The Neglected Context of Risk Assessment
A Mindset for Method Choice

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During World War II, Lancaster bombers deployed by the Royal Air Force were being shot down increasingly often because German air defense aircraft were continuously being improved. When scientists were asked why the casualty rate was so high, they concluded that the Lancasters were vulnerable because they lacked speed and maneuverability. It was recommended that gun turrets be removed to make the aircraft lighter. Military authorities, however, thought that guns were good and more guns were better, so they added guns and gunners, which slowed the aircraft even more, which led to even more casualties. A bomber without gun turrets was inconceivable (Sagan, 1993).

A bomber without gun turrets is like a risk assessment without formal modeling; it is inconceivable to insiders. When I was asked to comment on methods of risk assessment in maritime risk mitigation, the invitation came with the stipulation that it would help if my remarks encouraged people to think "outside the box" on the question of how to do risk assessments. The formal methods of risk assessment that are now common in the maritime industry appeal to the heart of the engineer that lurks in many maritime personnel. But those formal methods are also blunt instruments. They give the misleading impression that risk is well understood, fully mapped, and that, if it weren't for operator error, the maritime system would function reliably.

What formal methods miss is the situated nature of risk taking. Formal methods are less sensitive to local contingencies, subunit norms, informal agreements, idiosyncratic labels and language, tricks of the trade, strong local cultures, emergent changes, unintended consequences, sudden opportunities, resourceful improvisation, and unexpected setbacks. Local variations such as these shape most risk scenarios even though these determinants go undetected. Their presence is not just noise. It is often more patterned and more predictable than people imagine and more tied to personal and organizational factors than people are willing to admit.

To incorporate more of these factors requires a return to some of the basics in inquiry with the question, How has this issue been handled by people currently doing maritime risk assessments? In many cases the answer is, Not very well. Those lapses in procedures of inquiry stand in the way of more effective risk mitigation. If modelers make more of an effort to address problems such as those I will mention, then the adequacy of their database will improve, as will the lessons that practitioners are able to draw from these data. Modeling doesn't need more analytics any more than the Lancasters need more guns. It needs different analytics and nonanalytics. To think outside the box is to take that diagnosis seriously.

Basics of Inquiry

I want to review eight basic features of inquiry that influence what one can conclude from a risk assessment and the uses to which it can be put. These features include (*a*) conception-perception linkages, (*b*) concrete-abstract systems, (*c*) tradeoffs in the accuracy of explanations, (*d*) tools that register complexity, (*e*) the vocabulary of risk, (*f*) traps involved in analyzing accidents in hindsight, (*g*) the choice of comparison, and (*h*) implicit theories of

human behavior. These eight features do not exhaust issues involved in choice of methods for risk assessment. But all eight furnish part of the infrastructure of any assessment. Whether one is involved in production or consumption of risk assessments, these eight features provide a standpoint from which one can start to judge the value of what is being proposed.

The context within which these features operate is built in part from practitioners' pleas for objective, scientific, truthful knowledge about risk mitigation that is neither political nor subjective (e.g., Gus Elmer's speech). As will soon become clear, truth can be approximated, but there are no guarantees. Formal inquiry generates data that are more defensible than data that are gathered casually. But the magnitude of the improvements that arise from formal inquiry is often less than is claimed. The combination of a competent researcher and a candid practitioner can increase the size of the improvements. But there are limits to what both can accomplish. These limits are what practitioners get paid to live with and what researchers get paid to document.

Empty Conceptions, Blind Perceptions

Sound risk assessment takes seriously Kant's (Blumer, 1969, p. 168) observation that "Perception without conception is blind, conception without perception is empty." Modelers often work with empty conceptions when they construct variables that have little empirical grounding. But that is no worse than practitioners who work with blind perceptions and are unable to see recurrence, patterns, regularities, and early warning signals because of their preoccupation with details.

Here's an example of blind perceptions in need of concepts. The example comes from a spirited exchange in the magazine *Professional Mariner.* Captain Donald Miley, a retired pilot on both the East and West coasts and a master of a 900-ft (274-m) containership, wondered whether we were looking too closely at accidents. The cause for his concern was a 1994 collision in New York between the *Jean Lykes* and the *Petrobulk Lion* and a glib analysis of the accident made by an inexperienced Coast Guard commander. Miley concluded his critique with the comment "Sometimes I think that Capt. Charles Bamforth, Coast Pilot, American Hawaiian Steamship Company, many years ago, had the right idea. He missed a turn and ran a ship ashore in the Delaware River. His full and complete report to the company was, "I made a mistake and ran the ship aground" (Miley, 1996, p. 16).

In the next issue, William Full, a master of a West Coast VLCC, took issue with Captain Miley's praise of Bamforth's brief report. Full asks of the statement "I made a mistake and ran the ship aground," is that it? Is that the sum and substance of the report? That is NOT enough. The report begs the question "what mistake? Did others on the bridge recognize that a ship-handling error was being made? If so, did they express concern? If not, what training might be provided so that, if the problem were encountered in the future, it would be recognized and action taken?" (Full, 1997, p. 6).

If Bamforth had developed a fuller story, a possible error chain could have been spotted. If that chain had been broken at any point the accident might not have occurred. These chains are not obvious. To notice them requires that blind perceptions be enriched by concepts that alert observers to details that may be important. People need concepts such as fatigue, deference, inattentiveness, complacency, ignorance, production pressure, regression, and culture to understand what to look for if they want to assemble an error chain. Likewise, to avoid empty abstractions, people who talk about fatigue, deference, and inattentiveness need to know what forms they take in everyday life, what they look like, and what contexts encourage and discourage their appearance.

Full (1997, pp. 6–7) concludes his appeal for more complete accident reports this way:

> I have to admit that accident investigations often begin to sound like a refrain with several of the same lessons learned and the same final recommendations, but that is only because many of us have not learned the lessons the investigations offer well enough. Reviewing and understanding the incidents that have befallen others is one way to develop the skill and knowledge to prevent them from happening on our own vessels.

When Full talks about "learning lessons," "understanding the incidents," and "knowledge to prevent incidents that befall others," he is referring to perceptions that are made meaningful through their linkage with concepts.

To do effective risk assessment means to change empirically empty theories into richer theories that are grounded in perceptions of on-site practitioners. But effective risk assessment also means changing blind practice into informed practice by means of more abstract summaries of sequences that happen over and over again. It is in the best interest of practitioners to conceptualize regularities in the incidents they face because concepts free up scarce attention, which then allows people to notice more and catch developing problems at an earlier stage.

Concrete Systems, Abstract Systems

As a slightly different way to pose the issue of blind perceptions and empty conceptions, look at the two lists in Table 1 (these lists and their implications are adapted from Roethlisberger, 1977, p. 438). List A (A-relations) is the world of practitioners. The words in List A are the kind of

TABLE 1 Mindsets Associated with Concrete and Abstract Systems (Roethlisberger, 1977, p. 439)

A-relations	*B-relations*
Concrete	Abstracted
Nonlogical	Logical
Subjective	Objective
Internal	External
Here and now	There and then
Mutually dependent	Simple cause and effect
Exchange	Unilateral
Reflexive	Irreflexive
Intransitive	Transitive
Symmetrical	Asymmetric
Cyclical	Linear
Intrinsic	Extrinsic
Satisfying, rewarding	Optimal
Process	Structural
Emergent	Planned, designed
Diffuse	Specific
Existential	Probabilistic

terminology people use to describe action within concrete, real-world, maritime systems. List B (B-relations) is the world of researchers, modelers, and theorists. The words in List B are the way knowledge makers draw their lines for purposes of theory construction. List B is less about concrete systems and more about abstracted systems, context-free knowledge, and observations made by detached observers. When people try to build conceptions, the language they use and the stance they take, as summarized in List B, are often at variance with the ways practitioners use knowledge for purposes of action, as summarized in List A. That is old news, but the numerous contrasts in Table 1 suggest more places where researchers and practitioners might coordinate their complementary views in the interest of co-investigating risk mitigation.

But that old news is worth revisiting because it lets us talk about what we need to do to improve risk assessment. People who do risk assessments basically try to learn about A-relations by using the language and perspectives embodied in B-relations. That often means that analysts think of organizations by using images that are consistent with B-relations. This is a potential blind spot because these images tend to emphasize detachment, top-down directives, excessive formalism, rigid controls, technical efficiency, procedural rules, and authority structures. All these organizational images imply the need for and the relevance of a formal, quantitative risk assessment. But that conclusion is partly an artifact of an inability on the part of modelers to shed the language of List B and adopt the perspective of List A. Talk of formalism, technical efficiency, and authority structures is consistent with List B, even though it may fail to render accurately the qualities of activity in List A. List A is the world of people on the firing line.

If analysts encode practitioner activity in the language of detached controls and give practitioners diagnoses consistent with this imagery, the diagnoses are of no help. The world being described by List B is not the contingent, subjective, ad hoc world of List A that practitioners encounter. When this discrepancy becomes apparent, well-meaning practitioners often try to help analysts by showing them the conditions of risk they actually encounter. But when practitioners do this, analysts try to improve their methods by making an even greater effort to realize the virtues found in List B. This makes the resulting conceptualization even less relevant to practitioners. Increasingly powerful abstract models have less and less to say about being prepared when a disabled ship enters Long Beach Harbor at night with nonoperational radar.

The solution lies in movement toward grounded abstractions and patterned perceptions. To improve activities of risk mitigation (List A), practitioners need concepts that suggest what they can afford to ignore in order to make better use of their experience. Conceptualizations of risk consistent with List B can help refine self-awareness and understanding and can help in the development of larger institutional structures that embody experience of what works better. But these beneficial effects of work with List B are possible only if investigators stay in touch with the realities of List A.

To stay in touch is not as easy as it sounds. There is a danger that people will try to mix what may be incommensurable when they impose a B vision on an A world. The more productive question for practitioners and researchers to discuss is, For what kinds of problems is each view more useful? Assume that each list is a useful way of representing a system for certain purposes. Sound basic inquiry is built out of thinking that is both about proactive people in the maritime system (B) and useful for proactive people (A) who want to act on and change their environments. People who do that kind of thinking deliberately try to avoid empty conceptions and blind perceptions.

Tradeoffs Among Generality, Accuracy, Simplicity

Sound risk assessment also emerges from the realization that any answer to questions such as What can go wrong?, How likely is it?, and What are the consequences? (Garrick, 1999, unpublished data) can be characterized in at least three dimensions (Weick, 1979, pp. 35–42). Each answer has some degree of generality (answers have degrees of abstractness and may or may not apply to many different kinds of units). Each answer also has some degree of accuracy (answers fit the specific circumstances of a specific unit more or less fully). And, finally, each answer has some degree of simplicity (answers are more or less easy to grasp). If these three criteria are arrayed around a clock face with generality positioned at 12:00, accuracy at 4:00, and simplicity at 8:00, the dilemma in answering questions about risk becomes apparent. A story that satisfies any two criteria is least able to satisfy the third criterion. For example, formal analyses that blend generality with simplicity into a 10:00 explanation are applauded because they are accessible but criticized because of their inaccuracy. If the tradeoff moves in the direction of a general-accurate explanation to meet this criticism, then the recipient cannot understand the explanation because it is too complex and therefore dismisses it. It is inevitable that no one will ever be satisfied with any single assessment. That is a feature of the world and not of researchers who are unable to speak clearly. That can be a problem, but the larger issue and the clearer moral is that risk assessments require a multimethod inquiry that is capable of diverse patterns of tradeoffs. That is what is so important about Robert Bea's research program (1996, 1998) with its innovative blending of qualitative and quantitative methods.

In Bea's discussion of operating safety in offshore structures (Bea, 1998), the explanations fit at 10:00 and 2:00 and 6:00 because earlier (Bea, 1996) he relied on a combination of qualitative surveys, interviews, narratives, and critical incidents; quantitative analyses such as fault trees, probabilistic risk analysis, and other numerical models; and a mixed mode patterned after a safety indexing method. Bea's ability to resist the invisible hand of modeling enabled him to break frame and take fuller account of the less orderly, but no less impactful, context for reliability provided by human and organizational factors.

Principle of Requisite Variety

Sound risk assessment also honors the principle of requisite variety: it takes complex models to register complex events. Complex models cultivated in the interest of capturing complex events are not always tidy. This point is neatly illustrated by Clifford Geertz's edgy question "What is objectivity supposed to prevent: passion, relativity, intuitionism, prejudice?" (Geertz, 1995, p. 18). If those four factors are removed from inquiry, then the result may be truth that is trivial. Risk is not a cool subject. To register with accuracy how risk taking unfolds in everyday life, inquirers need resources such as passion, inconsistency, intuition, and a frame of reference. Those resources do not invalidate the work. Instead, they allow the inquirer to sweep in more potentially important determinants.

Although the principle of requisite variety appears to favor quantitative models, that is not the case. It favors stories. Stories simplify but less than do formal models (Daft and Wiginton, 1979). Stories are attractive because they have enough complexity to register sequence, development, interactions, and simultaneous occurrences, yet they are simple enough to serve as useful guides to action (Klein, 1998, chapt. 11). A big problem with using stories is that investigators are unskilled in collecting them. As a result, they work from "bad" stories that give no leads for risk mitigation, and they conclude that stories are worthless and that models are the only way to go.

Klein (1998, p. 190) and his associates have developed a way to extract stories of nonroutine events, which they refer to as the critical decision method. The procedure consists of four steps:

1. Pass 1: Briefly tell the story.
2. Pass 2: Retell story and get events pinned down to a timeline.
3. Pass 3: Probe the thought processes such as cues involved in initial assessment, meanings those cues hold, and expectations + goals + actions engendered by that assessment.
4. Pass 4: Could a novice get confused? Would a novice see this in the same way, what mistakes would they be likely to make, why would they make those mistakes? Use hypotheticals to evoke dimensions: if a key feature of that situation had been different what difference would it have made in your decision?

The importance of stories as a means for practitioners and researchers to converge on a common set of issues is suggested by Czarniawska and Joerges' (1996) description of how they present their assessments to practitioners.

> We have no intention to tell managers what to do in the face of change or stagnation [or risk mitigation]. We want to tell everybody who wants to listen a complex story of how changes come about and leave the actors to decide which conclusions to draw, fully expecting that managers might come to different conclusions than union stewards upon reading our reports. . . . Organizational actors are perfectly capable of producing simplifications and stylizations—action theories—themselves. . . . We owe them a different type of assistance in tackling the irreducible complexity of organizational life, one we call systematic reflection, as a complement to action-induced simplifications.

There seems to be little question that it takes complicated analyses to understand complicated systems. As Diane Vaughan found in her study of the *Challenger* disaster,

> Invariably, the politics of blame directs our attention to certain individuals and not others when organizations have failures. Invariably, the accepted explanation is some form of "operator error," isolating in the media spotlight someone responsible for the hands-on work: the captain of the ship, a political functionary, a technician, or middle-level managers.
>
> To a great extent, we are unwilling participants because without extraordinary expenditure of time and energy we cannot get beyond appearances. But we are also complicitous, for we bring to your interpretation of public failures a wish to blame, a penchant for psychological explanations, an inability to identify the structural and cultural causes, and a need for a straightforward, simple answer that can be quickly grasped. But the answer is seldom simple (Vaughan, 1996, pp. 392–393).

Although there may be agreement that risk mitigation occurs in complicated systems, there is disagreement about what methods most successfully register that complexity. To think outside the box is to entertain the possibility that words, narratives, and conversations register more complexity than do numerals, formulas, and derivations. Spurious precision in an imprecise world represents a failure to register precursors of risk whose containment is crucial to risk mitigation.

Vocabulary of Risk Assessment

Sound risk assessment affirms the importance of words. A colorful way to make this point is to argue that people who study risk need a "dry word hoard." The phrase comes from the last stanza of a William Meredith (1987) poem called "Partial Accounts" (cited in Weick, 1995, p. 197).

> Language, the dark-haired woman said once,
> is like water-color, it blots easily,
> you've got to know what you're after,
> and get it on quickly.
> Everything gets watered sooner or later with tears,
> she said, your own or other people's.
> The contrasts want to run together and must not be
> allowed to. They're what you see with.
> Keep your word-hoard dry.

It takes a rich vocabulary to catch nuances that are crucial for risk mitigation. It makes a difference whether risk is discussed in the context of ignorance, uncertainty, confusion, ambiguity, the inexplicable, the incomprehensible, or what Rosenthal calls a situation of unness—"unexpected, unscheduled, unprecedented, and almost unmanageable" (Lagadec, 1993, p. xxix). The label risk assessment itself calls forth connotations of stable traits, configurations that cause accidents, typologies, and indexing of some fixed quantity. What it does not imply is attention to process, unfolding, situation awareness, updating, incubation, dynamics, struggles for alertness, heedful interaction, solutions that unravel, and the need to reaccomplish processes (see Pettigrew, 1997, for a discussion of processual analysis and a glimpse of what a cross-section assessment may omit).

Traps of Hindsight

Sound risk assessment is more likely when people work with a deep awareness of the traps of hindsight. When people know how an event came out, they are tempted to look for antecedents that led unequivocally to that outcome. Given a bad outcome, we have a strong tendency to look for inaccurate perceptions, flawed analyses, and incorrect actions that produced that outcome (Starbuck and Milliken, 1988, p. 37). What we are less likely to look for are accurate perceptions that got lost in bad analyses, good analyses that led to incorrect actions, good analyses that were not implemented, and correct actions that had either no effects or unclear effects. If we know that there was a bad outcome then we will look for incorrect perceptions that led to incorrect analyses that led to incorrect actions. We will put perceptions at the beginning of our sequences and argue that perceptual accuracy makes all the difference and that the perceptions that produce accidents were inaccurate. We will conclude, incorrectly, that bad outcomes appeared to be inevitable and have tight causal couplings with antecedents. If those couplings are that tight and that determinant, then quantitative risk assessments are the only way to go because they exploit these tight causal ties. What observers keep missing is that the impression that causal linkages are tight in maritime accidents is an artifact of hindsight instead of a reality of the incidents themselves. What is missing from many accounts is significant information about how the event looked to the participants at the time, in their context, and doing what they were

doing. When people switch from hindsight to foresight it is much harder to distinguish accurate perceptions and accurate perceivers in advance from inaccurate ones. This is the lesson that Diane Vaughan has taught us in her analysis of the *Challenger* disaster.

Value of Comparison

Sound risk assessment is grounded in comparison. A simple way to demonstrate the power of comparison is to perform a small experiment suggested by Parmenter (1968). The next time you visit an art museum, before you actually view the exhibit itself, go to the gift shop. Purchase postcard reproductions of several items that are hanging in the gallery. When you get to the original work of art, hold the postcard reproduction alongside the original. What you will discover is that portions of the painting are not well reproduced on the postcard (e.g., the background is not that color at all, the gold sparkles much more in the original, the proportions are more dramatic, and so forth). What the postcard does essentially is alert you to features of the painting you might otherwise have overlooked. The imperfect reproduction serves as a clue to sites where the artist's genius is more evident. Similarly, what any maritime accident means, what is significant in its unfolding, may become clearer when it is compared with another accident and the observer looks for similarities and differences.

Implicit Theories of Behavior

Sound risk assessment is grounded in an implicit theory of human behavior as well as an implicit theory of what constitutes reliable evidence. Methodologists make assumptions about people. Sometimes these are explicit and sometimes they are not. In my own work, I assume that respectful interaction is fundamental to everything else (see Weick and Roberts, 1993). We all profit from our own experience and from the experience of others, which is all well and good until those experiences appear to conflict. Then we have the problem of what weights to put on our vantage point and on that of the others. Because the world is fallibly and indirectly known, and because our frames of reference are limited, we cannot afford to ignore completely what others think is happening. Therefore, if we want to pool our observations with theirs for maximum adaptiveness we have to live by three imperatives (Campbell, 1990):

1. The imperative of trust: It is our duty to respect the reports of others and to be willing to base our beliefs and actions on them.
2. The imperative of honesty: It is our duty to report honestly so that others may use our observations in coming to valid beliefs.
3. The imperative of self-respect: It is our duty to respect our own perceptions and beliefs and to seek to integrate them with the reports of others without deprecating them or ourselves.

Wherever tragedy occurs, it is likely that there has been a breakdown in one or more of these three imperatives. The wildland fire disaster at Mann Gulch is a breakdown in the imperative of trust. Crew members failed to believe that foreman Wagner Dodge's escape fire would save them, they refused to use it, and they perished. The wildland fire disaster at South Canyon is a breakdown in the imperative of honesty and self-respect. Crew members fighting this fire had serious doubts about who was in charge, where the escape zones were, and why they were digging line downhill, but they expressed none of these and 14 people perished. It is interesting that procedures for handoffs and briefings that have been adopted in the aftermath of these tragedies tend to incorporate all three imperatives. For example, a growing number of crew chiefs use the following protocol when they brief people on their assignments: here's what I think we face, here's what I think we should do, here's why, here's what we should keep our eye on, NOW TALK TO ME!

In this protocol, there is trust (the crew chief invites observations from others and listens to them), honesty (the crew chief gives a candid appraisal of how he or she sees things), and self-respect (there is an effort to resolve the differences among observations without either dismissing one's own observations or deprecating the observations of others). When people practice respectful interaction, they are in a better position to update their understanding of what is taking place and to mitigate risk.

The point is not that respectful interaction is necessarily the assumption methodologists should adopt. Instead, the point is that methodologists need to be explicit about what assumptions they make about people and organizations that guide their choices of what to assess. This explicitness enables practitioners and researchers alike to affirm those assumptions or to replace them and to judge the consequences of this replacement. What is mischievous in risk assessment are assumptions about people that are invisible and therefore not discussed and not examined.

Conclusion

Risk taking in the maritime system unfolds in an unknowable, unpredictable world of fallible people, unreliable technology, and lousy weather. Given that context, mariners rely on one another to make sense of what they face and what they should do about it. This core scenario tends to be missed by formal analytic models of risk

assessment. To make these models more valid, inquirers need to be more mindful of the following:

- Dual dangers of empty conceptions and blind perceptions;
- Different mindsets associated with abstract and concrete systems;
- Tradeoffs among generality, accuracy, and simplicity;
- Need for complex analyses to register complex events;
- Importance of word choice in descriptions of risk taking;
- Traps when accidents are viewed in hindsight;
- Value of comparison for diagnosis; and
- Theories of human behavior that lie behind the risk assessment.

As a final prod toward thinking outside the box in risk assessment, I want to invoke a disturbing puzzle that has emerged in fatalities that have occurred in wildland firefighting. When a wildland fire explodes and threatens to overrun a crew of firefighters, the crews' ability to outrun the fire improves if they drop their packs and tools so they can run faster, cover more ground, and escape to a safety zone. Given this relatively clear way to mitigate the risk of being burned, why is it then that, since 1990, 23 firefighters in four separate incidents refused to drop their tools when ordered to do so, were overrun by fire, and died with their tools beside them? Six died at the Dude fire, 14 died at South Canyon, 2 died at the California fire, and 1 died at the Buchanan fire. All died within sight of safety zones they could have reached had they been lighter and moved faster.

At the South Canyon disaster outside Glenwood Springs, Colorado, 14 firefighters were killed on July 6, 1994, when they failed to outrun a fire that exploded through a flammable stand of Gambel Oak just below them. When the bodies were being recovered, a site and thermal analysis was written for each body recovered. Part of the analysis for firefighter 10 reads "was still wearing his back pack. . . . Victim has chain saw handle still in hand with chain saw immediately above right hand. Saw blade is parallel to firefighter 9's left leg." The body of firefighter 10 was about 250 ft (76 m) below the safety of the ridge above, a distance that could have been covered had this person exerted the same amount of energy but dropped his pack and saw 5 minutes earlier.

There appear to be parallels in other settings. As researchers we need to be mindful of which tools slow our progress and need to be dropped so that we become faster, lighter, more agile analysts. We need not fear that if we drop our favorite analytical tools we are necessarily left empty-handed because we still have our intuitions, feelings, stories, experience, ability to listen, shared humanity, capability for fascination, and vocabulary to trigger both lines of questioning and ideas about what the answers might mean. To face mariners without our usual tools is not always a bad thing. When we do so, our identity as "scientists" may momentarily take a hit. If it does, we will probably survive.

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