DISCUSSION GROUP 1

Risk Assessment Models: Practical Applications and Guidance

Chair

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Panelists

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Discussion Paper

Weick, Karl E. The Neglected Context of Risk Assessment: A Mindset for Method Choice. (See page 17.)

Description/Objectives

Over the past 50 years, a dizzying array of risk assessment approaches has been developed: among them are descriptive and prescriptive models, analytic and behavioral methods, organizational and system models, statistical and "fuzzy" techniques for risk assessment. In this session, we

- Provide an overview of several of these methods, techniques, and models to provide context and background;
- Explore the appropriate use of differing techniques and models for different types of risk assessment problems and different domains; and
- Conclude with a discussion of lessons learned in applying different risk assessment models, techniques, and methods. Best practices from maritime and other domains are identified in this session.

SUMMARY OF DISCUSSION

Presented by B. John Garrick

Our group was asked to discuss risk assessment models, methods, and practical applications. To get the panel discussion going in some sort of systematic and organized fashion, we started with the purpose and objective of the conference. That purpose is to find ways to integrate risk assessment methodologies into the practical world of waterways management. Probably the most important words here are the "practical world." Those of us who are in the analysis and assessment business appreciate that and realize its importance. What we asked here was, why on earth would anybody want to do risk assessment? Here are some of the reasons we cited.

Risk assessment seeks the truth on issues and events about which there is uncertainty. When risk assessment has failed, it is usually because it has not told the

truth, especially with respect to uncertainty. Probability is the language of uncertainty. In Karl Weick's presentation, uncertainty is highlighted by his account of general, accurate, and simple explanations. Two of the three descriptors, but not all three, may be applicable to a given risk condition.

Fundamental elements of the risk management field are risk assessment, risk communication, and risk management. Risk assessment leads to the truth, risk communication leads to understanding, and risk management involves making decisions and taking action.

Risk management is proactive and should use multiple risk measures. Risk assessment should look at a greater scope than is customary in the marine field—for example, not just oil in the water. The scope of risk assessments may include health effects, facility damage, external events, human reliability, organizational components, and other attributes. Uncertainty analysis and common cause analysis are used effectively in other industries. Quantifying risk provides an enhanced basis for risk management.

Motivation to use risk assessment in decision making comes from the International Maritime Organisation, the U.S. Coast Guard, and an international emphasis on safety.

Current assessments rely heavily on experienced mariners. Risk assessment in the maritime field lacks a set of common principles and methods. Databases are not well aligned; the risk assessments should be driving the structure and content of databases.

The scope of an analysis depends on the industry. Marine transportation systems have special characteristics:

- Large rotating equipment;
- Confined and isolated;
- 24-hour working conditions, nonstandard conditions;
- Diversity of systems, extremes of the environment; and
- Safety culture—change is slow.

There have been some effective applications of risk assessment—for example, Prince William Sound and other isolated applications—but the marine industry is mostly reactive in nature. There are opportunities for risk assessment to add value to marine transportation safety. It can be conducted in a horizontal mode (multiple performance measures) and a vertical mode (go down to the level where there is information) with respect to scope. Agencies talk about transitioning to risk-based regulations. We need to expand the range of risk measurement.

If we know the risk, we are in a much better position to manage it, especially if we are able to measure it. The single important forward step that risk assessment has provided is that it has extended way beyond the issue of hardware performance in most applications, and it has tried to provide the connection between frontline systems and support systems. Examples of support systems are traffic rules, procedures, software, qualifications and training, human response, and organizational impacts. Of course, part of what we have been discussing here is that some parts of it have been done better than others. Pinpointing risk-reduction measures that have the greatest return and providing a basis for transitioning to risk-based and performance-based regulations appear to be the opportunities.

What we attempted to do was translate what the panel was trying to address into some questions. The questions are presented in Exhibit 1; we did not answer all of them, but they served us well in motivating and stimulating the discussion.

The first question is *Where can we get the greatest return? Where is the value added in using these methods?* What we mean by greatest return here is cost savings through improved risk management. *Are the current activities moving us in the right direction? Who is and who should be leading the way?* We did not discuss this point too much, but it is a very important one. *Is there a basic strategy of risk management and risk assessment for marine transportation? Would a general theory or a set of underlying, overarching principles be helpful in bringing greater order and progress to the process?* Finally, a question such as, *Given the heavy dependence on crew*

EXHIBIT 1 Questions for Discussion

- Where can we gain the greatest return (cost savings from better risk management) through the use of the risk sciences in marine transportation?
- Are the current risk assessments and risk management activities moving us in the right direction—for example, the Prince William Sound Risk Assessment, the U.S. Coast Guard's *Risk Based Decision Making Guidelines*, and the Formal Safety Assessment process?
- Who is and who should be leading the way?
- Is there a basic strategy of risk management and risk assessment for marine transportation?
- Would a general theory (general principles without being too prescriptive) of risk assessment endorsed by an oversight group or regulator of marine transportation provide coalescence and stimulation to more effective use of the risk sciences?
- Given the heavy dependence on crew and support groups for marine transportation safety and the diversity of organizations involved, how do we integrate the human and organizational factors into the risk assessment and risk management process?
- Is it possible to rate the opportunities for greatest gain in application of the risk sciences to the marine transportation system?

and support groups for marine transportation safety—and we heard a great deal about the diversity of organizations involved—*how do we integrate the human and organizational factors into the risk assessment and the risk management processes?* This is one of the reasons we had as our keynote speaker somebody who could speak to organizational issues.

Is it possible to rate the opportunities for greatest gain in the application of the risk sciences? As background in considering this question, I sent out a draft report to the panel and requested their comments on its conclusions. With the draft report as background, we came up with some observations about approaches that would lead to improvements (Exhibit 2).

One of the things that was discussed a lot was the soft issues—in the sense of *How do you interject policy into this process? How do you educate management?* It is true that we are talking about a substantial cultural change here. We are talking about something in which senior managers must become engaged. How do we avoid having this discipline take the form of something that only nerds do, and is it not really an integral and inherent part of the way we think and the way we make decisions? The only justification for doing risk assessment is to help us make better decisions. If we are not successful in convincing people to appreciate that and convincing management to embrace it from the point of view that it is a valuable aid to the decision-making process, we will probably fail.

The other thing that is not said so much here but that is part of the horizontal/vertical communication issue is what I've always believed, and the panel was in agreement with this, that one of the most important requirements of risk assessment is that it have an operations perspective. When I was doing a lot of risk assessment projects, the only person that I said no to was an owner of a large nuclear power plant in a foreign country. He asked us to do a risk assessment, but he did not want us to talk to his reactor operators. We turned it down. You cannot do that. If there is to be value received from these analyses, then you have to do it in such a way that you can enhance one of the most important outcomes of these analyses, accident management. You have to be able to recover from a degrading situation. You want to know what operational options you have for recovery. This is where the quantitative analyses have been enormously insightful in giving alternatives for recovering from specific equipment failures or human errors or external impacts, such as a severe storm or an earthquake.

So, the people element is something that has been emphasized here a great deal—the performance-through-people program—and I agree with that. It is a program we really want to push very hard. Then we laid out some guidelines for the risk assessment process (Exhibit 3).

The first thing we agreed on, not always unanimously, was the need to develop a set of method development principles. In other words, instead of trying to address the question of methods and general theory that would apply, maybe what we ought to be talking about are the underlying principles that guide their development. It is clear that the risk assessments must be flexible in order to accommodate the diversity of this industry. It is a dynamic system. It is a system that involves a wide variety of hardware, various nationalities, and a variety of procedures and regulations. These dynamics have to be in the process.

Everybody agreed that the human element should be a very visible and major input, even in the methods business. If there is a way we can bring human performance into the analysis and make it more specific, more explicit, and more deliberate, then we certainly should try to do that.

A lot of discussion about one of the problems with risk assessment is that its birth and its development came

EXHIBIT 2 Observations

1. Recognize the industry-specific characteristics of the marine transportation system.
2. Early success is more likely using qualitative methods.
3. Quantitative methods are important for special applications, especially those relating to design.
4. Stakeholders must participate and buy into the risk assessment.

EXHIBIT 3 Recommendations

1. Develop a set of method development principles that could be used by the diversified maritime community.
2. To accommodate that diversity, risk assessment methods must be flexible.
3. Incorporate the human element into the process.
4. Emphasize the more likely events in risk assessments instead of the catastrophic.
5. Investigate the use of interactive risk management.
6. Improve communications both horizontally (between industry sectors) and vertically (between management and workers).
7. Let the risk assessment drive the data needs.
8. Consider the total evidence, including the physics and mechanics of the event.
9. Use end state/goal orientation in conducting risk assessment.

about as a result of focusing on very rare and catastrophic events. It has served us extremely well in that regard. But, there is a great deal of interest in having it serve us better in the area of risk activities that happen more frequently.

We talked a lot about management and how to investigate the use of interactive risk management, both vertically and horizontally. Much of this is rooted in what you ought to be doing to enhance communication across and in vertical slices. You cannot neglect the issue of data when you talk about methods, even though another group will cover this subject in detail. Generally what we found about risk assessment is that to develop a database that supports risk assessment, do some risk assessment modeling first and figure out what you need. More programs than you can imagine have been killed by trying to do it the other way around.

Data have to serve purposes other than risk assessment, but, for the purpose of risk assessment, you really must determine what you need. The only way you can find that out is to do some risk analysis. That is not to say that you shouldn't use whatever data you can get.

One of the things that is very important, and I've already mentioned it, is the industry-specific characteristics of the marine transportation system. When you do your modeling, acknowledge those characteristics, especially the dynamics. Yesterday we saw an example of simulation as a way to represent the dynamics. You can also represent a dynamic system in discrete phases. There are a number of ways to do that.

We also agreed that, as far as embracing risk assessment methods, we are more likely to be successful with qualitative methods instead of pushing the large detailed quantitative risk assessment studies. However, I have a strong prejudice in that arena because most of the great strides we have made in understanding safety have come directly from quantitative and not qualitative risk assessments. In other words, we need to be quantitative sometimes to understand the subtleties of what can go wrong. It was sort of agreed that quantitative methods are important for special applications. Maybe there is some percentage of the issues that we're faced with where it would be very constructive and informative to do a much more quantitative analysis. The Prince William Sound Risk Assessment is an example of the quantitative approach. One of the things that is a tremendous asset when you are considering a design change is to be quantitative with respect to the risk implications of that design change. Thus, for design purposes, quantitative methods are much more beneficial.

Finally, stakeholders need to buy in to the process. It is more than that. They must participate in it. They must be a part of the establishment of the risk measures, the database, the parameters that you're actually going to calculate.

Questions and Answers and Discussion

Question: Can I ask whether your panel discussed how you get input from the operators, pilot masters, bridge crews, pilots, and so forth? I work mostly with the tanker industry and a lot of people say, well we get 95 percent of our oil coming in on foreign flag tankers. I don't think that is bad from a safety point of view, but I hear all these risk management words. Where do the rules fit in for the pilots and the pilot masters, . . . characteristics of vessels that to me are the real guts of whether you have safe operations in a marine transportation system in our ports.

Answer: I agree, and if some of the panel members want to help me respond to this, I would certainly appreciate it. I agree with you 100 percent. I think this is an area where the most difficult thing to change is the culture. I know it was in the nuclear field. But it has changed, and the way it has happened is basically a looking-over-your-shoulder process. You don't do any mechanical work on a nuclear plant these days without somebody watching you. It is a little bit like the aircraft industry, although I think it is even more rigid in the nuclear power industry. To talk about somebody watching a mechanic change a valve 10 years ago was absurd, but now it is accepted. All the paperwork that goes with it, all the documentation, and all the quality assurance (and I'm not saying there are not some glitches from time to time) are there and are in place. It took time and it took an accident and it usually takes some sort of a major stimulus to develop a basis for imposing rigid quality assurance procedures (as it is sometimes viewed by operators and crew members).

One of the most important things is, again, to communicate to the operators and the crew what value is in it for them to be a part of this process. Also, we must somehow remove them from the stigma of thinking they will get in to trouble if they expose something that reflects on fellow workers or what have you. It is a difficult area, and the only thing that I have found that works is the agreement to do some training. The performance-through-people program that the Coast Guard is talking about appears to be moving in that direction.

Question: In her talk yesterday morning, Karlene Roberts asked some questions for consideration: one question was "Where do I get my notions about what I think is wrong?" Well, to find out what is going on in the operation, you have to ask the operators. You have to ask them in terms they understand. You start by asking and you start by honoring in some way the experience of the operators. Why is it you do what you do? How is it you learned? Then, you ask more than one operator and you get some comparisons. You get storytelling out of that. You don't initially get a lot of data, but the stories are important and the stories aggregate to a common experience. You acknowledge

that this experience has value because it has led to a series of incremental, day-to-day risk management decisions these people are making. They may be making them based on good or bad information. They may be making them based on accurate or inaccurate perceptions. We don't know. But you have to start. If you start communicating to them in this process of thinking "How is it that I, as an operator, make my choices on what's wrong?" then they start listening to each other and they start thinking that way.

Answer: Let me give you an example. In an early risk assessment we went to people in the plant and we said, "What do you think of this?" They surprised us. They didn't like fault trees. They didn't like logic diagrams. So what we learned from that is that we need to represent the information in a form they can understand or are interested in, and that was really kind of the birth of the idea of a scenario-based approach to risk assessment. They understand scenarios. They understand if you have an initiating event like a pump failure when things can start to go wrong. So, when you put the fault trees in a black box and put the focus on outputs that they can become a part of and that they can correct us on, you can get the kind of input needed.

Question: I think this is all wonderful, but the new word in the '90s is risk assessment. I don't think we're risk assessing anything, because we just continue to avoid the same issue, and that is dealing with people. I've been in this business for 35 years and was involved in the beginning of the Alaska risk assessment, which, frankly, didn't prove anything to anybody except an awful lot of nice words. I have never had anybody come up to me in all these years and say what a wonderful document that was. What I've heard the most from everybody is that it is a lot of paper and the oil companies paid a lot of money.

I wish we could look around for a minute and ask how many people here are truly ship operators. I went through this piece of paper and I count eight. I think I now see five. My whole point is, who are we talking to? The government? Consultants? Academics like me? The issue is dealing with the people. The day this industry or the consultants and the government and so on and so forth get down and talk to people on the ships will be a new dawn. That does not happen. They don't want that to happen. Quite frankly, we are wasting our time.

What should we do to not waste our time? What we ought to do is be out there finding out where the difficult areas are and then proceed from there. That is not what you are doing here. Some people are putting numbers onto things and saying this is this and this is that.

The second thing too, sir, is that we are not talking today about Americans. We are talking about foreign flagships. We need to decide how we are going to deal with them.

Answer: Even though what you say may have a lot of truth in it, we have seen tremendous progress. We understand the mitigation capability of equipment now at levels we had no idea of 20 years ago with respect to some systems. We can put some degree of confidence and measurement in the ability of a high-pressure injection safety system to do its intended job. So, I cannot agree that it is nonsense or a waste of time. I'm basically a great sympathizer to the operations point of view. But I think the scientific process continues to push us to seek ways of measuring things, and I think that is all we are trying to do here. Of course, some of the analyses are going to be ridiculous and some of them are going to be much too narrow in scope, and some of them are going to be off target. But the overall movement is what you have to look at and where the progress has been made. In the refinery, chemical, and power businesses, there have been great strides made in enhancing our understanding of the underlying drivers of how to safely manage these complex facilities. This kind of thought process has made a contribution. I have been one of the most outspoken in support of one of your themes of getting the operators, the crew's perspective, into these processes, because a lot of them do not do that. If we do that and combine the two, we will see great progress.