to light, would have generated the type of organizational learning required to identify and address the underlying fundamental conditions that increased the likelihood that such a breakdown occurred in the first place. Instead, I would predict that first, individual attributions would have been made (most likely directed toward AWACS controllers and Army aviators). And second, a list of even tighter rules would have been written—rules that directly ‘fix’ those errant behaviors immediately antecedent to this particular incident. Deeper root causes such as interservice rivalries and the conditions that encourage practical drift would remain unexamined.” (Snook 2000, p.216-217).

Snook’s (2000) theory of “practical drift” is similar to Vaughan’s (1997) “normalization of deviance” and is what many people, especially the fire management community, are all wrestling with:

“...The ‘design set of rules,’ written to meet the worst-case scenario imagined, were bound to be interpreted as overly controlling and as an unreasonable burden on operators in the field. In contingency language, the rules didn’t match the situation *most* of the time.

When the rules don’t match, pragmatic individuals adjust their behavior accordingly; they act in ways that better align with their perceptions of current demands. In short, they break the rules. According to General Carleton, the Task Force Commander who took over after General Pilkington was relieved: ‘Violations of policy and guidance occur minute by minute out there. Some are willful violations, but most are not.’...

Such mismatches between the local demands of the situation and those of global design rules occurred with increasing regularity as operators gained personal experience in the field. As a result, the pervasive demands of day-to-day practice inevitably *shifted* the logic of action from one based primarily on formal rules, to one driven more tightly by the task—the ever-present demands of minute-to-minute practice. Over time, the seductive persistence of pragmatic practice loosens the grip of even the most rational and well-designed formal procedures. I call this phenomenon ‘practical drift’—the slow, steady uncoupling of local practice from written procedure...” (Snook 2000, p. 192-194)

In summary, the fire management community needs a new way of looking at the world that will lead to the discovery of deeper causes and account for practical drift. Signal detection theory presents one such possibility.

Signal Detection Theory

Signal detection theory began in the early 1950's with the development of "Identify Friend or Foe" (IFF) systems. It is the most robust methodology for assessing the effectiveness of diagnostic systems (Swets et. al. 1979, Swets and Pickett 1982). A commonplace application of the theory is found at all airports when you walk through a metal detector. The basics of the theory are captured in a 2x2 matrix:

Signal Detection Theory		State of Nature	
		Danger/ Threat	No Danger/ No Threat
Sense Making and Decision Making	Danger Approaching	Hit	False Alarm (Chicken Little / Cry Wolf)
	Danger Not Approaching	Miss (Fatality)	Correct Rejection

The "State of Nature" is what is actually out there. In this case, there is a dangerous or threatening situation or there isn't. A human is constantly making sense of the environment, picking up on signals that indicate whether or not danger is approaching. People (individually and collectively), will make sense of the situation, make decisions, and decide on an appropriate course of action, depending on whether they see danger approaching or not. The collective group may in fact exert tremendous influence on individual sense making and decision making, for example, peer pressure or taking the proverbial group trip to Abilene that no individual wants (Harvey 1988). Combining the two states of nature with the two sense making options results in four possible outcomes. For firefighter safety:

1) Make sense of the situation and decide that it is life threatening and take appropriate action to get out of harm's way; when the situation is in fact life threatening (HIT). Sometimes a Hit may be a "near-miss" or "close-call." An example of a Hit is when a fire begins to blow up, a crew recognizes the situation and makes their way to a safety zone.

2) Make sense of the situation and decide that it is not life threatening and take (in)appropriate action; when the situation is in fact life threatening (MISS). Fatalities typically occur when the threat is not recognized until it is too late (not enough time) to take appropriate evasive action. Note that the appropriateness of the actions taken can only be judged in hindsight.

3) Make sense of the situation and decide that it is life threatening and take (in)appropriate action; when the situation is in fact not life threatening (FALSE ALARM). This is the proverbial

story of “Chicken Little” or “Crying Wolf.” For example, based on a weather prediction of impending red flag conditions, crews are pulled off the line; and the red flag conditions never materialize.

4) Make sense of the situation and decide that it is not life threatening and take appropriate action; when the situation is in fact not life threatening (CORRECT REJECTION). A crew sizes up the fire potential and decides that it is safe and most effective to build line downhill. The line is completed without incident.

An example of events in 1987 and 1988 in the Persian Gulf can illustrate some basic signal detection concepts. U.S. warship in the Gulf had to identify aircraft flying in their airspace as friend or foe. Based on their assessment of incoming signals, the commanders of the ships had to ultimately decide whether to attack or not. Obviously, the strategy was to attack hostile aircraft (foe) and to not attack nonhostile aircraft (friend). An example of a miss was when the commander of the USS Stark failed to attack an Iraqi fighter on May 17, 1987. Thirty seven of the 200 men serving aboard the ship died. The Stark’s commanding officer was criticized by the Navy for failing to defend the ship. He retired at reduced rank. An example of a false alarm was when the commander of the USS Vincennes shot down an Iranian civilian, commercial airliner on July 3, 1988, killing all 290 people aboard. The Navy supported the commanding officer of the Vincennes. Professional management of these situations requires balancing on a tightrope, and may be akin to riding a see-saw. Evidence from various sensors is collected to identify an incoming aircraft. A certain threshold of evidence exists. If the amount of evidence exceeds the threshold, the aircraft is classified as hostile and the order is given to attack. Below the threshold, an aircraft is classified as friendly. Increasing the threshold of sufficient evidence will result in fewer aircraft being classified as hostile. With few aircraft classified hostile, false alarms will drop but misses will increase. Alternatively, lowering the threshold of sufficient evidence will result in more aircraft being classified as hostile, reducing the number of misses, but increasing the number of hits. By taking measures to reduce the probability of another Stark-like incident, the Navy most likely increased the chances of a false alarm. Interestingly, Petty Officer 1st Class Michael J. O’Keefe of the USS Stark speculated that the USS Vincennes may have been prompted to fire at the Iranian jet liner by the failure of the USS Stark to defend itself (White 1989).

Paulos (1988) points out a few more examples of riding the miss/false alarm see-saw. “When punishment is being meted out, the stereotypical conservative is more concerned with avoiding [misses] (the deserving or guilty not receiving their due), whereas the stereotypical liberal worries more about avoiding [false alarms] (the undeserving or innocent receiving undue punishment). Of course, there are always people who will object to the strictness of the Federal Drug Administration in not releasing drug X soon enough to prevent suffering, and also complain loudly when drug Y is released prematurely and causes severe complications.” (pg. 108)

There are many benefits with using signal detection theory *as a starting point* of an expanded causal model. First off, it provides a ready explanation for Snook’s (2000) theory of practical drift. Written procedure is often focused on the worst-case low-probability scenario – avoiding a “miss.” Local practice is often focused on the high-probability, typical scenario and the efficiencies of reducing the amount of crying wolf. If more attention is focused on preventing a miss while keeping the possibility and consequences of false alarms in mind, Vaughan’s (1997) normalization of deviance can be minimized. By focusing on both misses and false alarms at the same time, the signal detection matrix captures the tenth standard firefighting order: Fight fire

aggressively (minimize the likelihood of false alarms), having provided for safety first (minimize the likelihood of a miss).

Second, signal detection theory dovetails with some of the hallmarks of high reliability organizing (Weick and Sutcliffe 2001). Three of the five hallmarks of high reliability organizations (HROs) are preoccupation with failure, reluctance to simplify interpretations, and sensitivity to operations. A preoccupation with failure for HRO is focusing on the Miss of signal detection. "People in HROs worry a lot about the temptation to normalize unexpected events. They are well aware of the danger of making false positive errors (diagnosing trouble where there is none). But they have less fear of a false alarm than they have of missing something significant that could escalate" (Weick and Sutcliffe 2001, page 40). In the terms of signal detection theory, HROs are focused on minimizing misses, while well aware of false alarms. Recall that for the 10th standard firefighting order, providing for safety (minimize a miss) is the first priority. There may be a temptation to look at the world through rose colored glasses and simply focus on success (hits and/or correct rejections). Conversely, there may be a temptation to focus on one type of error - to simply focus on misses or simply focus on false alarms. Keeping the whole matrix in mind is an example of an HRO's "reluctance to simplify interpretations." As an entry into an expanded causal model, we begin to ask some interesting questions. In hindsight, what were the first signals; who was picking up on them; how were they being communicated throughout the system; why were there time-lags; what was the source and level of noise; how can we get better, both individually and collectively, at detecting weak signals early on? The whole matrix and especially the recognition of false alarms shows a "sensitivity to operations." By periodically taking a moment in the heat of operations to pause and ask oneself and one's group, where are we in the matrix, the matrix becomes a tool for continually updating assessments of the situation.

Unless you have a perfect system, there will always be some error rate. If you simply lower the decision threshold to detect more misses, without improving the entire system, you simply increase the likelihood of false alarms and the subsequent practical drift. This is why the rhetoric of "zero tolerance" makes no sense from a signal detection point of view. Achieving zero misses in an imperfect system means accepting an infinite amount of false alarms. Suggestions for improvement need to focus on the entire system and work to reduce both misses and false alarms. Weick and Sutcliffe (2001) echo this important concept. "Nowhere in this book will you find any mention of perfection, zero errors, flawless performance, or infallible humans...Error is pervasive. The unexpected is pervasive. By now that message should be clear. What is not pervasive are well-developed skills to detect and contain these errors at their early stages" (page 67). In summary, signal detection theory provides a tool to help people make sense of complex situations as they are emerging – what Weick and Sutcliffe (2001) refer to as "mindfulness." It can also be used to develop deeper causal models by prompting people to search for the answers to why something happened.

Third, signal detection theory also dovetails with the concepts of a learning organization (Senge 1990, Garvin 1993, 2000). Argyris (1977) defined organizational learning as "a process of detecting and correcting error." Thus, organizational learning is all about detecting and correcting misses and false alarms. Garvin (1993) states that learning organizations are skilled at five main activities: systematic problem solving, experimentation with new approaches, learning from their own experience and past history, learning from the experiences and best practices of others, and transferring knowledge quickly and efficiently throughout the organization. Rogers (2003) provides insight on the diffusion of innovation throughout organizations and society. One

example of diffusing knowledge through an organization is the use of a lessons learned center, such as the Wildland Fire Lessons Learned Center (<http://www.wildfirelessons.net>). Learning is often about pushing beyond obvious symptoms to assess underlying causes (Garvin 1993). The signal detection matrix can be used to help frame some of the questions used in an After Action Review (AAR): what was planned (hit or correct rejection); what actually happened (hit, miss, correct rejection, false alarm); and why did it happen? As mentioned above, signal detection theory provides a mechanism to begin to explore underlying causes, takes a comprehensive systems approach to problem solving, and guides the experimentation and learning from one's own and others past experience. In summary, signal detection theory provides a framework and is a comprehensive tool for analyzing responses to weak warning signals. It can focus attention on detecting and correcting errors.

While signal detection provides an expanded way of looking at the world that will facilitate sense making, learning, and the exploration of deeper and richer causal models; leadership is also needed to transform our organizations toward the further pursuit of high reliability and learning.

Leadership

Following South Canyon and the first wildland firefighters human factors workshop (Putnam 1995), there has been a growing recognition of the importance of leadership (see for example <http://www.fireleadership.gov>) and leadership development has steadily improved. But there is still more that can be done. The notion that progress is being made and that individuals and organizations are growing leads us to the idea of development and the stages of development.

The developmental stage of a leader is increasingly recognized as perhaps the most important aspect of successful change efforts in organizations. Some even claim that organizational transformation requires the presence of leaders who have reached a high stage of personal growth and development. Goleman's (2002) work shows the link between an executive's emotional maturity (exemplified by such capabilities as self-awareness, and empathy) and performance. After extensive research into what were the factors necessary for transforming a good company into a great one, Collins (2001a, 2001b) reported that "Level 5 leadership" was essential. Collins introduced a hierarchy of five levels of leadership capabilities: highly capable individual, contributing team member, competent manager, effective leader and level 5 executive. The defining characteristic of a level 5 leader is the paradoxical combination of personal humility and professional will. These characteristics are also reminiscent of Greenleaf's (1970) notion of servant leadership and Badaracco's (2002) "leading quietly."

Drath and Palus (1994) trace ideas about leadership evolving from personal dominance, to interpersonal influence, to people making sense and meaning of their work together. Heifetz (1994) and Heifetz and Laurie (1997) echoed these ideas when they pointed out that for most senior executives, providing leadership and not just authoritative expertise is extremely difficult. "Solutions to adaptive challenges reside not in the executive suite but in the collective intelligence of employees at all levels..." Weick and Sutcliffe (2001) provide additional insight: "With every problem, someone somewhere sees it coming. But those people tend to be low rank, invisible, unauthorized, reluctant to speak up, and may not even know they know something that is consequential." (p. 74)

Building on Kegan's (1982, 1994) developmental psychology, Rooke and Torbert (2005) point out that what differentiates leaders is their internal "action logic" – how they interpret their surroundings and react when their power or safety is challenged. Rooke and Torbert (2005) identified seven types of action logics: Opportunist, Diplomat, Expert, Achiever, Individualist,

Strategist, and Alchemist. On one end of the spectrum is the Opportunist who is self-oriented, manipulative, and wins any way possible with a strong belief that “might makes right.” At the opposite end of the leadership development spectrum, an Alchemist generates social transformations by integrating material, spiritual, and societal transformation. The majority of people surveyed are Experts (rules by logic and expertise, seeks efficiency) and Achievers (meets strategic goals, effectively achieves goals through teams, juggles managerial duties and market demands). All levels are important and have a valuable contribution to make. At the top, what sets an Alchemist apart from Strategists is their ability to renew or even reinvent themselves and their organizations in historically significant ways. Rooke and Torbert (2005) note that the path to Strategist and Alchemist action logics is qualitatively different from other leadership development processes.

Heifetz (1994) pointed out that leadership is value-laden and involves our self-images and moral codes. Kohlberg (1981) investigated moral development and came up with the following stages: magic wish, punishment/obedience, naïve hedonism, approval of others, law and order, prior rights/social contract, universal ethical, and universal spiritual. Gilligan (1978) described three stages of moral development: selfish, care, and universal care. Wilber (2000a, 2000b) has sought to develop a comprehensive model that includes development and seeks to integrate art, science, and morals. Seeking to integrate a variety of theories of development, including ego development (Loevinger 1976) and moral development (Gilligan 1978, Kohlberg 1981), Wilber developed a four quadrant model that distinguishes between what is interior and exterior, and the individual and the group.

Four Quadrants:	Interior	Exterior
Individual	<p>I subjective Self and consciousness Art / Beautiful Theory Y – McGregor; EI - Goleman</p>	<p>IT objective Brain, organism, things Science / True Theory X – Taylor; “Reengineering” – Hammer</p>
Collective	<p>WE intersubjective Culture and worldview Morals / Good Culture – Schein, Lewin</p>	<p>ITS interobjective Social system & environment Systems Science / True Systems Dynamics – Senge, Garvin</p>

The individual-interior quadrant is the subjective domain of art and is concerned with the question, what is beautiful? The individual-exterior quadrant is the objective domain of science and is concerned with the question, what is true? The collective-interior quadrant is the inter-subjective domain of morals and is concerned with the question, what is good? The collective-exterior quadrant is the inter-objective domain of systems science and is also concerned with the question, what is true? One of Wilber’s primary messages is that all four quadrants are important

and necessary. No attempts should be made to reduce any one quadrant to another quadrant. Development occurs in all four quadrants. The major business theories have been categorized into these four quadrants (Wilber 2000a). The individual-exterior quadrant has been the most popular and includes such management theories as Theory X (Taylor 1911), total quality management (Deming 1986), and business process reengineering (Hammer and Champy 2001). The individual-interior quadrant includes Theory Y (McGregor 1985), and emotional intelligence (Goleman 1995, 2000, 2002). The collective-interior quadrant is concerned with culture change, probably best exemplified by the work of Schein (1992) and Lewin (1997). This quadrant is also the domain of moral leadership of which Harvey's (1988) classic collection of business stories is an excellent example. The collective-exterior quadrant includes systems dynamics – the “fifth discipline” of learning organizations (Senge 1990). Meaning making or sense making is especially important. Weick (1993, 1995, 2001) develops the central role and importance of individual and collective sense making. Kegan's (1982, 1994) theories of adult development are based on how the relationship of subject (interior) and object (exterior) evolves and matures as people develop.

Trying to integrate art, science, and morals is perilous. In a book based on extensive interviews with entrepreneurs and scientists, Senge and others (2004) articulated the problem: “A number of scientists we interviewed have very serious spiritual practices that they regard as integral to their science. For me, this connection between inner work and outer work is one of the most important findings from the interviews. But most of them do not feel safe talking about it, even those who have achieved some integration of the two domains.” (p. 39) Not feeling safe to talk is partly a function of the climate of an organization. The importance of climate has been recognized at least since the time of McGregor's (1985) work on “managerial climate” in the 50's and early 60's. Heifetz and Laurie (1997) talk about the importance of a holding environment as “a temporary ‘place’ in which a leader creates the conditions for diverse groups to talk to one another about the challenges facing them, to frame and debate issues, and to clarify the assumptions behind competing perspectives and values.” Collins (2001b) clarified the emerging concept that “leadership is equally about creating a climate where the truth is heard and the brutal facts confronted.” In the absence of a conducive climate, high levels of personal courage are required. This all important climate is one of the pillars of making Collins' (2001b) transformation “from good to great.” Collins (2001b) offers four basic practices for creating a climate where the truth is heard: lead with questions, not answers; engage in dialogue and debate, not coercion; conduct autopsies, without blame; and build “red flag” mechanisms. Collins (2001b) describes engaging in dialogue and debate as “the process was more like a heated scientific debate, with people engaged in a search for the best answers.” (p. 77) The “red flag” mechanism was described with a personal example:

“I issued to each MBA student an 8.5” x 11” bright red sheet of paper, with the following instructions: ‘This is your red flag for the quarter. If you raise your hand with your red flag, the classroom will stop for you. There are no restrictions on when and how to use your red flag; the decision rests entirely in your hands. You can use it to voice an observation, share a personal experience, present an analysis, disagree with the professor, challenge a CEO guest, respond to a fellow student, ask a question, make a suggestion, or whatever. There will be no penalty whatsoever for any use of a red flag. Your red flag can be used only once during the quarter. Your red flag is nontransferable; you cannot give or sell it to another student.’”(Collins 2001b, p. 79)

And so we come full circle, back to signal detection theory. The signal detection matrix can be used as a tool to help create a climate “where the truth is heard and the brutal facts confronted.” The matrix helps frame challenges being faced and leads to interesting questions that can focus dialogue (Dixon 1996, Ellinor and Gerard 1998, Isaacs 1999) and debate. The matrix can also serve as a departure point to discover deeper causal models and so assist in conducting investigations without blame.

Conclusions and Next Steps

From the first human factors workshop ten years ago (Putnam 1995) to the recent HRO workshops (Keller 2004), the fire management community is making significant progress in firefighter safety. But, as the job of firefighting has become more complex and more dangerous, our improvements in safety have barely kept pace. It sometimes feels like we’re just keeping our head above water. We need to think about what it would take to make a quantum leap forward. At the heart of that leap forward lies the importance of sensemaking. Sensemaking is the key to situational awareness and the mindfulness of high reliability organizing. Signal detection theory offers a potent tool to improve our sensemaking capabilities and begin to develop deeper and richer causal models of tragedy. Our sensemaking evolves as we develop in life, and may very well be the most critical aspect of leadership development and thus organizational change. Our ability to overcome our immunity to change (Kegan and Lahey 2001a, 2001b) and transform our organizations into ones based on high reliability organizing principles and learning principles will be dependent on the emergence of highly developed leaders at all levels of our organizations. One of the primary tasks of leadership at all levels is creating an organizational climate where “the truth is heard and brutal facts confronted,” and thereby foster development of individuals and organizations. Some specific suggestions for possible next steps include:

- Benchmark the Marine Corp Warrior Project (Heckler 1992) to see what lessons may be applicable to improving situational awareness and leadership development.
- Explore the applicability of Notre Dame’s executive education program on “integral leadership” which “focuses on both multidimensional business conditions and key facets of human development (cognitive, emotional, physical, interpersonal, ethical, moral, and spiritual) as the most comprehensive way of developing oneself, guiding others, and building successful organizations.”
- Explore the relationship, if any, of developing artistic capabilities (Cameron 1992, Edwards 1999) to improved situational awareness and leadership development.
- Improve the collection of safety statistics by investigating the development of a logarithmic safety index (Paulos 1988) and the development of Receiver Operating Characteristic Curves which plot hit rates against false alarm rates (Egan 1975, Swets 1973).
- Experiment with introducing the signal detection framework into briefings and periodically bring up signal detection in routine conversation on the fireline. Incorporate the signal detection framework into After Action Reviews.
- Test the use of a signal detection framework as a portal into expanded and deeper causal models in investigations.
- Develop organizational policies, procedures and processes that facilitate forgiveness and grace (Harvey 1988) as part of creating a climate where the truth can be heard. As an example, I have noticed that Staff Rides tend to serve this purpose. If Pope John Paul II

can forgive someone for intentionally trying to kill him, surely we can find it in our hearts to forgive people when sensemaking collapses on a fire and crews suddenly find themselves in the words of Kegan (1994) “in over their heads.”

- Signal detection may also help with what Harvey (1988) calls “The Gunsmoke Phenomenon” – the ability of leaders to stand up to angry lynch mobs.

Finally, hopefully this paper has stimulated more questions than answers and is thereby an example of leading with questions, not answers.

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