Understanding Public Reaction to Risk Analysis

Donald MacGregor

Decision Research
A Branch of Perceptronics
1201 Oak St.
Eugene, OR
97401

Prepared for:

NSF/EPA Workshop on
Risk Perception and Risk Communication

December, 1984

Decision Research Report 84-17

Understanding Public Reaction to Risk Analysis

In 1973, the Ford Motor Company introduced to the American automobile-buying public the Ford Pinto. Weighing 2000 pounds and costing only $2,000, it was shepherded from the drawing board to production in only 34 weeks, somewhat of a record in the automobile business where two-year leadtimes are not unheard of even under moderately severe time pressures from competition. For the Ford Motor Company, the Pinto was a successful entry into the small car market and became one of the more popular compact automobiles on the road.

Five years later, the Ford Pinto sat disected on the floor of an Indiana courtroom, its manufacturers charged with criminal negligence for failing to design its fuel tank sturdy enough to withstand a rearend collision that took the lives of three teenagers. Amid courtroom testimony of expert witnessess and mutual charges of irresponsibility, a spotlight was cast on the behavior of Ford executives and engineers, and the decision they made to not install a relatively inexpensive component in the Pinto's fuel tank that would have helped prevent such catastrophic consequences. Though Ford Motor Co. was ultimately exonerated of the criminal negligence charges brought against it, an important side effect of the publicity associated with the case was the revelation of a cost-benefit analysis Ford had supposedly done to show that making safety improvements to the Pinto's fuel tank was not reasonable given the balance of costs to benefits, even at less than $20 per vehicle (e.g., Dowie, 1977). Part of that analysis attached a specific dollar value to the lives that could be expected to be lost if the fuel tank modification was not undertaken. The press indicted

Ford with callously trading human lives for dollars. Ford argued that cost-benefit analysis was a standard fixture in many government organizations, and that, indeed, it had even patterned its cost-benefit analysis after one done by the National Highway Traffic Safety Administration, using their value-of-life methodology.

The real impact of Ford's use of cost-benefit analysis on the criminal charges brought against them is difficult to assess; it does not appear that the prosecuting attorney even brought it into evidence in the trial. What was significant about the case, however, was that for the first time, an application of a formalized decision-making methodology, costbenefit analysis, received sharp criticism in the national press, sensitizing the public to the existence and use of these methodologies, and exposing those who conduct them to public criticism.

What is the potential significance of such adverse public reaction to a formal decision methdology and how can one begin understanding and addressing lay people's concerns? This paper discusses some general issues related to this question and touches on research topics that would further our knowledge of how to incorporate formal analysis into the societal decision-making arena.

An Empirical Approach

One attempt to shed some light on this question comes in the form of an empirical study directed toward understanding the evaluative dimensions on which formal decision making approaches are judged (MacGregor & Slovic, 1984). That study called for individuals to judge a number of decision-making approaches cast in the context of two different hypothetical consumer product safety decisions, one involving a change to the design of

the fuel tank of a compact automobile (a case somewhat paralleling that of the Ford Pinto), and a second involving a change in the formulation of a prescription antibiotic drug that would reduce the risk of potentially fatal side effects. Formal analysis was represented by a cost-benefit analysis similar to that in Figure 1. An abbreviated version of Figure 1 eliminated the value of life steps (F and G) and was named, for convenience sake, expected value risk analysis. The primary difference between the two approaches came at the step of assigning an explicit value of life and trading it off against costs. In the cost-benefit case, the manufacturer making the decision was portrayed as acting strictly on the balance of costs to benefits; in the expected value risk analysis case, the manufacturer was portrayed as making a deliberative decision on the basis of the change in expected fatalities should product safety be altered. A third method involved simply abiding by standard manufacturing practices within the industry. Other factors in the decision context were varied, including whether or not product safety was improved as the result of applying the decision methodology.

Insert Figure 1 About Here

Individuals were asked to study the decision context and the approach being adopted, and judge the approach on a set of evaluative scales relating to its acceptability. Figure 2 presents a factor analysis of those evaluative ratings. The points in the factor space represent decision-making situations in which each of the three decision approaches were used. Two basic factors emerged from the analysis. The first factor, on the horizontal axis, relates to the "logical soundness" of the decision

approach and is exemplified by such judgments as the quality of its logic, apparent completeness, and understandability. The second factor, on the vertical axis, relates to the "moral sensitivity" of the approach. Its components were judgments such as embodiment of moral and ethical considerations, and sensitivity to those impacted by the decision. In general, points in the upper right quadrant received positive evaluations on both factors while points in the lower left received negative evaluations.

Insert Figure 2 About Here

Several results are apparent from the factor plot of Figure 2. First, the factor structure suggests that there is reasonable order to the perceptions people have of decision-making approaches, even when they are embedded in contexts consisting of other details. The dimensions emerging from the factor analysis, "logical soundness" and "moral sensitivity" are suggestive of the types of concerns that both lay and expert might consider meaningful and important. This is encouraging because it provides evidence that the types of reactions to cost-benefit analysis that surfaced as part of Ford's experience with the Pinto fuel tank design are amenable to study in an empirically sound framework. (Something about further research here?)

Second, the upper right quadrant is dominated by decision-making situations in which the manufacturer applied a risk analysis but did not take the step of attaching a specific dollar value to lives, instead considering the safety risks in a deliberative manner ("expected value risk analysis"). The lower right quadrant is dominated by situations in which the manufacturer abided by standard practices within the industry. Cost-

benefit analysis, as portrayed in Figure 1, tended to occupy a middle position.

The Role of Deliberation

What one draws from these data depends, in part, on one's perspective. Certainly, professional decision makers take the view that increased explicitness and emphasis on normative modeling of a decision are criteria to be highly valued, and that a decision-making method can be judged independently of the context in which it is applied. Indeed, the goal of methodologies such as risk/cost-benefit analysis has been to assist policy and decision making by providingng a picture of risks "as they really are" in a way that could facilitate making choices between hazardous alternatives. This attention to objectivity has led risk analysts and, perhaps, decision makers in general to lean heavily on method as the basic support for the actions they choose to take, with an emphasis on quantifying risks in actuarial terms for the purpose of comparing them on a common, often monetized, scale. Embodied in the perspective of formal analysis are some very strong advantages. Formal techniques provide normative underpinnings for justifying a decision maker's actions, they help avoid error brought on by the cognitive limitations of the decision maker, they foster better communications about the decision as well as more effective evaluation after the fact, and they make explicit value tradeoffs, thus helping to insure that decision makers will be consistent with their own values.

What formal analysis strives to achieve in a sense, is to make explicit the components of a decision-making problem. In a general way, it assumes that values and tradeoffs left unexplicated are detrimental to the

quality of the choice process and, indeed, should be avoided if possible. However, those exposed to the decisions of others may judge decision methods by a different set of criteria. Among methods that make risk information explicit, are those that make explicit the value tradeoffs involved in arriving at a choice, such as cost-benefit analysis. Among experts in decision making, cost-benefit analysis has been an object of controversy. For some decision-making situations, particularly those involving health and safety consequences, meeting the criterion of explicit value tradeoffs means attaching a monetary value to nonmarketed goods. Both the valuing of non-marketable commodities and the balancing of costs and benefits in a monetarily based calculus has been criticized on ethical grounds (see, for example, Kelman, 1981). Public evaluations of cost-benefit analysis may contain parallels to these types of arguments, as the data presented above suggests. In some contexts, a thoughful consideration of risk information may be preferred to an analysis that makes explicit value tradeoffs involving health and safety.

Decision makers may want to consider placing special emphasis on understanding the moral and ethical concerns that are important to those affected by the decision they make. They may want as well to study the extent to which those concerns are reflected in the methodologies they use to assist them in decision making. It may be that the process of deliberation is seen by people as the means by which important moral and ethical considerations are reflected in a decision making process. Increasing the degree of mechanization of a choice process may only serve to make it appear less sensitive to human values, and thus less acceptable to those it was designed to serve. If risk analysis and other formalized

analytical approaches to decision making are to achieve a broad public consensus of support, ways need to be found to insure that soft, social values are apparent in their execution.

At present, we know very little about how people wish to see nonmarketed considerations incorporated into decision-making approaches. Deliberation is, perhaps, one approach, but would have to spelled out much more clearly for it to play any practical role. For example, are there situations where deliberation is clearly not acceptable, such as when unaccompanied by any analysis of risks? What is the appropriate balance between an explicit analysis of risks and an unexplicated, intuitive weighing of those risks? What constitutes evidence to people of sufficient deliberation? Is the perceived quality of a decision-maker's deliberation related to other aspects of that individual or institution, such as trust and confidence?

Evaluation by Context

Public concerns over risk analysis may stem in part from a tendency to judge a decision approach not in isolation, but in terms of events subsequent to its application. For the decision maker, choosing a method or approach is an early step in a process that also involves (somewhat later) selecting an alternative and experiencing consequences. A spectator to these stages may not be able to evaluate the method independently of their judgments of other aspects of the context. They may apply a form of "alls well that ends well" reasoning, where decision-making methods that are compatible with their own intuitions, and that lead to choices they would like to see made, are the most highly valued. From the perspective of the consequences experienced by those exposed to the actions of a

decision maker, decision-making methods can appear to lead to inevitable results. When those results are positively valued, the decision-making method leading to them may be positively valued as well. This form of causal reasoning whereby subsequent stages of a decision process are seen as determinisitically linked to the outcome of the previous stages would suggest that lay perceptions at least can be understood only by examining the full context in which a decision approach is applied.

Another way in which context may influence the perceived acceptability of risk analysis arises from the complex nature of real-world decisions. Taken in isolation, a decision problem to which risk analysis has been applied may appear very different than when expressed in the context of a host of decisions. Furthermore, the reasonableness of the inputs to a risk analysis may change when a singular decision is viewed among a plurality of choices to be made. For example, the fuel-tank decision made by Ford involved choosing between including or omitting a relatively inexpensive safety component. Viewed in isolation, a small additional cost per car could be judged a reasonable amount to pay for any increment in safety. On the other hand, automobile designers must make many such decisions and tradeoffs, not just for safety, but performance and styling as well. Perhaps Ford's decision to leave out a relatively inexpensive part that provided a small reduction in risk would have beeen regarded differently if it were one among many such inexpensive parts that add up to a much larger cost. Consideration of many small decisions could influence the perception of an isolated decision in another context. Elaborating, for example, some of the many decisions involved in the design and engineering of a product may affect the way a specific safety decision is seen.

Realization of Consequences

One of the rules that decision makers are learning to live by is that in a probabilistic world "good" outcomes can never be guaranteed. No matter how carefully a decision maker analyzes a problem, events can occur that can make a seemingly complete analysis deficient. Part of this may be due to our inability to anticipate all of the ways in which things could go wrong. Consequently, knowledge of how events turn out can lead us to believe that decision makers could or should have been able to anticipate that future.

Outcome knowledge may also influence perception of risk anlaysis by making conrete that which is abstract in the analysis. For example, expected (statistical) deaths are abstract, unidentified, future deaths which are not familiar to us in the same way as are everyday (potential) personal relationships. On the other hand, an actual identified life in jeopardy may concretize aspects of an analysis that were only imaginary at the time it was conducted. Retrospectively, the analysis may seem less sensitive to human and moral concerns than it did prospectively.

The quality of an outcome may have an effect on the acceptability of some procedural aspects of an analysis. For example, the acceptability of placing a dollar value on lives may differ depending on whether things turn out for better or worse. In an unpublished pilot study, groups of individuals were presented with an overview of the Pinto case and a version of the cost-benefit analysis similar that used by the Ford Motor Co. They were also given a brief explanation of the concept of placing a dollar value on life for decision-making purposes. Subsequently, they were asked to express their degree of agreement with the value-of-life concept. When

no details of consequences following Ford's decision were given, slightly less than half (43%) indicated that they agreed with the concept. However, for a separate group, told of the deaths of three teenagers when the fuel-tank of their Pinto exploded on rear-end impact, agreement dropped to 12%. These results suggest that in the context of a real-world decision problem, knowledge of events subsequent to the decision can color how portions of an analysis are judged.

Directions for Future Research

Risk analysis is a relatively new discipline. Its methods are controversial, even among experts, and untried in many problem domains. Where it has been used, there is evidence that it has not always been used properly. Adequate guidelines are not readily available to insure that its application by the untutored and inexperienced will meet any accepted standards of quality. Exposure of such an infant technology to the public poses formidable risks to its chances for long-term survival. However, to shelter it from public view only increases the likelihood that it will fail to develop the acceptance it needs to become an integral part of how social decisions are made. An important resolution that has come out of the study of risk perception is that there are no universally acceptable risks, but rather an acceptable risk is that risk associated with the most acceptable alternative in a particular decision problem. The acceptability of risks can be evaluated only in the context of a specific decision, in which case there are no generally acceptable risks, only accepted ones (e.g., Fischhoff, Lichtenstein, Slovic, Keeney & Derby, 1981).

An important implication of this refinement is that perceived risk may be partly determined by the decision-making context from which risks evolve. Consequently, peoples' perception of risk may also be influenced by the way in which decisions about risks are made. If so, then an acceptable risk may be one arising from an acceptable decision-making process. Further research is needed to identify the role that decision making methods play in determining public attitudes toward technological decisions and the people and institutions that make them. The results of that research would be an important step toward understanding how public risk attitudes and concerns can be incorporated into the methodologies used by those who make decisions concerning risks at the societal level.

There are other forms that future research in this area might take, all of which would be profitable given our present level of understanding. One of the more general questions that deserves study relates to developing a better understanding of what role people wish deliberative decision making to take in societal decisions. Are there social, moral and ethical values that appear to people to receive adquate attention and consideration only through thoughtful, deliberative behavior on the part of a decision maker? What are the constitutents of deliberation and how do people judge the adequacy of deliberation? How is cost/risk benefit analysis judged as a component of a deliberative decision-making process? Our limited research knowledge to date suggests that deliberation on the part of a decision maker can, under some circumstances, enhance the perceived quality of risk analysis. The generalizability of this finding to other contexts and other variants of formal analysis needs to be established before it can be put into useful practice.

Deliberation as a component of decision making can also imply the incorporation of intuition into the substance of a decision maker's thoughts. A relatively rich background of research exists on people's intuitive reasoning abilities, the general theme of which has been to show that intuition can lead to flaws in judgmental processes. We are much less knowledgeable about what functions people believe intuition serves. Do they, for example, perceive intuition as a mental activity that serves the purpose of distinguishing basic right from wrong? Is it seen as the avenue by which important moral and ethical issues are resolved in the course of day to day activities? Do people have greater trust and confidence in those who they feel are better endowed with intuitive abilities? By what research methodologies can we study peoples' perceptions of the function and quality of intuition, particularly as it applies to societal decision making? Pursuing this research direction would give us a basis for understanding how to interface the rational, mechanized principles of decision making as represented in formal analysis with the relatively "soft" human values that are components of important moral and ethical dimensions of social decisions.

References

Dowie, M. Pinto madness. Mother Jones, Sept./Oct., 1977, 19-32.

Fischhoff, B., Lichtenstein, S., Slovic, P., Keeney, R., & Derby, S. Acceptable risk. Cambridge, Eng.: Cambridge University Press, 1981.

Kelman, S. Cost-benefit analysis: An ethical critique. Regulation, 1981, 5, 33-40.

MacGregor, D. & Slovic, P. Perceived acceptability of risk analysis as a decision-making approach. Decision Research Report 84-1, 1984.

Captions for Figures

Figure 1: Cost-benefit analysis

Figure 2: Factor plot of decision-making conditions in the two-factor space coded for decision-making method.

Figure 1
Cost-Benefit Analysis

Cost if the Vehicle is Changed

A. The manufacturer could expect to sell 400,000 compact cars at $4,250 each.

B. Making the change to the vehicle would cost $11 per car, bringing the price of the vehicle to $4,261.

C. Therefore, the total cost to consumers for making the change to the vehicle would be: 400,000 x $11 = $4,400,000.

Benefit if the Vehicle is Changed

A. Each year, 500 people die from accidents associated with driving or riding in compact cars.

B. There are about 49 million drivers and passengers of compact cars in the United States.

C. The chances of an individual being fatally injured in an accident while driving or riding in a compact car are:

1 chance in 98,000
(or a probability of .0000102).

D. Changing the vehicle would reduce the chances of a driver or passenger being fatally injured to:

1 chance in 99,000
(or a probability of .0000101)

This represents a change of about 1 chance in 10,000,000. You might think of it this way; driving or riding in a compact car without the change would be like taking an additional risk with a 1 in 10,000,000 chance of fatal injury.

E. Change in fatalities:

Predicted fatalities if the car is not changed:
.0000102 x 49 million users = 500 fatalities
Predicted fatalities if the car is changed:
.0000101 x 49 million users = 494 fatalities

Changing the vehicle results in a difference of: 6 fatalities

F. The costs per fatality were estimated to be: $400,000 per fatality

G. Therefore, the total benefit of changing the vehicle would be: 6 fatalities x $400,000 = $2,400,000

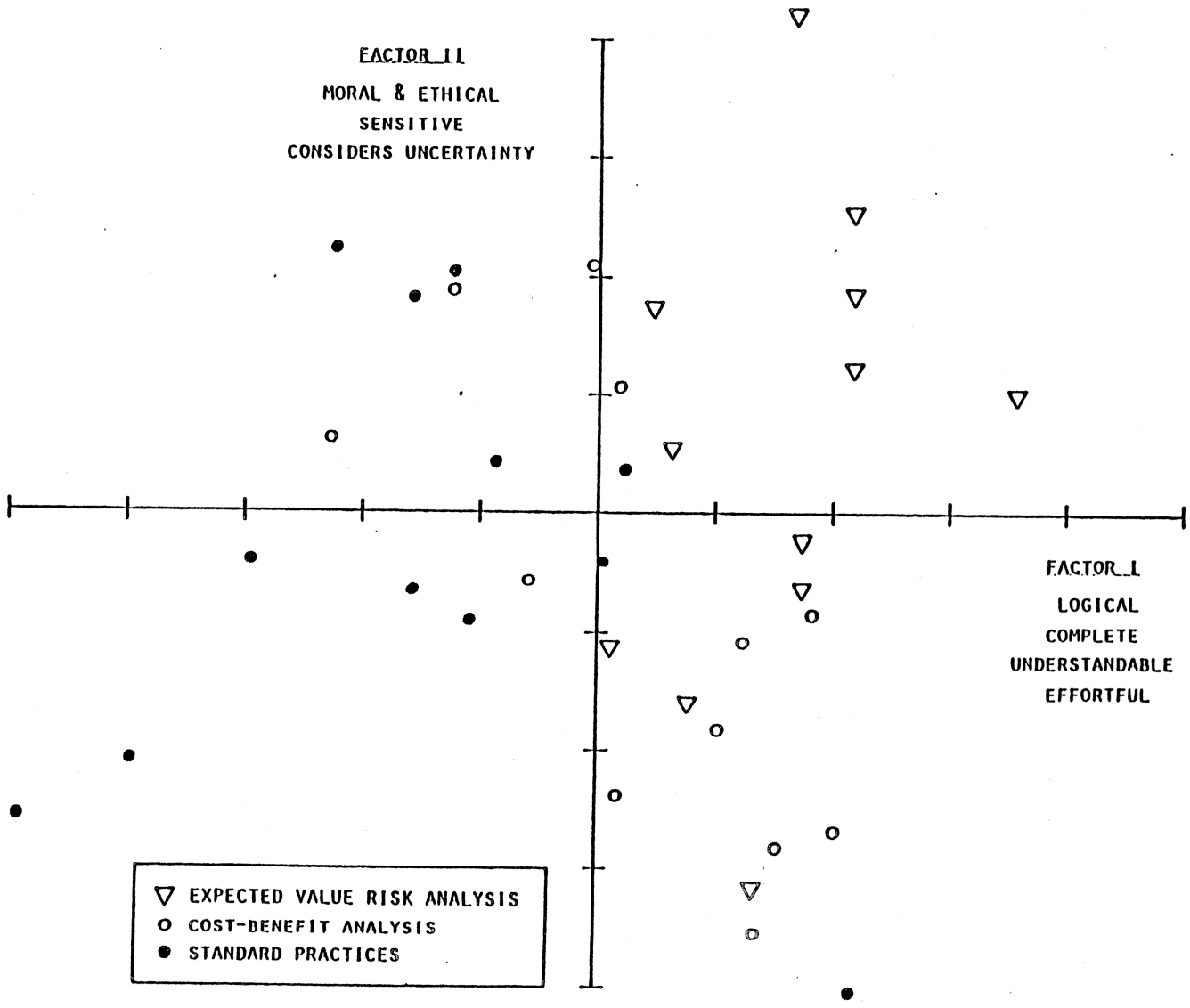

Figure 2. Factor plot of decision-making conditions in the two-factor space coded for decision-making method.