



# Risk Perspectives

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## Abstract

The US Forest Service has engaged in a transformation of its safety culture to meet the Chief of the Forest Service's goal of a zero fatality organization. This process represents a conscious change, from a compliance based safety program to one that is centered on risk management and ultimately to prevention through learning. As the organization initiated risk management strategies, it became clear that there were a number of different meanings, perspectives and definitions of risk. These meanings were associated with deep beliefs held by the organization and by individuals. Members of the organization agree that risk management concerns all activities, either from the perspective of prevention or protection. However, simply exhorting personnel to try harder or to prescriptively perform risk assessments was found to be counter-productive and actually destructive to the development of expertise. Discussions with field personnel indicated the need for an alternative method to identify specific times when a risk assessment should be conducted. This paper focuses on the key differences between how the field personnel perceive risk (a situational assessment based on conditions observed in a dynamic environment) and how risk is regarded at the senior leadership level (fundamentally as a function of probability and severity). Additionally, it challenges common models of risk by introducing perspectives of risk as suggested by the *Epidemiological model*, *Normal Accident Theory*, *Resilience Theory* and *Practical Drift*. Cultural and organizational biases are considered when the paper recommends dialogue as a method to develop a common risk language, to combat assumptive behavior and to develop a more resilient safety program.

**Key Words:** Risk Management, Safety Culture, Expertise, Dialogue, Intuition.

## Introduction

Risk . . . how we define this term dictates how we can and will address it. I have not attended a safety meeting where this term has not been discussed and yet, when I ask what this term means, I get a wide variety of definitions. This is not an unexpected response, as risk has both organizational and individual meanings. This describes a unique character of the word that may, in fact, make it difficult or even impossible to completely define. The person facing a life or death situation in an aircraft, or on the fire line, may define risk in a completely different way than the person who writes policy for the organization. Neither perspective is wrong and both are important to the functioning of the organization.

Risk perspectives can be thought of as the different ways segments of our organization define and deal with risk. Recently, the Forest Service divided risk management into three phases: Strategic, Operational and Real-time. Leadership is fundamentally focused on Strategic risk management with less direct involvement in Operational and Real-time. Field personnel are precisely the opposite, having the strongest emphasis on Real-time and a diminishing role in Strategic (see Figure 1). This is a normal and necessary delineation of roles and responsibilities within a functioning organization.

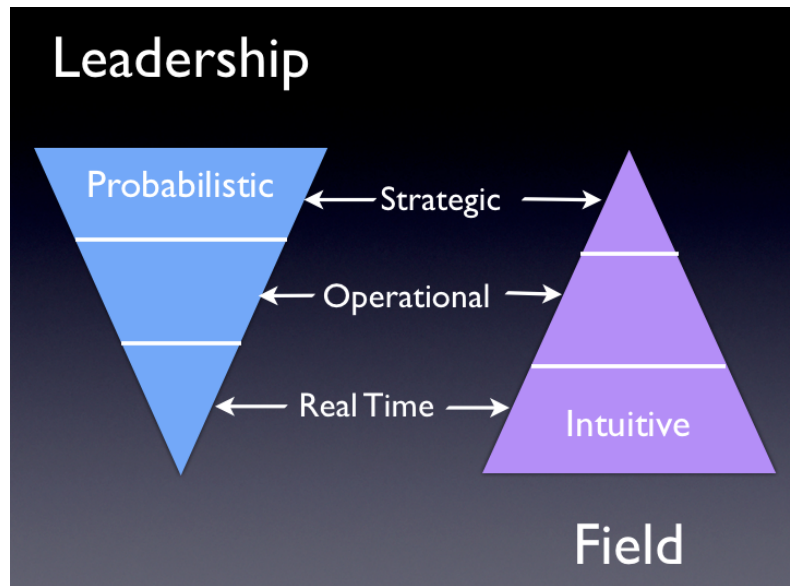


Figure 1

One difficulty arises as organizations attempt to communicate about risk across hierarchical boundaries. The definition of risk that each group uses, and therefore the language that each group has come to use regarding risk, are different. For example, Risk for Senior Leadership is often discussed in terms of probability and severity (or consequence). The field considers the consequence and the probability of an occurrence using an intuitive process rather than a deductive or highly analytical process. Analysis takes place at the level of expert performance and is commensurate with the experience of the personnel involved - The higher the level of expertise the greater the intuitive response. "The *expert* not only sees what needs to be achieved; thanks to a vast repertoire of situational discriminations, he or she also sees immediately how to achieve the goal. . . This allows the immediate intuitive situational response that is characteristic of expertise." (Dreyfus, H., Dreyfus, S., 2005). This is accurate and necessary under conditions where workers must do complex, adaptive problem solving, as opposed to fundamentally technical or rote procedural work.

The importance of expertise and mastery cannot be understated. When personnel perform at the expert level they are less likely to make mistakes and more likely to

develop effective creative solutions to complex problems (Rasmussen, J. 1997). Complex, interactive and dynamic work requires adaptive, intuitive problem solving to be safely and efficiently completed. "Applying procedures is not simple rule following. Applying procedures successfully in actual situations is a substantive cognitive activity" (Dekker, 2006). This applies directly to fieldwork conducted by the Forest Service.

A modern example from outside the Forest Service, was Qantas flight QF32, the Airbus 380, which experienced an uncontained inflight engine explosion. When this incident occurred, there were numerous checklists and procedures available to the crew designed to assist them with inflight emergencies. The multiple simultaneous failures were not part of the flight manual instructions and were not included in the crew's simulator or ground training. The crew had no manuals, rules, process or checklist to handle this emergency and had to adapt to meet the challenges of the complex emergency. A New York Times article about the incident, illuminates details and indicates the critical need of expertise and adaptation,

*"With the power lines severed, the crew could not move fuel from the rear tanks to the forward ones as they emptied, creating the potential that the plane would become so tail-heavy it would stall and crash. The crew also could not reposition the left wing's slats, which are small panels that normally help maintain lift at the low speeds of takeoff and landing. The damage to the spar could have been catastrophic if the plane had hit turbulence. The crew's first challenge was simply to identify the cause of the alarms that suddenly flooded the cockpit's computer screens. The number and variety of them put the situation beyond the realm of anything the pilots, who are trained to follow a logical sequence for a single system failure, would have drilled for."*

## **Methodology**

This research initiative, regarding formalization of risk process, began approximately four years ago in the aviation-training program called System Safety Leadership for Aviation Management (SSLAM). Following a request from Senior Forest Service leadership to develop formalized risk management processes for USFS operations the project was intensified. The majority of risk management literature was developed to meet the needs of the insurance industry as part of actuarial analysis, or as a result of the RAND corporation's work on Failure Modes and Effects analysis. The central theme of this research describes risk in terms of Probability and Severity (or Consequence).

US Forest Service field operations are characterized by work in dynamic, interactive and complex environments. Risk related literature centered on the Epidemiologic model (Probability X Severity) was too limited to recognize the expert modes of action, which are required to achieve safe mission accomplishment (Dryefus, et al 2005). These operations require innovation and adaptation, expressing more

complex interrelationships than the Probability and Severity model alone can address. Accident investigations supported this conclusion and indicated that additional research was needed. Resilience theory, Practical Drift and Normal Accident theory all seemed to have applicability to US Forest Service operations. Research was directed toward literature focused on these areas of study to verify their applicability.

Several organizations claimed to have risk processes designed to operationalize the Probability and Severity model. These included the US Coast Guard, US Air Force, Federal Aviation Administration and Canadian commercial lumber industry. Most of the processes were titled 'Operational Risk Management' (ORM) and included components of both strategic and operational risk tools. Other models were specifically directed at real-time risk management. These included Observe, Orient Decide Act (OODA, developed by the US Air Force during the Korean war), Stop, Think, Act, Review (STAR, developed by Department of Energy) and Perceive, Process, Perform (PPP, developed by the Federal Aviation Administration).

These processes were formally introduced to operational personnel in USFS Research and Fire organizations. In addition risk processes used in wildland fire operations were also identified. Field risk processes ranged from fully intuitive and unwritten analysis to written checklist format assessments. Formal inquiry of the use and existence of risk process were conducted in classroom scenarios. Students were asked to identify risk processes they had access to and how they were used. Informal study was conducted opportunistically by asking Researcher Station personnel, Forest Health Protection personnel and firefighters if they had access to any formal risk assessment processes and a large number of written processes were discovered as a result of this inquiry. This resulted in assessment of why these processes were not being used.

## **Results**

### Field Research

During the informal review of risk processes, two types of risk analysis were identified: Self-designed (those developed by field personnel) and those published in inter-agency approved written guides or direction. Inquiry regarding use of the existing processes indicated they were ineffective and unused. All groups indicated that field personnel did not use "one-size fits all" or "check-list" models proactively. Although the risk assessments were intended to be used as decision aids, field personnel indicated these processes were used after a "go/no-go" decision had been made, to justify the decision, or to simply complete the required documentation.

The reported field use of formalized risk processes was minimal and indicated the existing processes did not meet the original intent or did not provide the field personnel with valuable information beyond their intuitive assessments. Numerous

responses reflected a cultural resistance to the introduction of any new process, which would further delay initiating the operations phase of the mission.

New processes should avoid the “checklist” format and concentrate on establishing a dialogue centered on risk theory. Standard language was also identified as an area of concern, so any proposal should include methods to establish a standard risk language.

This research indicates that the field has little or no confidence in existing formalized risk processes and that a new approach to the formalization of risk is needed to re-engage field personnel in the process. Implementation of any new or existing process(es) must consider how frequently the process should be used. Mandatory use may actually reduce the perceived value of the process and result in disuse. Another issue is recognizing when to use a risk process. Real-time processes may require a signal to stimulate use during critical operations.

### Application of Existing Theory

The most commonly recognized risk assessment process defines risk in terms of probability and severity. Most of the language surrounding this model is economic and this process is frequently used to evaluate programs that have a great deal of quantitative data. This model is often used in engineering and insurance industries to compare risk to benefit. Failures of this model are usually related to “problem framing”, capturing all the critical variables. This process is very time intensive and best suited for strategic risk assessments. This limitation resulted in assessment of how academic groups described system operation to determine if there was another way to assess or define risk from a field perspective. Four risk models are suggested based on current safety models or accident/incident analysis methods.

The epidemiological model is often described using the ‘Swiss Cheese Model’ (SCM) (Reason, 1997). In this theory, risk is viewed as *energy to be contained*, frequently by the use of barriers. Barriers do two things; they either prevent the incident from occurring, or reduce/mitigate the outcome of the event once it has occurred. Barriers developed using this concept include: seatbelts, airbags, wakeup strips on roadways, NOMEX, fire shelters, etc. Every barrier, while it may serve an important function, also has the potential to add complexity to the system. Additionally, effective barriers will also, frequently, be exploited by the user to improve efficiency or for process optimization.

An example of process optimization resulting from the implementation of effective barriers can be seen in the relationship between highway use and speed limits. As the motoring public gains confidence in highway safety barriers like: improved automobile and roadway design, airbags, crumple zones, improved tire and steering technology, ABS braking systems, road handling, etc., highway speeds increase steadily. The state of Texas is currently considering increasing the speed limit on

their highways. As drivers normalize the improvements designed to improve safety they increase their speed to meet the demands of efficiency.

The second risk perspective was introduced by Professor Charles Perrow, in “Normal Accidents: Living with High-risk Technologies”. Professor Perrow indicates that risk can be seen as a function of complexity and coupling. Simply put, the more complex a system is, the more difficult it will be to diagnose abnormal system functions. Therefore, the more difficult it will be to intercede and the more likely it is to fail. The reaction to this perception of risk is often to add redundancy, change the structure of the system, or otherwise seek to reduce system complexity. Coupling refers to a condition where small seemingly unrelated normal system issues affect down stream functions – Disturbances propagate through the system and there is little opportunity to improvise solutions. A nice example of this would be, you show up for your flight at the airport and clear security. Your plane is broken so they get a replacement, which does not have space for overhead bags, so you gate check your carry-on. The flight is delayed and this reduces your connection time. The plane lands and taxis to the gate, but there is no crew at the gate due to thunderstorms in the area. You finally get off the plane with only a few minutes to get to your next flight and realize you have to wait for the carry-on bag, so you miss your flight. Seemingly unrelated, yet normal, problems in the system interact and result in an undesired outcome.

Scott Snook, in “Friendly Fire” devised a model of ‘practical drift’ based on ‘practical action’. Practical action, as the name suggests, refers to locally efficient actions to meet operational needs and reinforced through repetition without feedback or negative outcome (Snook 2000). This model recognizes rule versus task-based incongruities – going by the book versus adapting behavior to the local practical circumstances. Risk viewed from this perspective would be described as drift of actual work away from work as designed or imagined. Rules, regulations, processes and procedures define work as imagined. This forms a baseline, from which normal and accepted work drifts or deviates. Drift can be the result of goal conflicts in the workplace, often exemplified by shrinking budgets with increased work demands. Rules, which are too complicated to be understood, or conflict with other rules, also factor into this drift. Another goal conflict arises when people cannot follow the rule verbatim and must adapt the rule in order to complete the mission. Drift is normal and necessary in complex, dynamic and interactive work, and can actually manifest as process improvement.

The fourth perspective of risk comes from resilience research, which focuses on human, organization and system variability – Professor Hollnagel refers to ‘stochastic resonance’ to illustrate that output variations in several sub-systems (or processes) may interact and create a major disturbance or accident (Hollnagel, 2005). This model poses an interesting dilemma, because variability is both positive and negative about a perceived norm. Engineers put a line above and below an assumed norm, about which variability fluctuates; this line is called a ‘control’. Ecologists seem to understand this line more conceptually and call it a ‘boundary’. Going

outside the boundary on the positive side represents maximum performance (which is not sustainable) and on the negative side the variability results in failure or accidents. This model would consider risk to be function of variability.

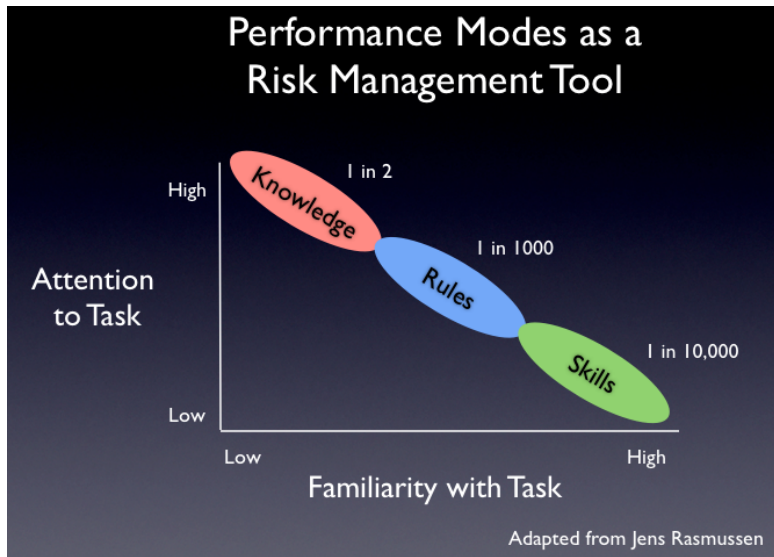
Use of a single risk model or perspective limits our ability to understand, discuss, assess and/or manage risk. All four models serve to fill out a bigger picture of risk and perhaps pose the question, "Is this something we should try to manage, understand or communicate?" At the Senior Leadership level of the Forest Service, strategic risk assessment, based on the probabilistic model, is necessary. The probabilistic approach at the field level is often limited by time constraints and the demands of the situation. Field personnel may conduct probabilistic analysis, but when time is limited, the assessments must be adjusted accordingly and naturally become more intuitive. The models show that the critical components of risk at the field level are less analytically centered and best discussed and shared at the crew level through dialogue. Sharing at this level also represents an opportunity to build expertise with novices through coaching.

All of the models share the notion that risk embodies two concepts: 1) the future is uncertain and 2) the future may contain bad outcomes that we wish to avoid. The four models support the importance of understanding human adaptive interaction and its effect on creating safe outcomes. All four models and the probabilistic model explore different ways of thinking and talking about uncertainty and avoiding potential bad outcomes, as such all are important perspectives to consider when addressing risk.

## **Conclusion**

### Real- time Risk Assessment

*"Anything that can go wrong, will go wrong."* This is the standard response generated by what we call "Murphy's Law". Reality is quite different, *"Anything that can go wrong . . . probably won't go wrong."* The reason for this is quite simple - people create safety. People in the workplace see the potential for an adverse outcome and intuitively take action to intervene and prevent the incident or accident from occurring. Professor Rasmussen would say that the highest level of appropriate intervention occurs during skills-based performance, which represents the highest level of expertise. This is a function of many variables, perhaps the most important being, the more experience a person has the better they are at anticipating outcomes (Dreyfus, et al 2005).



**Figure 2** The Rasmussen Scale describes performance modes. The small numbers suggest worst-case error rates for each mode.

Professor Rasmussen supported the importance of expertise when he described three basic divisions of work performance: knowledge-based, rules-based and skills-based (see Figure 2). This division of human performance describes the relationship of expertise to the novice, and provides us with insight into how we might improve the assessment of risk during operations (real-time).

We should recognize that any number of variables or conditions can change the mode in which we find ourselves, so during any given mission we can shift between skills-based and knowledge-based performance and back again. At the skills-based performance level, our familiarity with the task is high and our attention to the specific task is low. This corresponds with our mental model of the world being in synch with the real world. Essentially, things happen the way we predict they will. When this is not the case and we are operating in rules or knowledge-based performance, we will see differences between what we predicted and what is actually happening. These differences could be described as ‘surprises’, which are frequently indicated by the sensation of anxiety. So any time we are surprised by what we observe, or feel anxious, we should question what is happening and understand that we must increase our attention to task. In this case, attention to task equates to risk analysis. Evaluation and decision are cognitive functions that cannot be conducted concurrently with action. As a result, a break in action is required to conduct risk assessment – “Time to think and time to act” (Hollnagel 2009). The Rasmussen scale (above) can provide us with a way to improve our ability to recognize opportunities to take a break in action, in order to conduct an evaluation.

*Anytime we are surprised by what we observe, we should question what is happening.*

*Assumption is the enemy of questioning!*



Questioning is another major aspect of risk assessment. Accident investigations often have a common denominator - *assumptive behavior*. Assumptive behavior is can be expressed by the phrase as, “because I know something, I believe that you know it.” Assumption is the enemy of questioning. Most field personnel know this at a very intuitive level. Recognizing when we are surprised is important, because it can be used to amplify the signal strength of differences, that otherwise might go unnoticed.

Recognition of differences during operational missions is a key component of both risk identification and safe operation. For example, as a combat flight crew in Iraq, before we left the Base we would receive a briefing regarding the known threats we should expect to encounter during the mission. The crew would develop a plan to meet the expected threats, with an understanding that no plan, regardless of how good it may be, will survive the contact with the enemy<sup>1</sup>. The plan is still important, as it is the first step in building a mental model of the situation – a base reality, from which we could determine differences. Without this plan, it would be difficult to determine what changed. Before we departed the airfield, I would always say, “Crew, no matter where we are, or what we are doing, I want you to tell me right away if you see anything *Dumb, Dangerous or Different*.”

Professor Rasmussen gives us another way to recognize differences. If we see surprises, we know that we are no longer in skills-based, the least error-likely performance-mode. Surprises become a strong signal to stop and re-evaluate. The evaluation, itself, could range from very simple to complex. At a minimum, any evaluation should include, “*What is our worst case scenario? What is our plan for my worst-case scenario and have we communicated that plan? And, “Where are we one mistake away from failure?”* This is similar to LCES<sup>2</sup>, an example of real-time risk assessment. The Rasmussen scale helps to identify weak signals and therefore tells us when to conduct a risk assessment. “*Most descriptions of decision-making divide it into a number of steps. Exactly how many and what they are*

*Ron Heifetz uses the metaphor of being on the dance floor and periodically needed to get up on the balcony to watch what is unfolding.*

*We need to be skilled at moving back and forth between the balcony and the dance floor.*

<sup>1</sup> Helmut Graf von Moltke – a student of Von Clausewitz, made this statement in reference to Von

<sup>2</sup> LCES is a fire line acronym for Lookout, Communication, Escape Route and Safety Zone – indicating that all these must be in “established and known to all firefighters before it is needed” Interagency Incident Response Pocket Guide (NFES 1077).

*called depend upon the model in question. But there is general agreement that it is necessary both to orient oneself and evaluate the situation, decide what to do and plan how to do it, and then finally carry it out.” (Hollnagel 2008).*

### Risk Dialogue and Formalization of Field Level Risk Assessment

Formalization of a risk analysis process presents an interesting problem. Too much formality will result in processes that are not used or are ‘pencil whipped’; too little formality may result in important hazards going unnoticed or the process will not benefit the user. One thing is clear when it comes to operational and real-time risk processes - They should be developed as close to the work as possible, to preserve operational context. Leadership has a significant role in the development of Operational and Real-time risk processes, *establishing purpose*.

Purpose can be described as the boundaries or minimum criteria and the philosophic intent of the process to be developed. This concept is consistent with a doctrinal or principle-centered approach.

*Risk Processes should be developed as close to the work as possible.*

It is important that field risk analysis be dialogue based. Dialogue facilitates the crew’s ability to build a shared mental model of what they will likely face. This mental model should be the result of the expertise of the group, and should offer an opportunity to coach the least trained or most junior members of the crew. Dialogue puts the crewmembers in the best possible condition to recognize where the environment is different from the original assessment by building a shared mental model. This translates to real-time risk assessment and increases the crew’s ability to recognize differences between observed conditions and the shared mental model.

Dialogue also goes beyond the crew and the idea of developing a shared mental model. Risk dialogue across hierarchical boundaries will facilitate the ability of leadership to understand crew strengths and limitations. For example, our current management of fatigue is limited to compliance with crew-rest guidelines. There are a number of studies that point to the limitations of this model. A recent Duke University study provides convincing data regarding what happens to the mind when personnel become fatigued. This study indicates that fatigue does more than dull the senses, which we frequently correct with stimulants. It states that a fatigued mind is actually *biased toward positive outcomes* and literally has difficulty recognizing negative outcome events. “A single night of sleep deprivation (SD) evoked a strategy shift during risky decision making such that healthy human volunteers moved from defending against losses to seeking increased gains.” (Venkatraman, V. et al 2011). The choice of options literally becomes smaller - a mental myopia, that reduces the person’s ability to recognize potential bad outcome

*Operational and Real-time risk assessment should be dialogue based.*

events<sup>3</sup>. Furthermore, studies indicate that stimulants will not change this condition. As this example indicates, dialogue would create the opportunity for a clearer or deeper assessment of the crew's ability to perform the task in question.

The second challenge is when to employ risk evaluation processes. Culturally, it may be difficult to introduce pre-mission risk management processes. A recent Forest Service study asked practitioners what kind of risk assessments they conducted. The inquiry uncovered a large number and variety of risk assessment tools currently in use. This indicates a need to develop standardized processes at several levels of the organization. A structured dialogue may be an acceptable form of pre-mission risk formalization.

Initial formalization of a risk analysis may be most effective if introduced during 'After Action Reviews' (AARs). AARs afford the opportunity to openly discuss issues, especially surprises in a non-time-critical environment. The introduction of risk language should be well planned and introduced in a way consistent with adult learning. The process should address when personnel were surprised by what they saw during the operation, when they felt anxious and when an observed outcome was perceived to be a function of fortune (as opposed to design). The discussion should then move to a dialogue about what these key topics indicated about the risk accepted during the mission. This basic approach should also introduce a common, agreed upon language, that we can use for subsequent risk dialogue.

### **Future Research Plan**

The absence of common formalized risk processes, standard philosophy (doctrine) and language regarding risk, indicates the need for additional research. This research could be conducted in three concurrent phases outlined below:

Phase One should concentrate on understanding the risks faced during an operation and understand the best way to introduce philosophic principles of risk to the field. This phase should be introduced as close to the action as possible but not in a time critical phase of the operation. It is therefore suggested that *key questions* be introduced to a diverse group of personnel during After Action Reviews to generate a dialogue. These questions should be designed to recognize assumptions made pre-engagement and to determine if these assumptions were valid. The questions should uncover times when crewmembers felt anxious, surprised or lucky. The emphasis should be placed on the development of a risk dialogue to identify what can be learned locally and globally, and what should be factored into the next operation.

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<sup>3</sup> This phenomenon is recognized by casinos and is one reason they increase betting minimums later in the evening.

Phase Two should be a natural outgrowth of the previous phase designed to develop a Forest Service standard language around risk assessment and communication of identified risks. This language should facilitate dialogue between hierarchical levels of the organization.

Phase Three should address how to develop Operational and Real-time risk processes. No one in the organization understands the risks faced by field personnel like they do. Therefore it is recommended that the people actually engaged in operations (the 'sharp end') should develop the risk assessment processes. There have been several processes developed by field units, which demonstrate the efficacy of allowing the sharp end to develop assessments designed to promote pre-engagement dialogue. These are currently being tested in field applications, with positive results, however a broader application is needed to fully evaluate this method.

Each field group expressed concern that a standardized template would not be able to address local variables, which could be critical to operational risk assessments. Therefore, processes designed to provide latitude to address variables like unit, equipment, locality, terrain, crew variability etc. should be designed and evaluated.

Selected field units should begin developing gradational risk assessment processes as part of a research project. These processes should be designed to evaluate the ability to structure the risk process in three possible ways. First, identify the minimum requirements for a real-time risk analysis (to identify what is dumb, dangerous or different). Second, crews should be interviewed to determine if there is a common cognitive process for real-time risk assessment, which can be institutionalized (similar to the OODA process). Third, identify a more structured or formalized process, which could be used by field units as a fireline assessment, based on observed conditions, as opposed to mandatory pre-mission evaluations.

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