The Policy Implications of Differing Concepts of Risk

Judith A. Bradbury
Science Applications International Corporation

The author draws on the policy analysis literature to delineate the linkage between conceptualization of risk and the formulation and proposed solution of risk-related policy problems. Two concepts of risk are identified: (1) a concept of risk as a physically given attribute of hazardous technologies and (2) a concept of risk as a socially constructed attribute. The argument is advanced that the social construction of risk provides a firm, theoretical basis for the design of policy. The discussion links the perception, management, and communication of risk to the more fundamental issue of the nature and role of science and technology.

A neglected area in the field of risk analysis is the implications for policy of differing conceptual approaches to risk. The purpose of this article is to draw on the policy analysis literature to delineate the linkage between conceptualization of risk and the formulation and proposed solution of risk-related policy problems.

An insight from the literature that is of particular relevance to the current debate about risk is the emphasis on problem structuring as the most crucial task in policy development (Dunn 1981). If a policy problem is not structured appropriately, that is, if it does not take into account all of the dimensions of the problem, policy failures are likely to result. In effect, attempts will have been made to solve the wrong problem (Ackoff 1974).

This discussion examines three broad groups of studies and the concept of risk that underlies the way they formulate risk management and risk

---

AUTHOR'S NOTE: The author gratefully acknowledges helpful comments made on earlier drafts of this article by Steve Rayner, Oak Ridge National Laboratory; Steve Grady, Janice Morrissey, and Brent Sigmon of Science Applications International Corporation; and Bill Dunn and Alex Weilenmann of the University of Pittsburgh.

Science, Technology, & Human Values, Vol. 14 No. 4, Autumn 1989 380-399

communication policy problems. I identify two concepts of risk. One concept reflects a view of scientific knowledge as composed of objective facts: these facts provide the basis for decisions. A second concept reflects the view that facts cannot be separated from values in policy-related science contexts. My argument is that this latter concept, which addresses key dimensions of the problems, provides a firm theoretical basis for the design of policy. The argument is based on a social constructivist perspective that views the discussion of risk as involving a more fundamental discussion about the nature and role of science in modern, industrialized society.[1]

In this discussion, *risk assessment* is defined (following Kates and Kasperson 1984, 7029) as including the processes of identification, estimation, and evaluation. *Risk management* is defined broadly as "the process by which decisions about risk are made" (adapted from Zimmerman 1986, 436). This latter definition differs from some common usages in which the term refers more narrowly to the process of regulation or to the selection and implementation of a strategy for control of a specific risk. I approach the discussion from the standpoint of my interest in nuclear waste policy.

Two Concepts of Risk

Otway and Thomas (1982) have pointed to a fundamental difference in views toward, and use of, the risk concept. The two risk concepts represent ideal types, which are frequently blurred in practice. However, each is linked to and implicitly underlies a particular formulation of risk management and communication policy problems.

One approach conceives of risk as a physically given attribute of hazardous technologies: objective facts, which can be explained, predicted, and controlled by science, are separated from subjective values. A second approach conceives of risk as a socially constructed attribute, rather than as a physical entity that exists independently of the humans who assess and experience its effects. This latter viewpoint emphasizes that the processes of risk identification and risk estimation can never be value-free, that the scientist's judgment involves the balancing of conflicting evidence, and that "'factual' empirical evidence alone does not lead to any conclusions" (Wynne 1980, 182). Consequently, the so-called objective activities of risk identification and estimation need to be integrated with, rather than separated from, the subjective process of evaluation.

The Concept of Risk as a Physically Given Attribute

A view of risk as a physically given attribute of hazardous technologies underlies the approach of two different groups of studies: the traditional, technical approach to risk assessment and the psychometric, social science approach of Slovic and associates.

The Technical Approach

The traditional, technical approach defines risk as the product of the probability and consequences (magnitude and severity) of an adverse event (Hadden 1984). This concept, which until recently dominated the risk analysis literature, reflects the influence of engineering safety studies on the emergence of modern risk analysis (Otway and Thomas 1982; Kates and Kasperson 1984). Probabilistic risk assessment (PRA) of nuclear reactor risks, which developed into a "multi-billion dollar activity" after its first major application in the WASH-1400 report (U.S. Nuclear Regulatory Commission 1975), has been applied to a variety of nonnuclear situations (Vesely 1984, 154).

Most PRA practitioners would agree that their estimates, which incorporate the analyst's judgments at many critical points,[2] cannot be viewed as value-free or so-called objective reality. This is particularly the situation, for example, for technological developments such as high-level waste repositories, where there is no base of accumulated experience against which the analyst's calculations can be validated and where the time frame for predicting and preventing risk extends thousands of years into the future. Moreover, as Spangler has emphasized, value-laden, "nitty-gritty, everyday decisions" are made routinely by scientists and engineers employed by government and regulatory bodies (Spangler 1985, 920). Nevertheless, the policy implications of this inevitable element of human judgment frequently are obscured or overlooked: among approaches that start from the phenomenon of risk rather than from the perceiver of risk, an implicit reification of risk may be discerned. That is, risk is treated as an objective fact.

The implicit reification of risk can be seen in continued attempts to make a distinction between fact and value, between the activities of identification and estimation on the one hand and the activity of evaluation on the other.[3] This distinction may be useful as an analytical tool; it is misleading when it assumes that risk identification and estimation represent value-neutral activ-

ities and that evaluation can be undertaken as a separate step (Conrad 1980, 248; see also, Hadden 1984; Wynne 1980).

Reification also can be seen in approaches to risk management that incorporate an unexamined assumption that technical analyses represent absolute, rather than relative, truth. Logically, such an assumption leads to the view that risk management decisions are rational to the extent that they are based on the realist, nonpersonal factors (mortality statistics, economic efficiency) of technical analysis.[4] From this viewpoint, the public's failure to make risk decisions on a similar basis is seen as economically inefficient and as evidence of irrationality or lack of knowledge and understanding.

Although the technical approach to risk may be entirely appropriate for purely engineering decisions, it is inappropriate when used as the basis for societal decisions.[5] Structuring the risk management problem solely in terms of technical and economic rationality fails to recognize that societal rationality has additional dimensions. Two key dimensions omitted are (1) the political dimension—how to proceed in a democracy when there is a discrepancy between "what the experts deem most important and what the public demands from its government" (Plough and Krimsky 1987, 7) and (2) the ethical dimension—how to surface and address questions of values that inherently are embedded in the judgments of the analyst. The omission of key dimensions leads to attempts to apply inappropriate solutions, that is, attempts to solve the wrong policy problem.

The unexamined assumption that technical analyses represent absolute, rather than relative truth also leads, logically, to a structuring of the risk communication problem in terms of lack of public understanding and knowledge. Equally logically, the proposed solution is to convince or educate the public about the real risk. Structuring the communication task this way requires the skills of the social scientist for implementation. However, as Rayner has emphasized, when risk managers turn to behavioral scientists for advice, they meet "apparent theoretical disarray" (Rayner 1988, 201). The theoretical disarray has significant practical implications.

The Psychometric Approach

Social science studies of risk include both the pioneering psychometric, risk perception studies of Slovic and associates and a large body of attitudinal research. The research has examined a wide range of factors, including underlying beliefs and values, that are incorporated into an individual's assessment of risk. In this section, I focus on the contributions of Slovic and associates, which have received prominent treatment in the literature.

These psychometric studies have found differences between expert and lay risk judgments, and they point to a concept of risk that is multidimensional and considerably more complex than the statistical or actuarial concepts of the technical analyst. But as in the technical approach, Slovic and associates start from the technical concept of risk, rather than starting from the person who is perceiving the risk or the broader, social implications of technology. In examining the individual's response to risk, this research provides a subjectivist interpretation within a realist paradigm. Psychometric research thus straddles technical and social paradigms uneasily.

Because of ambiguity in its initial concept of risk, the psychometric school is unable to develop a truly social critique that would assist in solving problems left unsolved by the technical approach. The ambiguity is epitomized in its common use of the term *perceived* risk. The term connotes that natural sciences study reality, while the factors discovered by the social sciences represent "mere perceptions" (Thompson and Parkinson 1984, 557). Such a distinction is misleading: experts' and laypersons' assessments of risk both constitute judgments and both are subject to bias (Kates and Kasperson 1984; Earle and Cvetovich 1985). The ambiguity of the term is particularly evident in conflicting statements that appear in the work of Slovic and Fischhoff, two prominent researchers from the psychometric school. Some statements specifically deny the possibility of absolute, real risk; others clearly suggest that the experts' definition of risk is the real, correct one. Thus it is possible to interpret the psychometric research findings in different ways: (1) as a demonstration of the diversity of risk judgments, that is, that the difference between expert and layperson represents a legitimate difference in viewpoint or (2) as implying that there is a standard of real risk (the technical definition of risk) against which lay perceptions may be judged to be more or less accurate. In the latter case, the difference between expert and layperson is attributed to a lack of public understanding. From a policy standpoint, the difference between interpretations is significant.

Fischhoff's work provides examples of the first interpretation and the related policy approach. In an early article, he emphasizes the element of values in risk decisions and the potential for bias in technical expert as well as lay judgments (Fischhoff 1979). In a more recent publication, Fischhoff and his coauthors (1983) provide a detailed discussion of underlying reasons for disagreements between experts and laypersons, including situations (e.g., the Alaska pipeline) in which laypersons have information the experts lack. Here, Fischhoff starts from the premise that attributing disagreements to public misperceptions is "often factually wrong" and "from a societal perspective corrosive by encouraging disrespect among the parties in-

volved. . . . Although there are actual risks, nobody knows what they are. All that anyone does know about risks can be classified as perceptions" (Fischhoff, Slovic, and Lichtenstein 1983, 236, 237; see also Fischhoff et al., 1981, xii).

The policy approach linked to this premise is clearly different from the technical approach, in which the management problem is structured in terms of economic and technical rationality and the communication problem is seen to be informing or educating the public about risk as defined by the technical expert. For Fischhoff, risk management involves seeking citizen participation in risk decisions (Fischhoff 1979); education of the public is only one of a number of possible policy solutions. Management requires careful thought and research "to clarify just what it is that the various parties know and believe"; only after this clarification can the underlying problem and its associated solution—"scientific, educational, semantic, or political"—be diagnosed (Fischhoff et al. 1983, 247). Although Fischhoff does not specifically address the issue of risk communication, his general orientation toward the communication task involves the structuring of a two-way rather than one-way process of communication. Such a process enhances mutual learning and respect between public and experts. "That respect may be one of society's greatest assets" (Fischhoff et al. 1983, 247).

Examples of the second interpretation of psychometric research findings are more evident in publications authored by Slovic as sole or lead author (although Fischhoff is a contributing author to a number of these joint publications). The assumption of a standard or real risk as defined by the expert can be discerned in many areas, for example: (1) the early, well-known article, "Rating the Risks," which opens with the statement: "People respond to the hazards they perceive. If their perceptions are *faulty*, efforts at public and environmental protection are likely to be misdirected" (Slovic, Fischhoff, and Lichtenstein 1979, 14, emphasis added); (2) comparison of ratings of experts, who "have statistical evidence on hand," with those of laypersons who "in most cases . . . must make inferences based on what they remember hearing or observing" (Slovic, Fischhoff, and Lichtenstein 1981, 17); and (3) the use in a variety of articles, of terms such as *perceived risk, misperceptions, inaccurate* views, or *when people err* and even the use of a title such as "Facts and Fears: Understanding Perceived Risk" (Slovic, Fischhoff, and Lichtenstein 1980a). Despite acknowledging that expert judgments are also subject to bias (Slovic, Fischhoff, and Lichtenstein 1977, 1984), Slovic tends to focus on "biased newspaper coverage and biased judgments of the public" (Slovic, Fischhoff, and Lichtenstein 1981, 19) rather than on the implications of expert biases.

Significantly, the policy applications Slovic discusses are based on a technical concept of risk. His management focus is the lack of public understanding and knowledge exacerbated by the media. The proposed solution is to inform and educate the public: "The fact that perceptions of risk are often inaccurate points to the need for warnings and educational programs" (Slovic 1986, 405; see also, Slovic, Fischhoff, and Lichtenstein 1980b). Elsewhere, he singles out two policy applications of psychometric research: the need for education of the public and the need to understand and forecast public response to technologies (Slovic, Fischhoff, and Lichtenstein 1981). The need to involve people with differing perspectives in making societal decisions is not elaborated.

Among psychometric researchers, Slovic has been a foremost contributor to the recent discussion of risk communication policy. Here, the underlying conceptual confusion evident in earlier work is compounded by his adoption of the terminology and focus of linear, one-way communication models. The result, which may be unintended, is an implicitly technocentric approach to risk communication. Two examples of this approach can be cited: the manual for plant managers, published by the Chemical Manufacturers' Association (Covello, Sandman, and Slovic 1988), and a conference discussion on risk communication, subsequently published by the Conservation Foundation (Covello, von Winterfeldt, and Slovic 1987).

The manual for plant managers begins with the seven cardinal rules of risk communication, which have been published as a handout by the Environmental Protection Agency (Covello and Allen 1988). The first rule acknowledges that in a democratic society, citizens have a right to participate in decisions that affect their lives; the goal of risk communication should not be to diffuse public concerns and avoid action. Significantly, however, the goal of risk communication is "to produce an informed public that is involved, interested, reasonable, thoughtful, solution-oriented, and collaborative" (Covello, Sandman, and Slovic 1988, 2). This focus on the public is an almost-classic example of what Rogers and Kincaid (1981, 39) cite as the "individual-blame" bias of linear communication models. The manual acknowledges but does not stress ways that the provision of information to managers from and about the public might also enhance the communication process. It does not suggest enhancing communication as a two-way process among participants who have equal, though differing, contributions to make. Nor does it discuss ways the public might be involved in making decisions about risk, rather than being passive recipients — the "target audience" (Covello, Sandman, and Slovic 1988, 9) — for technical spokespersons' messages. Rather, the manual focuses on risk communication as an act

rather than a process and stresses ways to enhance the technical manager's presentation of probabilistic risk concepts. Effective communication is conceived in the limited sense of the manager's ability to explain risk concepts clearly.

The manual is based on an earlier publication by Covello, von Winterfeldt, and Slovic (1987). In this earlier discussion of four tasks of risk communication, the theoretical underpinnings of the authors' approach to risk communication are revealed. Communication is restricted to the "act" (Covello et al. 1987, 112) rather than the process of communication. Throughout, the discussion uses the terminology of linear models of communication, which posit transmission of a message, via a channel, from a source to a receiver. Over the past decade, one-way transmission models, which were accepted during the 1950s and 1960s, have been subjected to severe criticism.[6] Essentially, the goal of the message-source-channel-receiver model is persuasion rather than information sharing: the focus is the effect of communication on a passive receiver rather than the context in which communication occurs and the relationship between senders and receivers as joint participants in the mutual generation of meaning.

Adopting linear model terminology leads Slovic and his coauthors to particular problems in reconciling practice with theory in their fourth task of risk communication, namely, joint problem solving and conflict resolution. While recognizing elsewhere that "the heart of effective communication is negotiation and coalition building not manipulation" (Covello 1987, 65) and that "risk communication efforts are bound to fail unless they are structured as a two-way process" (Slovic 1986, 410), Covello and Slovic fail to structure risk communication accordingly. Rather, they reinforce a structuring of the policy decision in technical terms: government and industry officials (the source) send messages to individual citizens (receivers). The authors are thus unable to present a firmly grounded case for a two-way process of communication and negotiation.

The one-way feature of the communication model of Covello et al. has been criticized, and suggestions have been made for an alternative, two-way model that explicitly recognizes the role of all parties as communicators (Leiss and Krewski 1987). But such criticism stops short of identifying the fundamental cause of the problem. The problem stems from the initial concept of risk. The very selection of linear model terminology is only symptomatic of a continuing failure to recognize the philosophical contradictions of both the model and the authors' underlying concept of risk. Ambivalence over the risk concept reinforces the role of the experts as the sole possessors of the accurate facts: there is no logical alternative but to

place the experts in the role of communicators *to* rather than *with* the public. The technical approach to risk communication follows inevitably.

In sum, therefore, the theoretical confusion evident in the work of the two most prominent authors from the psychometric school has serious policy implications. Nowhere do the authors explicitly acknowledge a difference in viewpoint or specifically address the implications of their initial concepts of risk. However, in starting from the phenomenon of risk rather than from the perceiver of risk, they cannot provide a theoretical basis adequate to support an unambiguous interpretation of their findings. As a result, there is no consistent, firmly grounded basis for structuring the policy problem.

The ambiguity is additionally significant in that policy decisions about risk typically are made by technical managers rather than by social scientists. In this context, the insights of the literature on knowledge utilization are particularly relevant. That literature emphasizes that knowledge, as opposed to the physical symbols of a body of knowledge, does not have an independent existence: the products of knowledge are interpreted differently by various users according to their frames of reference. Frames of reference constitute the underlying structure of assumptions, expectations, and decision rules or criteria for assessing knowledge claims, structuring inquiry, and constructing meanings (Dunn and Holzner 1988; Dunn, Holzner, and Zaltman 1985). They form the "unreflected basis for structuring inquiry" (Holzner and Fisher 1979, 231). By virtue of their frames of reference, technical managers are predisposed to adopt technical approaches to risk management. The information/education solution is more likely to be congruent with their preexisting structuring of risk management in technical terms and their structuring of the communication problem in terms of a lack of public understanding of science. Although psychometric researchers might protest that the breadth of their studies does not support a narrowly technocentric view and that the value of the studies lies in their display of the rich and wide diversity of views about risk that need to be incorporated into risk decisions, technical managers may not perceive these features.[7]

Thus, perhaps against their best intentions, authors from the psychometric school have contributed to a formulation of risk management and risk communication on the technical analyst's terms. The management approach in effect permits the technical manager to pursue the technical aspects of technology development in isolation from its social implications, that is, to adopt what Wynne has termed a *tool concept* of technology. The participation of, and communication with, other affected groups becomes a separate activity, an adjunct rather than an integral part of management decision making. In the process, social science knowledge comes to be viewed in

purely instrumental terms: the social scientist is reduced to the subordinate role of change-agent. Such a role subtly undermines the autonomy of the public whose attitudes are deemed to be in need of change and also causes ethical problems for the social scientist.[8]

The Concept of Risk and Technology as Social Processes

Cultural scholars start from the premise that risk and technology are social processes rather than physical entities that exist independently of the humans who assess and experience them. This alternative concept, which explicitly addresses the value-embedded nature of all knowledge claims about risk, leads to a formulation of the management and communication policy problems different from that of the technical approach. The discussion changes from a focus on probabilities to a focus on the risk perceiver—expert as well as layperson—and hence to a focus on social institutions and the social and cultural context in which risk is assessed and managed.

The viewpoint that risk is socially constructed rather than a physically given attribute is most succinctly expressed by Otway and Thomas (1982, 70):

> It is clear that truths do not exist independently of *people*, whether taken to be individuals, significant social groups in the general public, professional or political/industrial groups. It is *people*, and not independent facts, who constrain the way concepts are framed, questions posed, and research goals set. And it is people who design event and fault trees, close options, choose attribute sets, fund data collection, interpret and publish findings. Once the criterion of an absolute truth is abandoned, then surely no one can avoid the inference *that people see the world differently* and that these differences emerge from different experiences of differently constructed social worlds.

Among cultural theories, the grid/group framework of Douglas and Wildavsky (1982) illuminates the social processes that affect the tendency to take or avoid different types of risk. These authors emphasize that ideas about the world, including perceptions of risk, come from human experience, but experience differs among groups. Different forms of social organization thus influence the way we take or avoid risks. Differences in views of risk can therefore best be understood by analyzing different forms of social organization and underlying value systems. Moreover, as Plough and Krimsky succinctly point out, "There is a social context of expertise and officialdom as well as of lay communities. Bias, irrational action, and narrow interest group behavior intrude into both these contexts" (1987, 9).

Wynne (1980, 1983) examines the issue of technological risk in terms of its relationship to an underlying view of the social relations of expertise and the nature and effects of technology. His distinction between what he terms a tool concept of technology and technology as a way of life highlights the need for participation as an essential, rather than simply a desirable, part of the societal decision-making process on technology and risk. Each of the two viewpoints on technology is associated with a distinct view of the role of risk assessment and of public participation. Wynne is critical of the narrow focus of the tool concept, which adopts a view of technology as a neutral phenomenon and risk as a reified concept. This latter viewpoint seeks to identify, predict, and control physical impacts and insulates physical risks and effects of technology from broader social effects. Participation is restricted in scope because it is viewed as a factor external to technology—as an inefficient process that may delay the technology's deployment.

The alternative view of technology as a way of life recognizes that technology is not a neutral phenomenon but is social in origin, character, and effects. From this viewpoint, the implications of technological development are the social relationships involved in innovation and implementation rather than its physical consequences. The key uncertainties in risk-related problems stem not so much from technical uncertainties, as addressed in technical risk analysis, as from uncertainties over potential social changes. Face-to-face interaction among groups and participants from a range of sociocultural perspectives is a prerequisite in the development of socially viable technologies. The societal question is "not whether and how to let the so-called 'outsiders' in, but of whether it is sane and feasible to keep the 'insiders' (the risk-bearers) out" (Wynne 1983, 19).

The major contribution of the social and cultural literature on risk and technology is the insight it provides into problem unsolving and into an appropriate reformulation of the risk management and risk communication problems. Although cultural theorists have been accused of embracing a radical, social reductionist stance (see especially Funtowicz and Ravetz 1985), it can be argued that their insights have pinpointed and provided a firm theoretical foundation for an appropriate design of policy.

In the notion of *problem unsolving,* the social and cultural approaches explicitly recognize that decisions based on statistical probabilities are too narrow to be used as the basis for social acceptability. Such decisions seem to solve problems, but leave their deeper dimensions unsolved. The cultural approaches do not deny the importance of technical, economic analyses in informing the risk decision. Their criticism is that technical and economic analyses are being used alone to drive decisions (Hadden 1984). Improved

technical analyses are not the key to improved risk management decisions. Decisions that involve transcientific, rather than scientific, questions cannot be answered by science (Weinberg 1972). Since societal risk management decisions on the level, acceptability, and distribution of risk involve questions of values, and since differing values are held by those affected, risk management decisions must take into account the political, social, and ethical, as well as the technical, aspects of the policy problem.

Moreover, the cultural approach provides an *appropriate formulation of the policy problem* by starting from the risk perceiver, from different perspectives on risk and the inherently value-laden nature of risk decisions, and by emphasizing the essential role of participation by a range of perspectives in societal decisions about risk. The management approach implied in the cultural view is premised on a belief in the rationality of differing values and differing risk claims (where rationality is defined, in the words of Dunn [1981, 225], as a "self-conscious process of using reasoned argument to make and defend advocative claims"). Once it is explicitly acknowledged that "truths do not exist independently of people" (Otway and Thomas 1982, 70), the policy problems are structured in terms of negotiating among the "alternative cultural perspectives" (Rayner 1984, 160) of all sociocultural groups—the technical analyst, the policymaker, and the various groups involved in, and affected by, policy implementation. Managers need to understand the basis of their own and of other groups' perspectives on risk and to initiate the development of institutional means for accommodation.[9]

From this viewpoint, acceptance and acceptability of risk cannot be analytically determined but must be negotiated, that is, socially constructed. This is essentially a question of policy analysis rather than science (Clark 1980), in which a priority is placed on the consent of the governed to the process by which decisions are made.[10] The solution is not—and indeed cannot be—a definitive one. Rather, it requires putting in place a process that, in Clark's words, will permit learning from error and that provides for the negotiation of mutually acceptable solutions in the dialogue among those involved. The key questions to be addressed are how to compare critically the competing claims as to what constitutes risk and how to reach societal decisions concerning the control of risk and technology when a diversity of values exists. Some key insights on the need for and nature of this dialogue are provided by Funtowicz and Ravetz, and by Dunn.

Funtowicz and Ravetz address the need for a "civilized dialogue of risks" (1985, 841) in their differentiation of three types of policy-related research, each of which calls for a qualitatively different approach or method for solution. Their discussion may be viewed in the context of Ravetz's search

for a "new appropriate sort of science" (1987, 89) to replace our inherited conception of science as the facts—a conception that is inadequate to meet the challenge posed by policy-related science issues, characterized by uncertain facts, disputed values, high stakes, and a need for urgent decisions. Funtowicz and Ravetz (1985) distinguish a factual and a valuative dimension (systems uncertainty and decision stakes) in such problems; the dimensions may be assigned low, medium, or high values. Where both dimensions are low, a traditional, technical approach is appropriate. In these situations, disputes are likely to be settled easily, either because a substantial body of data has accumulated or because disputes between scientists are not seen to involve critical social issues. This traditional approach is inappropriate, however, for policy issues such as high-level waste management where both dimensions are high, that is, where the data base is not well established and where important values are at stake. Here the approach (termed *total environmental assessment*) takes the form of a dialogue, even on technical issues. Although these types of problem seem, initially, to be a "clash between incommensurable world views," over time they "tend to stimulate the production of relevant facts and value-commitments," thus enabling resolution by "political debate rather than civil war" (Funtowicz and Ravetz 1985, 844).

Dunn (1982, forthcoming) provides specific guidance on the nature of the dialogue in his advocacy of the Toulmin model of argumentation (Toulmin 1958; Toulmin, Rieke, and Janik 1979) as the conceptual framework for structuring practical, policy discourse. (The term *practical* is used in Aristotle's sense, namely, providing guidance about what is right and just.) The model, which recognizes the need for ethical, valuative analysis, is thus broader in application than Campbell's (1987) call for a sociology of scientific validity. A primary advantage of the Toulmin model is that it provides a systematic approach to appraising and critically testing the various grounds for assertions or claims. It thus accommodates the range of knowledge claims (e.g., ethical arguments, arguments based on scientific knowledge, or arguments based on experience) that typically are encountered in policy debates. In effect, the dialogue is a process of "reasoned argument and debate" (Dunn 1982, 302) or critical social transactions among stakeholders with different reference frames who "engage in the competitive reconstruction of knowledge claims" (Dunn 1982, 304). In this process, each stakeholder's underlying assumptions and standards of assessment (both implicit and explicit) surface for cross-examination: knowledge is socially constructed on the basis of competing knowledge claims and the expansion of learning over time.

From this viewpoint, risk communication is an integral part of the critical dialogue—a process of negotiation among alternative cultural perspectives.

The viewpoint is consistent with recent convergence theories of communication that see communication as a process of knowledge transaction among participants and the negotiation of shared meanings over time (Rogers 1986; Rogers and Kincaid 1981). Such a concept has several important policy implications.

First, this concept views communication as a two-way process of knowledge sharing and negotiation and for eliminating the blame-the-public orientation of linear model terminology. The priority for management is not the publication of information products but the development of processes of interaction. The various publics affected by policy may need information; equally important, managers also need information about these publics. Information, however, is a means to improve the quality of the process and the relationship among participants rather than an end in itself.

Second, this concept views communication as an integral part of decision making. It is linked to a view of technology as a social system, or way of life, in which the assessment of physical risks is only one part of the societal decision-making process and participation is an essential part of that process. Communication is seen as an integral part of the management function of actively seeking dialogue with those who hold alternative cultural perspectives—with the various groups of experts, laypersons, and organizations that act as filters for and express the public's views.[11]

Third, this concept highlights the relational aspects of communication and the context in which communication occurs. It includes both the interpersonal, explicit exchange of information (which is the sense of the term typically employed in the literature) and the implicit meaning conferred by participants' actions.[12] Communication conceived as a process of developing shared understanding and generating mutual meaning is thus linked to the broader process of participation in its Aristotelian sense. This is the concept of political action as a mode of existence—as a common enterprise in which humans create values and the nature of social reality.[13]

Fourth, this concept provides a role for the use of social science knowledge in policy making that extends beyond the instrumental role to which it so frequently is assigned. Here, rationality is constitutive, not instrumental; social scientists are freed from their subordinate role. Thus the cultural approach opens the door to the use of social science knowledge for practical and critical as well as for technical (instrumental) purposes.[14] Used for practical purposes, social science knowledge can help facilitate the development of creative solutions to policy problems by the parties concerned. Used for critical purposes, social science knowledge can contribute to defining the nature of the policy problem itself.

Finally, this concept links the current discussion on risk communication to the more fundamental discussion of the appropriateness of older concepts of science to address the problems we currently face. Risk is not a topic to be discussed in isolation from the more fundamental issue raised by Ravetz: can science and scientists remain credible if they try to design policy on risk as if "they face simple policy questions determined by simple factual inputs" (Ravetz 1987, 90)?

Conclusion

Social and cultural approaches, which explicitly deny the possibility of a standard of absolute risk, provide a firm theoretical foundation for an appropriate formulation of the policy problem of risk and a framework for solution. Improved technical analyses are not the key to improved risk management and risk communication decisions. The risk management problem requires the development of institutional procedures for structuring a critical dialogue among different perspectives and societal groups. In addressing the question of how to evaluate socially constructed knowledge claims and in pointing to the need for citizen consent and participation, prominent authors from this school have suggested a framework within which the dialogue can take place. The communication problem is formulated as an integral part of this critical dialogue. Communication is seen as a convergence process of knowledge transactions among participants who have equal, if different, contributions to make to societal decisions.

This concept places the risk discussion firmly within a social constructivist framework. Thus the entire discussion of risk — of perception, management, and communication — is conceptually linked to the larger societal debate on the nature and role of science in our modern, industrialized civilization.

Notes

1. The discussion, throughout, draws heavily on the insights of Ravetz (1973, 1987), whom Campbell regards as the founder of the social constructivist movement (Campbell 1987, 391). In his 1987 publication, *Usable Knowledge, Usable Ignorance: Incomplete Science with Policy Implications,* Ravetz argues that our "one-sided experience of science as the facts," which is "deeply embedded in our image of science" (p. 92), has not prepared us for dealing with many of the policy-related science issues we currently face. These issues, resulting largely from the interactions of technology with the environment, raise novel questions of control. Here, we are confronted with pervasive scientific ignorance and the impossibility of separating facts and

values. From this viewpoint, the risk discussion is about how we replace our inherited, simplistic conception of science with a "new appropriate sort of science" (p. 89).

2. As Vesely (1984, 155) has noted, "The dominant risk contributors found in a PRA are often those which are most subjective and have the largest uncertainties: examples are human error and dependent failure contributions." Experts in the field recognize that the value of such assessments lies primarily in the systematic, disciplined thinking that they impose on the assessors.

3. For example, Lowrance's (1976) two-stage model of risk assessment reappears as a recommendation for a "clear distinction" to be made between assessment and evaluation in the 1983 report by the National Research Council, *Risk Assessment in the Federal Government: Managing the Process.*

4. For examples of such approaches, see Wilson's (1979) incremental risk approach, which evaluated the introduction of new risks with already existing risks in terms of life expectancy rates, and Cohen's (1980) comparison of societal activities in terms of dollars spent per averted fatality and the cost per twenty years of added life expectancy.

5. Both the theoretical and the applied literature support this conclusion. For example, Shrader-Frechette (1986) points to specific flaws in the equity and rationality arguments underlying the commensurability presupposition on which proponents of the technical approach rely. Nelkin's (1979) compilation and discussion of a range of cases of technological controversy demonstrates the limitations of technical competence.

6. Particular criticisms of the linear model made by Rogers (1986) and Rogers and Kincaid (1981) are (1) the concept of information as a physical entity to be transmitted like a material object and the associated lack of recognition of the interpretive element in the communication process; (2) the psychological, "individual-blame" bias in which the focus becomes the effect of communication on the individual receiver rather than the context in which communication occurs and the relationship between senders and receivers as joint participants in the process; and (3) the underlying theory of mechanistic causation.

7. The author's recently completed research on the use of social science knowledge in implementing the Nuclear Waste Policy Act confirmed that technical managers were more likely to interpret psychometric studies as a difference between real and perceived risk. Moreover, the overwhelming majority of all agency personnel who were interviewed conceived of communication as a one-way provision of technical information to the public, rather than a two-way process of convergence among different perspectives (Bradbury 1989).

8. Otway notes an alternative solution for those reluctant to adopt the education/information approach: risk-related social science research can provide decision makers with "a better understanding of social phenomena." However, as he succinctly points out, "the problem is that nobody really knows what to do with the results" (1980, 134).

9. The findings of social science research conducted in applied settings (and frequently independently of the traditional risk perception field) provide confirmation of many of the key theoretical insights of the cultural approach to risk. For example, the research of Elliott (1984, forthcoming), conducted from the perspective of mediated dispute resolution, is in striking agreement with Rayner (1984, 1987). Fundamentally, the approach of both lines of research is premised on a belief in the legitimacy of and the need to accommodate differing values and perceptions of risk.

Elliott (forthcoming) emphasizes that "the debate about rational analysis has been misplaced" and refocuses the discussion of rationality in terms of the essential rationality of different forms of coping with risk. He points out that, from the viewpoint of risk management, a key difference between groups lies not so much in their perceptions of risk, but in preferred ways of

coping with risk and uncertainty. These preferences stem from the importance placed by each group on different characteristics of risk.

By working with the practical implications of differences in perceptions, by trying to manage risks as perceived by the affected groups rather than vainly trying to alter perceptions or educate a seemingly uninformed, irrational public, Elliott has reformulated the risk management task in a way that points to the possibility of effective solution.

10. See especially, MacLean (1986), who argues that citizen consent to the *process* by which decisions are made is the key to acceptability. He advances two reasons for the crucial role of consent and outlines three models of consent that represent a continuum from direct to indirect. Because individuals and groups may have different preferences for one or another form of consent and the associated method for making decisions about risk, the decision process as well as the decision outcome becomes an important expression of our values. Rayner and Cantor (1987) similarly emphasize the importance of citizen consent. As epitomized in the title of their article, the question is not "How safe is safe enough?" but "How fair is safe enough?"

11. See Mitchell (1987), who emphasizes communicating via the already existing frameworks of the receivers (i.e., people interpret new information according to these frameworks). The links between the experts and the public are political organizations and ideologies that have arisen to express, and act as filters for the expression of, the views of different segments of the public. Communication (and bargaining) with and among these organizations is a key, though frequently ignored, aspect of the communication problem.

12. Lievrouw (1988) points out that communication consists of more than "micro-scale personal encounters." In addition to meanings that are created interpersonally, participants in the knowledge-sharing process attribute meanings to the artifacts, social structures, and institutions created by other participants. Therefore, it is impossible to separate the interpersonal aspects of communication from other aspects of management activities.

13. For a succinct discussion of the implications of differing conceptions of participation, see Keim (1975).

14. This discussion of the technical, practical, and critical purposes of social science knowledge draws on the distinctions made by Habermas (1971).

References

Ackoff, R. L. 1974. *Redesigning the future: A systems approach to societal problems.* New York: John Wiley.

Bradbury, J. A. 1989. The use of social science knowledge in implementing the Nuclear Waste Policy Act. Ph.D. diss., Graduate School of Public and International Affairs, University of Pittsburgh.

Campbell, D. T. 1987. Guidelines for monitoring the scientific competence of preventive intervention research centers: An exercise in the sociology of scientific validity. *Knowledge* 8:389-430.

Clark, W. C. 1980. Witches, floods, and wonder drugs: Historical perspectives on risk management. In *Societal risk assessment: How safe is safe enough?,* ed. R. C. Schwing and W. A. Albers, 287-313. New York: Plenum.

Cohen, B. L. 1980. Society's valuation of life saving in radiation protection and other contexts. *Health Physics* 38:33-51.

Conrad, J. 1980. Society and risk assessment: An attempt at interpretation. In *Society, technology and risk assessment,* ed. J. Conrad, 241-76. New York: Academic Press.

Covello, V. T. 1987. Case studies of risk communication: Introduction. In *Risk communication: Proceedings of the National Conference on Risk Communication held in Washington, DC, January 1986,* ed. J. C. Davies, V. T. Covello, and F. W. Allen, 63-65. Washington, DC: Conservation Foundation.

Covello, V. T., D. von Winterfeldt, and P. Slovic. 1987. Communicating scientific information about health and environmental risks. In *Risk communication: Proceedings of the National Conference on Risk Communication held in Washington, D.C., January 1986,* ed. J. C. Davies, V. T. Covello, and F. W. Allen, 109-34. Washington, DC: Conservation Foundation.

Covello, V. T., and F. Allen. 1988. *Seven cardinal rules of risk communication.* Washington, DC: U.S. Environmental Protection Agency, Office of Policy Analysis.

Covello, V. T., P. M. Sandman, and P. Slovic. 1988. *Risk communication, risk statistics, and risk comparisons: A manual for plant managers.* Washington, DC: Chemical Manufacturers Association.

Douglas, M., and A. Wildavsky. 1982. *Risk and culture.* Berkeley: Univ. of California Press.

Dunn, W. N. 1981. *Public policy analysis: An introduction.* Englewood Cliffs, NJ: Prentice-Hall.

——— 1982. Reforms as arguments. *Knowledge: Creation, diffusion, utilization* 3(3):293-326.

——— Forthcoming. Reconstructing policy inquiry: The logics of public discourse. *Evaluation and Program Planning.*

Dunn, W. N., and B. Holzner. 1988. Anatomy of an emergent field. *Knowledge in Society: The International Journal of Knowledge Transfer* 1(1):3-26.

Dunn, W. N., B. Holzner, and G. Zaltman. 1985. Knowledge utilization. In *The international encyclopedia of education,* ed. T. Husen and T. N. Postlethwaite, 2831-39. Oxford: Pergamon.

Earle, T. C., and G. Cvetovich. 1985. Risk judgment and the communication of hazard information. In *Environmental impact assessment, technology assessment, and risk analysis,* ed. V. T. Covello, J. L. Mumpower, P. J. M. Stallen, and V. R. R. Uppuluri, 257-312. New York: Springer-Verlag.

Elliott, M.L.P. 1984. Improving community acceptance of hazardous waste facilities through alternative systems for mitigating and managing risk. *Hazardous Waste* 1:397-410.

——— Forthcoming. The effect of differing assessments of risk in hazardous waste facility siting negotiations. In *Negotiating hazardous waste facility siting and permitting agreements,* ed. G. Bingham and T. Mealey. Washington, DC: Conservation Foundation.

Fischhoff, B. 1979. Informed consent in societal risk-benefit decisions. *Technological Forecasting and Social Change* 13:347-57.

Fischhoff, B., S. Lichtenstein, P. Slovic, S. L. Derby, and R. L. Keeney. 1981. *Acceptable risk.* New York: Cambridge Univ. Press.

Fischhoff, B., P. Slovic, and S. Lichtenstein. 1983. The public vs. "the experts." In *The analysis of actual vs. perceived risks,* ed. V. T. Covello, W. G. Flamm, J. V. Rodricks, and R. G. Tardiff, 235-49. New York: Plenum.

Funtowicz, S. O., and J. R. Ravetz. 1985. Three types of risk assessment: A methodological analysis. In *Environmental impact assessment, technology assessment, and risk analysis,* ed. V. T. Covello, J. L. Mumpower, P. J. M. Stallen, and V. R. R. Uppuluri, 831-48. New York: Springer-Verlag.

Habermas, J. 1971. *Knowledge and human interests.* Boston: Beacon.

Hadden, S. G. 1984. Introduction: Risk policy in American institutions. In *Risk analysis, institutions, and public policy,* ed. S. G. Hadden, 3-17. Port Washington, NY: Associated Faculty Press.

Holzner, B., and E. Fisher. 1979. Knowledge in use. *Knowledge* 1:219-43.

Kates, R., and J. X. Kasperson. 1984. Comparative risk analysis of technological hazards (a review). CENTED Reprint no. 46. Worcester, MA: Clark Technology Center for Technology, Environment, and Development.

Keim, D. W. 1975. Participation in contemporary democratic theories. In *Participation in politics,* ed. J. R. Pennock, 1-38. New York: Liber-Atherton.

Leiss, W., and D. Krewski. 1987. Risk communication processes: A review of some conceptual models and some current practices. Department of Communication, Simon Fraser University, British Columbia.

Lievrouw, L. A. 1988. Four programs of research in scientific communication. *Knowledge in Society: The International Journal of Knowledge Transfer* 1(2):6-22.

Lowrance, W. 1976. *Of acceptable risk: Science and the determination of safety.* Los Altos, CA: William Kaufman.

MacLean, D. 1986. Risk and consent: Philosophical issues for centralized decisions. In *Values at risk,* ed. D. MacLean, 17-30. Totowa, NJ: Rowman & Allenheld.

Mitchell, R. C. 1987. Nuclear and other energy sources. In *Risk Communication: Proceedings of the National Conference on Risk Communication held in Washington, D.C., January 1986,* ed. J. C. Davies, V. T. Covello, and F. W. Allen, 77-81. Washington, DC: Conservation Foundation.

National Research Council, Commission on Life Sciences, Committee on the Institutional Means for Assessment of Risks to Public Health. 1983. *Risk assessment in the federal government: Managing the process.* Washington, DC: National Academy Press.

Nelkin, D., ed. 1979. *Controversy: Politics of technical decisions.* Beverly Hills, CA: Sage.

Otway, H. J. 1980. Discussion paper on A. Mazur. In *Society, technology and risk assessment,* ed. J. Conrad, 163-64. New York: Academic Press.

Otway, H. J., and K. Thomas. 1982. Reflections on risk perception and policy. *Risk Analysis* 2:69-82.

Plough, A., and S. Krimsky. 1987. The emergence of risk communication studies: Social and political context. *Science, Technology, & Human Values* 12 (Summer/Fall):4-10.

Ravetz, J. R. 1973. *Scientific knowledge and its social problems.* New York: Oxford Univ. Press.

——— 1987. Usable knowledge, usable ignorance: Incomplete science with policy implications. *Knowledge* 9:87-116.

Rayner, S. 1984. Disagreeing about risk: The institutional cultures of risk management. In *Risk analysis, institutions, and public policy,* ed. S. G. Hadden, 150-68. Port Washington, NY: Associated Faculty Press.

——— 1987. Risk and relativism in science for policy. In *The social and cultural construction of risk,* ed. B. B. Johnson and V. T. Covello, 5-23. Norwell, MA: Reidel.

——— 1988. Muddling through metaphors to maturity: A commentary on Kasperson et al., "The social amplification of risk." *Risk Analysis* 8:201-4.

Rayner, S., and R. Cantor. 1987. How fair is safe enough? The cultural approach to societal technology choice. *Risk Analysis* 7:3-9.

Rogers, E. M. 1986. *Communication technology.* New York: Free Press.

Rogers, E. M., and D. L. Kincaid. 1981. *Communication networks: Toward a new paradigm for research.* New York: Free Press.

Shrader-Frechette, K. 1986. Risk-cost-benefit methodology and equal protection. In *Risk evaluation and management,* ed. V. T. Covello, J. Menkes, and J. Mumpower, 275-96. New York: Plenum.

Slovic, P. 1986. Informing and educating the public about risk. *Risk Analysis* 6:403-15.

Slovic, P., B. Fischhoff, and S. Lichtenstein. 1977. Behavioral decision theory. *Annual Review of Psychology* 28:1-39.

——— 1979. Rating the risks. *Environment* 21(3):14-39.

——— 1980a. Facts and fears: Understanding perceived risk. In *Societal risk assessment: How safe is safe enough?*, ed. R. Schwing and W. A. Albers, 181-213. New York: Plenum.

——— 1980b. Informing people about risk. In *Product labeling and health risks*, ed. L. Morris, M. Mazis, and B. Barofsky, 165-80. Banbury Report 6. New York: Cold Spring Harbor Laboratory.

——— 1981. Perceived risk: Psychological factors and social implications. In *The assessment and perception of risk*, ed. F. Warner and D. Slater, 17-34. London: Royal Society.

——— 1984. Perceptions and acceptability of risk from energy systems. In *Public reactions to nuclear power*, ed. W. Freudenburg and E. Rosa, 115-35. Boulder, CO: Westview Press.

Spangler, M. B. 1985. Heuristic opinion and reference evaluation for assessing technological options—a user's view. In *Environmental impact assessment, technology assessment, and risk analysis*, ed. V. T. Covello, J. L. Mumpower, P. J. M. Stallen, and V. R. R. Uppuluri, 917-52. New York: Springer-Verlag.

Thompson, P. B., and W. J. Parkinson. 1984. Distinguishing between HC/LP and LC/HP risk. In *Low probability high consequence risk analysis*, ed. R. A. Walker and V. T. Covello, 551-67. New York: Plenum.

Toulmin, S. 1958. *The uses of argument*. Cambridge: Cambridge Univ. Press.

Toulmin, S., R. Rieke, and A. Janik. 1979. *An introduction to reasoning*. New York: Macmillan.

U.S. Nuclear Regulatory Commission. 1975. *Reactor safety study: An assessment of accident risks in U.S. commercial nuclear powerplants*. WASH 1400. Washington, DC: U.S. Nuclear Regulatory Commission.

Vesely, W. E. 1984. Robust risk analysis: The need for it in nuclear probability risk evaluations. In *Low probability high consequence risk analysis*, ed. R. A. Walker and V. T. Covello, 153-60. New York: Plenum.

Weinberg, A. 1972. Science and trans-science. *Minerva* 10:209-22.

Wilson, R. 1979. Analyzing the daily risks of life. *Technology Review* (February):40-46.

Wynne, B. 1980. Technology, risk and participation. In *Society, technology and risk assessment*, ed. J. Conrad, 173-208. New York: Academic Press.

——— 1983. Redefining the issue of risk and public acceptance. *Futures* 15 (February):13-32.

Zimmerman, R. 1986. The management of risk. In *Risk evaluation and management*, ed. V. T. Covello, J. Menkes, and J. Mumpower, 435-60. New York: Plenum.

Judith A. Bradbury is an Analyst with the Oak Ridge Office of Science Applications International Corporation (P.O. Box 2501, 800 Oak Ridge Turnpike, Oak Ridge, TN 37831 USA), where she specializes in social impact assessment and institutional relations. She worked for several years as a consultant to the Department of Energy on the Nevada radioactive waste repository and on the proposed siting of a monitored retrievable storage facility in Tennessee. This article is from her recently completed doctoral dissertation, which examined the use of social science knowledge in implementing the Nuclear Waste Policy Act of 1982.