

# **RISK PERCEPTION: A SYSTEMATIC REVIEW OF CONCEPTS AND RESEARCH RESULTS**

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## **1 INTRODUCTION**

In the year 1968 the Survey Research Institute at Allensbach (FRG) conducted a national poll in the Federal Republic of Germany in which a representative sample of German women were asked what kind of profession the ideal husband should have. In 1968 the most attractive profession for a man was that of nuclear physicist. Eleven years later the same question was again asked of all females between the ages of 16 and 70. In this poll the nuclear physicist was not even mentioned among the first 20 nominations. The top of the list was occupied by a completely different type of professional activity. The winner of the game was forest ranger (Allensbach, 1979)!

What has the attractiveness of male professions to do with risk perceptions?  
There are two answers to this question:

- (1) The shift of prestige assignment from a technology-oriented to a nature-oriented profession reveals a semantic change in the public understanding of risk. In the past, technology was predominantly perceived as a powerful means of reducing risks due to natural catastrophes, climate variations, infectious diseases, and biological competitors for food and biotope (Markl, 1980), but in recent years it has become increasingly associated with causing risks and threats to human beings and the natural environment. People have become aware of the fact that the tools that liberated them from natural constraints themselves posed new risks on their lives (Hohenemser *et al.*, 1981, p 2; Renn, 1984; Renn and Swaton, 1984).
- (2) The change of professional prestige in modern societies further demonstrates the interdependences between perceptions, general social attitudes, values, and world views. There is no doubt that science is dependent on the concept of isolating specific phenomena from their natural or social context in order to construct modes of causal or sequential relationships with the aid of analytical techniques. This is also true for studies of risk perception. However, it should be kept in mind that in real life risk perception does not exist as a distinct psychological process among other types of perception, but forms an integral part of assembling and representing beliefs and perceived characteristics of an object or event in the mind of the individual. Considerations of risks may or may not play a major role in this opinion- or judgment-forming process. Potential benefits, side effects, symbolic meanings, value orientations, the attitudes of reference groups about the risk source, and the prestige and image of those who promote or oppose implementation of the risk source are just some of the many factors, apart from risk considerations, that influence people's perceptions of objects or events (Pearce, 1978; Hoos, 1980; Thompson, 1980; Conrad, 1981b; Lee, 1981).

Division into features relating to the risk and those relating to the risk source is admittedly a purely analytical expedient for psychological research. In reality, people judge objects, events, and activities only, and not risks ( *cf.* Brown and Green, 1980).

Would it then not be better to remove the concept of risk perception from the terminology of cognitive psychology and to replace it by object perception? This sort of recommendation can indeed be justified in view of the often unthinking use of the concept of risk perception, but it is not necessary from the nature of the case, for perception of an object naturally also includes perception of the hazardous consequences of this object, their mental assimilation, and the development of general mechanisms to cope with the situation of uncertainty (Renn and Peters, 1982). Thus the hierarchical rank of aspects related to risk, benefit, and uncertainty with respect to object assessment can be analytically investigated. In the same way the separate measurement of object and risk perception can answer the question whether there are typical patterns in the intuitive perception of risk sources which can give some pointers toward the "common sense" assimilation of uncertainty owing to potential danger sources.

## **2 BASIC CONCEPTS OF RISK PERCEPTION**

For the purpose of reviewing the major theoretical concepts and empirical studies in the field of risk perception it is necessary to define the main terms frequently used in the literature on risk perception.

### *Object perception*

Object perception describes the process of mentally representing and assimilating information and experience with respect to a physical object or entity (Renn and Peters, 1982).

### *Values*

A value is a conception, explicit or implicit and distinctive of an individual or characteristic of a group, of the desirable which influences the selection from available modes, means, and ends of action (Kluckhohn, 1951).

### *Beliefs*

A belief represents the cognitive images a person has of a given object, i.e., it is a probability judgment whether an attribute is or is not, and to what degree, associated with the perception of an object. The subjective feeling of goodness and badness which is linked with each attribute refers to the effect a person might have and is called subjective evaluation (Fishbein and Ajzen, 1975).

### *Attitude*

Attitude is a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related (Allport, 1935).

### *Concerns*

A concern refers to a state of positive or negative responsiveness of individuals to awareness and processing of any information or personal experience regarding salient areas of interest on that matter (Renn and Swaton, 1984).

### *Risk perception*

Perceived risk is the combined evaluation that is made by an individual of the likelihood that an adverse event will occur in the future and its probable consequence (Royal Society, 1983, p 34).

In *Figure 1* an attempt is made to illustrate the interconnections between beliefs, concerns, values, attitudes, and perceptions. The model includes five basic categories: physical environment, social environment, cultural environment, psychological motives, and socialized motives. Any individual is confronted with a specific object that is embedded in a social situation and a cultural context

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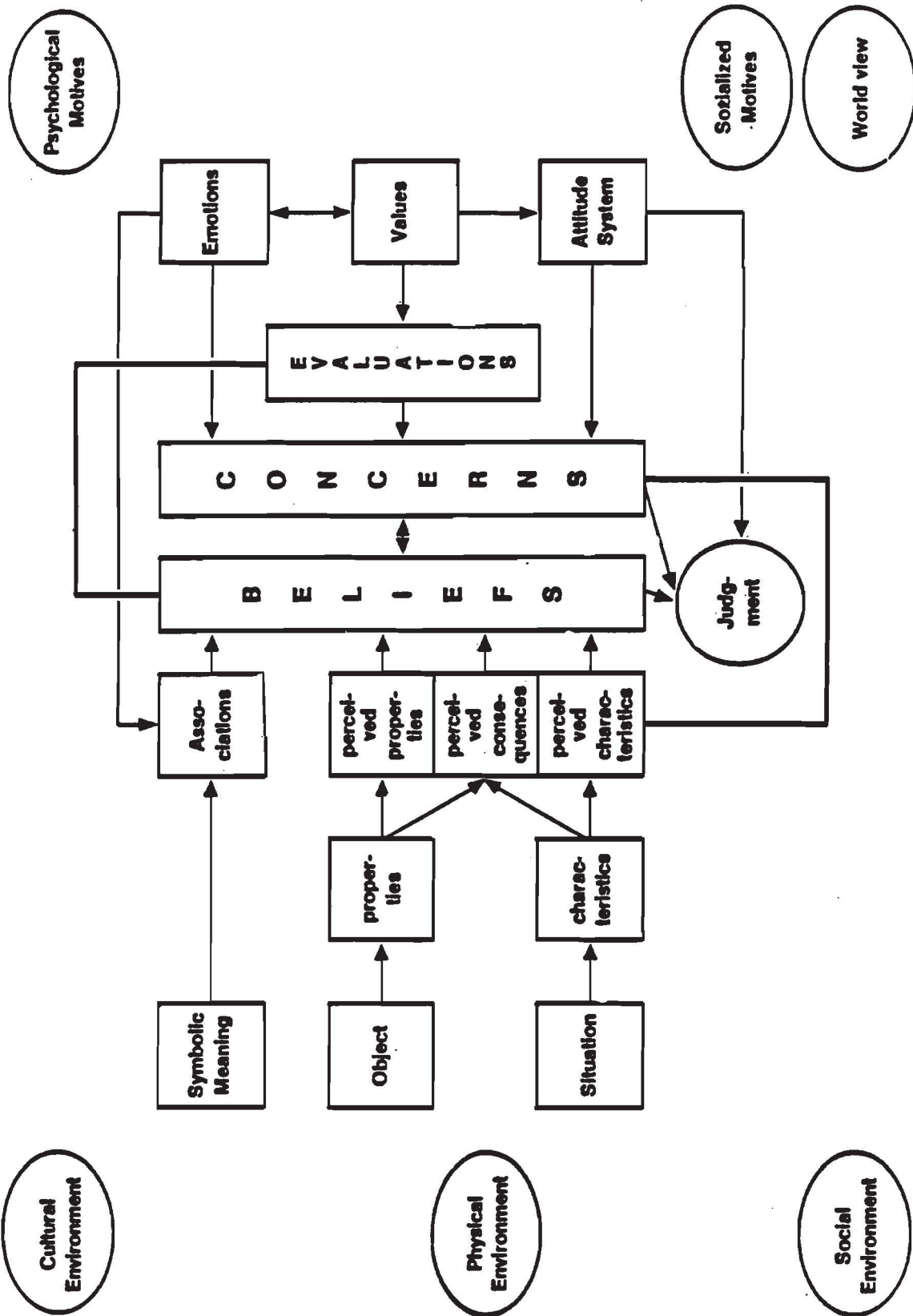


Figure 1 A conceptual framework of the interdependences between beliefs, concerns, values, and attitudes.

(symbolic meaning). The physical properties of the specific object and the characteristics of the situation are elements of the individual perception process. The perceived properties are not necessarily identical with the real properties. Limited access to information, intuitive selection filters, and preevaluations bias the perception process. In parallel with the perception of properties the social characteristics are assembled and perceived; both processes are combined in the subjective assessment of consequences that are associated with the object. Associations derived from the cultural context or from personal experience are also activated at this stage and are compared with the subjectively assessed consequences.

The next step refers to the phase of processing the perceived object properties, situational characteristics, predicted consequences, and associations into a belief system. The selection of what enters the belief system, the mode of abstraction from personal experience and mediated information in order to form generalized convictions, and the way of ordering the perceived items into salient clusters are influenced by the value orientations, emotions, and attitudes toward similar objects. In addition, general heuristics and personal style of reasoning have to be taken into account.

The last step refers to the process of balancing positive and negative beliefs, aiming toward a general evaluative judgment with respect to the object. For this purpose, beliefs are ordered according to their subjective importance, the judgments of reference groups are incorporated, the personal consequences of each possible judgment are assessed, and the possible outcomes are compared with earlier experience with similar objects.

This outline is, of course, just an analytical tool for understanding the process of attitude formation. The various stages are interlinked in the real world and proceed much more unconsciously, as pointed out here. However, it

represents a theoretical framework that helps to analyze our research concepts and the results of risk perception studies.

According to the analytical framework of object perception and attitude formation risk perception studies focus on three key questions:

- (1) What are the social goals, values, or motives that drive persons or social groups to attribute special concerns to specific risk sources?
- (2) In what way do people process information about risk sources, and what kind of logical structure and reasoning do they follow in arriving at an overall judgment on the acceptability of a perceived risk?
- (3) What kind of motivational or cognitive biases are incorporated when people select information from the various sources to which they have access, and why do they apparently violate their own rules of reasoning?

A more integrated approach to the investigation of risk perception can be developed by taking these three questions into account. For this purpose, we can divide risk perception studies into four rough categories: classical decision analysis, psychological decision theory, social-psychological judgment and attitude theory, and sociological concepts including policy analysis.

Classical decision analysis focuses on the rationality of the decision-making process under the assumption that we can make use of formal axioms to optimize our own judgment (Keeney and Raiffa, 1976). If we go a step further and demand that the optimization process be adapted to the individual metarational criteria of reasoning, this kind of research fits exactly into our key question (3) above.

Psychological decision theory (including social judgment theory) has put its emphasis on the individual process of common-sense reasoning, incorporating the social desirability of perceived consequences and specific motivational factors in

processing uncertainty (Hammond *et al.*, 1978). Research in this field can best be classified under key question (2), because its purpose is to head toward the individual process of understanding the representation and assimilation of perceived hazards and their probabilities, which leads to the formation of an overall judgment. Risk perception is being understood as a process of deriving attributes about specific objects from general social values and personal attitudes and linking these attributes to the perceived properties of the risk object or risk situation (Janis and Mann, 1977). This research lies on the borderline between key questions (1) and (2).

Finally, sociological research addresses the problem of group responses to risk and concentrates on the influence of social values, institutional constraints, reference group judgments, communication, and power interchange (Nelkin, 1977b; Otway and von Winterfeldt, 1982; Frederichs *et al.*, 1983). It is interesting to note that the sociological concepts of risk perception, in particular studies of power and pressure groups, have some features in common with the concepts of mathematical decision analysis – the other extreme of the scientific spectrum. Both concepts assume that individuals try to maximize their own utility (in sociological terms, their interest) and that objective measures can be identified to indicate whether individuals or groups are better or worse off after the risk has been taken. In decision theory the expected utility is an objective measure of a person's gain or loss; in sociological theory gain or loss of power is an objective yardstick for measuring social influence. In our framework sociological research deals primarily with key question (1).

*Table 1* gives an impression of the scope of scientific research in the field of risk perception. It should be acknowledged that the systematic overview simplifies the complex situation of risk research and ignores much of the conceptual differences within each class. For a more detailed classification reference should be



**Table 1** Classification of risk perception studies

<i>Research scope</i>	<i>Short description</i>	<i>General assumption</i>	<i>Application to risk perception</i>
Decision	Matching the decision process with normative model of rational reasoning	Maximizing utility of individuals or groups	Investigating the discrepancies between normative risk assessment and intuitive perception
Psychological decision theory	Analysis of the individual decision-making process	Existence of typical sequential structures to make judgments under uncertainty	Investigating the cognitive structure of the risk perception process
Social-psychological theory	Analysis of the social environment as a determinant for the decision-making process	Dominance of social influence factors in perceiving and evaluating risks	Investigating the influence of value commitments, social judgment, and communication processes on the individual decision-making process
Sociological theory	Effects and implications of social interrelations between groups and institutions on collective decision-making	Risk taking as an element of social exchange regarding resources and power	Investigating the interests and social positions which impose specific risk perception procedures

made to the corresponding literature (see Otway, 1977; Becker *et al.*, 1980; Covello, 1982; Royal Society, 1983; Renn, 1984).

### 3 RESULTS OF RISK PERCEPTION STUDIES

According to the various disciplines involved in risk perception research various conceptual frameworks have been used to determine the main factors that influence people's judgment on expected consequences and their likelihood. Researchers who work with utility concepts investigate predominantly the individual balancing procedure and intuitive heuristics that govern the process of assimilating and

evaluating information about risks. The most frequently applied instruments in this category of research studies are psychometric scales, semantic differentials, and correlation circles for determining spatial differences between various risks (Pellicier *et al.*, 1977; Fischhoff *et al.*, 1978; Vlek and Stallen, 1981; Pagés *et al.*, 1982).

Researchers who pursue the attitude concept are searching for salient beliefs and effects that determine the overall feeling of an individual toward the object and influence the willingness to take actions in correspondence with that feeling (Otway, 1980; Thomas *et al.*, 1980; Swaton and Renn, 1984). Attitude researchers usually use questionnaires to collect beliefs and affective patterns, which are later processed by factor analysis in order to detect the salient factors of risk perception.

Researchers who focus on value commitments and concerns analyze the course of social interaction between promoters and opponents of the new risk object or risk activity. They also observe the process of attitude formation as a function of avoiding dissonances between value orientations and the selective perception of information concerning properties of the risk object and the position and values of the people associated with the object. Within this research tradition surveys and direct observations are the most common instruments to analyze the causes of the development of various positions toward a risk source and to reveal the social constraints that filter the information that each individual is exposed to and which predetermines the willingness to take account of positive and negative consequences (Bechman *et al.*, 1981; Conrad, 1981a; Wynne, 1984).

In addition to these three basic concepts, more sociologically oriented approaches have to be mentioned which regard risk perception as an element of the continuous struggles of social groups for power and social influence (prestige, status, etc.). However, since this approach takes no interest in the investigation

of the underlying psychological and social factors of risk perception, it does not need a more specific consideration in this paper (Mazur, 1975; Nelkin, 1977a; Kutschelt, 1980; Douglas and Wildavsky, 1982).

The three perspectives of risk perception are not exclusive, but focus on different aspects of the perception process: the rationale of people to produce a balanced judgment, the genesis of beliefs about objects, and the social dynamics of processing and evaluating information. Hence it is not necessary to present the results of empirical studies separately for each research tradition. Rather, it seems appropriate to initiate a review based on a more fundamental insight into the individual process of forming beliefs about risk and risk sources, and to enlarge the discussion step by step with more remote factors, such as value orientations and trust in sources of information. Since the field of risk perception has become rather popular in recent years and numerous studies have been published, the following review can only address the highlights and discuss the main results. In order to be as brief and precise as possible, the review is organized as a collection of theses:

- (1) In general people do a good job in assessing the magnitude of a risk that is familiar to them. In principle they are quite aware of the threats and dangers to which they are exposed. *Figure 2* shows the results of two surveys, one American and one German. A random sample of persons in Germany and several groups in the USA were asked to estimate the average losses per year from various sources of hazard: estimated values are plotted on the  $y$  axis and the actual statistical figures on the  $x$  axis. There is a general tendency, in both the USA and Germany, to overestimate low risks and underestimate high risks, although the German sample tends rather to exaggerate the real figures. Nonetheless, the extent of agreement between estimated and actual values is fairly high (Lichtenstein *et al.*, 1978; Slovic *et al.*, 1979; Renn and

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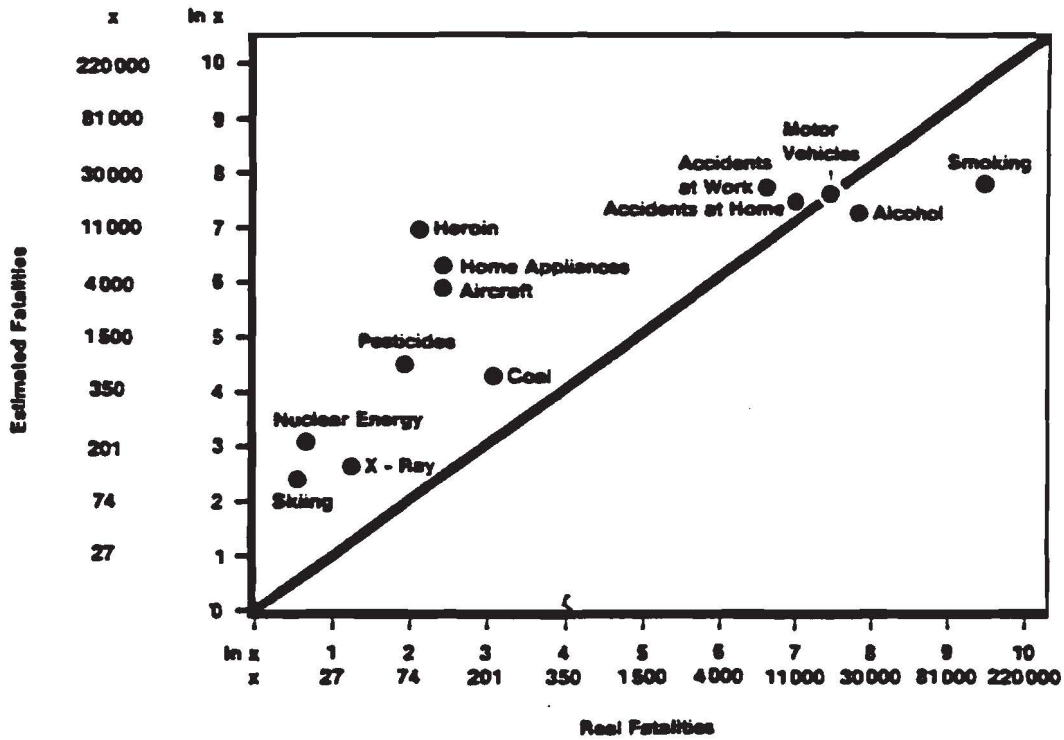
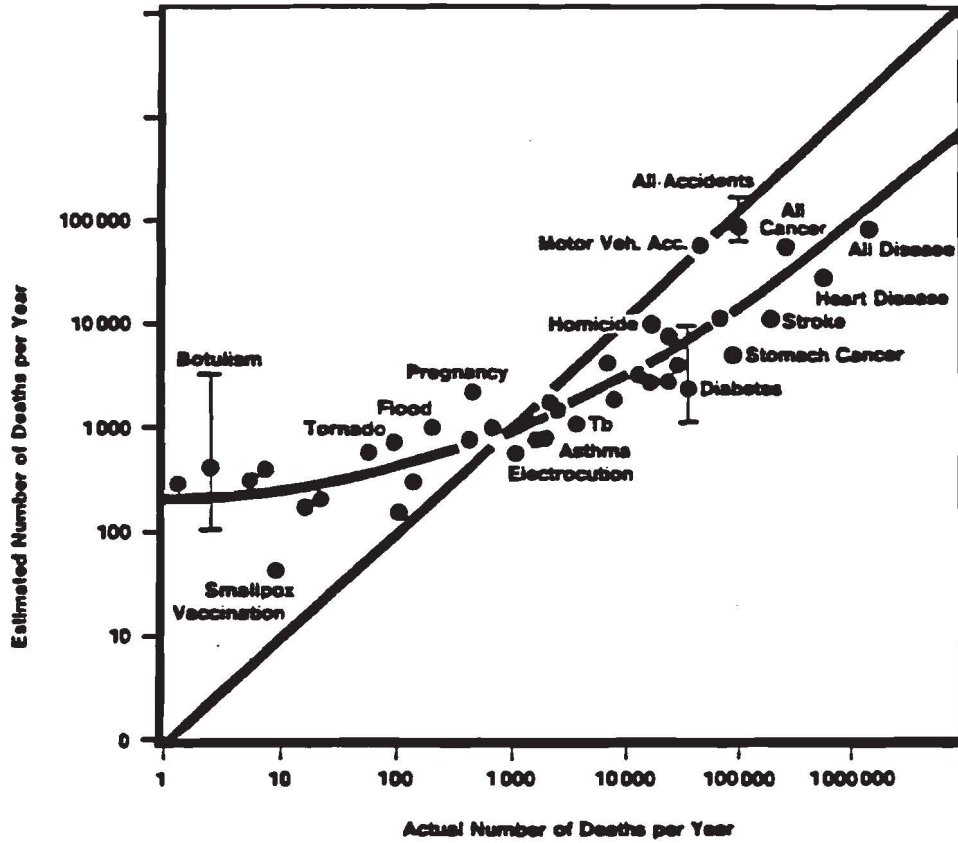


Figure 2 Respondents' estimated number of losses for the various risk sources compared with the statistically computed values. The upper graph shows the results of an American poll and the lower graph those of a German poll.

Peters, 1982).

- (2) The intuitive ability to determine the order of magnitude of risk disappears as soon as questions are asked relating to the number of lives lost in a catastrophic year, to be expected once during the span of a lifetime. Either all risk sources are graded almost uniformly, assigning around 3000 losses for each risk source, or exorbitant estimates are made, e.g., an average of 22000 deaths for drug abuse, 4000 for skiing accidents, and as many as 600000 deaths caused by nuclear power (all these figures are related to the Federal Republic of Germany) (Renn, 1981). When estimates are made for a normal average year, experience and common sense can bring about a relatively good approximation of the statistical values. However, when questions are related to disasters that can be expected over 80–100 years, the intuitive evaluation processes will not function since the extent of catastrophes cannot be drawn directly from a person's own experience (Slovic *et al.*, 1979; Renn, 1981; von Winterfeldt *et al.*, 1981).
- (3) If statistical or intuitively estimated values for expected losses are related to the intuitive rating of the benefit level, or to a risk–benefit ratio, an astonishing result is obtained. Presumed loss rates per year and risk perception (also risk–benefit perception) are practically independent of each other, i.e., most people do not assess risk sources according to the presumed losses per year but concentrate on other points of view (Renn and Peters, 1982). This insight is true not only of the German interviewers; American, English, French, and Australian studies confirm the low correlation between the public's loss estimation and risk perception (Slovic *et al.*, 1979; Glennon, 1980; Pagés *et al.*, 1982; Royal Society, 1983). Thus most people are more or less aware of the expected value of well-known risks; however, the expected values are merely one factor among many in the perception of these risks and,

as correlation analyses show, a factor with only slight explanatory value.

- (4) Most people are not familiar with the rationale of probability. When the probabilities of adverse effects are not intuitively comprehensible (as in the unlikely example of a jumbo jet crashing into a football stadium), the perceived degree of riskiness is likely to be related to the worst imagined accident. If the imagination of catastrophes is enhanced by media coverage, the negative risk perception is further reinforced. This coping mechanism tends to evoke high sensitivity for low probability-high consequence risks and a strong degree of disinterest in high probability-low consequence risks (Tversky and Kahnemann, 1974; Ross, 1977; Jungermann, 1982).
- (5) The attendant circumstances, i.e., the way in which people are exposed to a certain risk, are considered in the literature as qualitative features which influence the perception process. According to the investigations of Slovic and coworkers, three main factors shape the intuitive assimilation of risk-related information: the severity of losses when they occur (dread), the familiarity with the risk, and the "degree of personnel exposure" (societal versus personal risk-taking) (Slovic *et al.*, 1980, 1981). Studies of the quality of hazards lead to similar results. The Dutch researchers Vlek and Stallen came to the conclusion that risk perception is dependent on the "size of a potential accident" and on the perceived "degree of organized safety" (Vlek and Stallen, 1981, pp 235 *ff.*). Green and Brown report a high preoccupation of people for natural versus man-made risks, necessary versus unnecessary activities, major consequences versus minor impacts, personal control versus out of control, and easy versus difficult to escape (Green and Brown, 1980; Perusse, 1980). In contrast with the above studies, which use aggregational procedures for all risk sources in order to reveal universal factors for characterizing risk qualities, the studies by Gardner *et al.* (1980, pp 26 *ff.*) and by

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Renn (1981) were designed to analyze the independence of qualitative characteristics for each risk source (Renn, 1981). *Figure 3* shows the significance of individual qualitative features to the evaluation of the risk in question for nine risk sources. The corresponding correlation coefficient is on the  $y$  axis, i.e., the intensity of the relationship is depicted, and boxes with individual feature classes for nine different risk sources are given on the  $x$  axis.

If we first consider the primary factors, i.e., the features that exert the greatest influence on risk evaluation, it becomes apparent that benefit-related points of view predominate. People first of all evaluate risks according to the possibilities and accompanying circumstances of their application, e.g., whether they themselves can profit from them, whether they are of benefit to everyone or only a minority, and whether there are not further alternatives that provide the same benefit with less risk. In the case of nuclear energy, pesticides, and electrical appliances the emphasis is on risk features. Whereas the voluntariness of utilization brings about a positive weighting of the concomitant risk in the case of electrical appliances, the dominance of the factor "catastrophic consequences possible" in the case of nuclear energy and "possibilities of long-term damage" in the case of pesticides has a negative effect on risk perception. It is thus clear that statistical loss rates are not the decisive motives for skepticism toward nuclear energy and pesticides.

- (6) Apart from qualitative risk features, which are believed to be universal factors in the risk perception process, research has been conducted to find salient clusters of beliefs relating to different sources of risk. Large-scale experiments carried out by the Risk Assessment Group of the International Atomic Energy Agency, Vienna, showed that people classify their attitudes toward energy systems according to the following criteria: indirect effects from the risk source (e.g., health hazards); economic benefits (e.g., increase

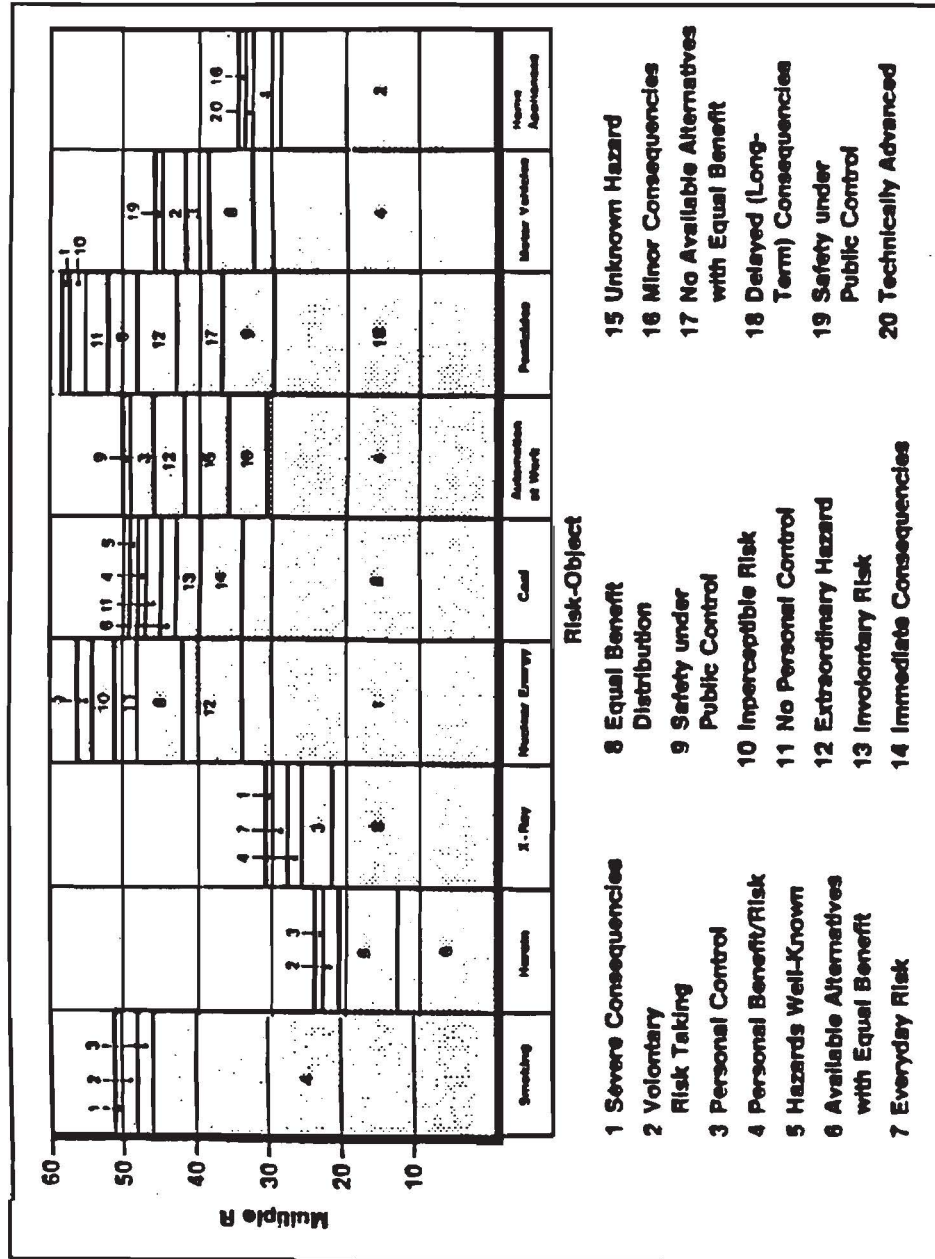


Figure 3 The influence of qualitative risk and benefit characteristics on the general perception of risk and benefit from various risk sources (multiple correlation coefficient).



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in the national income); environmental risks (e.g., pollution); psychological and physical implications (e.g., capacity for control of the risk, artificiality of the risk source); effect on social and technical progress (e.g., providing security of supply, social leveling). These five dimensions in attitudes were obtained on the basis of the results of surveys of the assessment of various energy systems (Otway, 1980; Thomas, 1981). Since energy systems only cover some of the possible risk sources, we conducted a similar experiment in the form of an intensive survey involving 12 different types of risk source. The aim was to discover the most important attitudes and their systematic structure. Various statistical procedures were used to trace the attitudes subjected to enquiry back to their central basic pattern (factor analysis) and comparable sets of factors were developed by means of aggregation. This interpretation gave rise to an allocation and, finally, to an evaluation of risk sources under the following five points:

- (i) Effects on the person himself and on the social environment (health, supply level, security, etc.).
- (ii) Extent to which persons are directly affected (personal benefits, damage, comfort, well-being, liberty, etc.).
- (iii) Effects on economic and social welfare (employment market, social leveling, general standard of living, quality of life, etc.).
- (iv) Sociopolitical and social values (social justice, democratic rights, equal distribution of benefits and detriments, etc.).
- (v) Effects on the conditions for coping with the future (maintaining output level, defense of liberty, ensuring supply level, etc.).

Not all of these five criteria are brought to bear for every risk source and the significance of the individual factors varies greatly. In order to obtain an overall view of the intensity and composition of the five criteria for various risk sources, the average values of the individual factors have been compiled for six risk sources in *Figure 4*. The bars that extend below the zero line show negative estimations with respect to the risk source under consideration, while the bars above the zero line show the corresponding positive evaluations (Renn, 1981).

- (7) People seem to avoid risks that pose a pending danger to them. The randomness of occurrence is perceived as a potential threat because a dangerous situation might occur at a time when the individual is not prepared to react in an appropriate manner. Instinctively, human beings react to dangerous situations with the responses of aggression, escape, or playing dead. If a dangerous situation is to be expected, stress is likely to occur so that the instinctive reaction can be performed fast and almost automatically. Stress, however, cannot be sustained over an extended period of time. Therefore, people feel uneasy if a dangerous situation can occur at any time without prior notice. In this situation they prefer risk avoidance behavior. If they cannot initiate action to move away from the dangerous situation, they demand collective regulation as a means of maintaining control over the impending danger. This aversion to randomly occurring hazards is not related to any probability, but just to the nature of randomness. The feeling of uneasiness is reinforced if people have the impression that there will be no time to flee or protect themselves against the potential hazard (Green and Brown, 1980; Perrow, 1984).
- (8) Risk refers to a compound judgment constructed on the assessment of personal utilities and associations with the risk source. This explains some of the

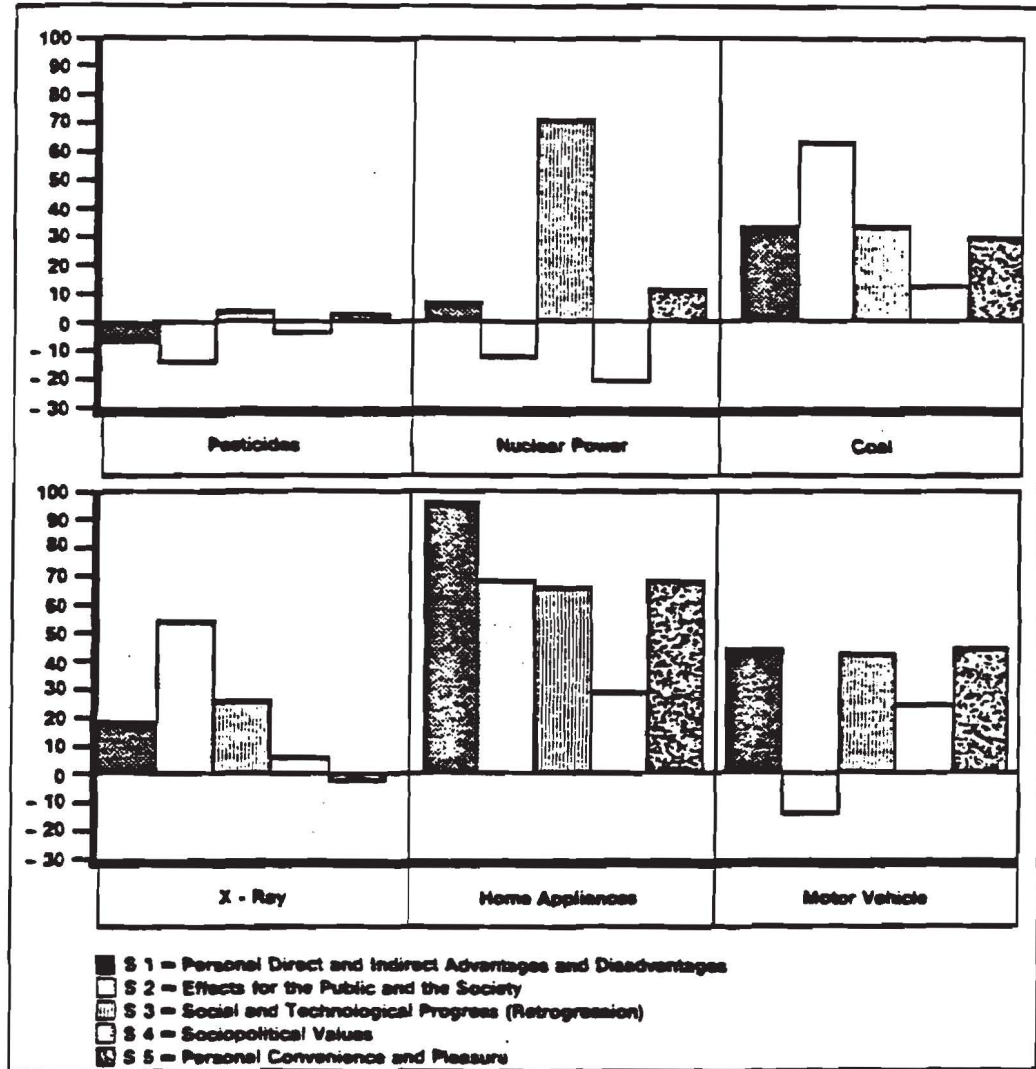


Figure 4 Importance of five belief clusters with respect to estimates of the risks of various technologies.

difficulties that experts encounter when applying risk comparisons in public. Risk in connection with skiing, for example, has a different connotation from risk related to nuclear energy. Risk in the former application is perceived as a peculiar thrill to the individual. In the latter case, however, nuclear energy is perceived as a threat to personal health. Any attempts locally to compare the two risks fail to convince anyone except the risk expert (Gardner *et al.*, 1980; Renn, 1985).

- (9) People are willing to accept risks more frequently if they feel that risks and benefits are distributed equally. Thus justice is a key factor in risk perception. When risks are confined to an identifiable population (e.g., the neighborhood in the vicinity of a hazardous waste disposal site), this population is likely to respond negatively to them. The notion of justice implies two categories: equity of risk and benefit distribution, and exclusiveness of exposure to risks or benefits (Keeney, 1980; Renn, 1984).
- (10) In general, it has been proved that value orientation and the general attitude system will increasingly influence risk perception if the risk sources have already undergone politicization. For example, scientists of the Arbeitsgruppe Angewandte Systemanalyse (Working Group on Applied Systems Analysis), Karlsruhe, discovered that the formation of judgments on nuclear energy strongly depends on the value orientation of the individual (more materialistic, more postmaterialistic, more environmentally conscious) which, however, has practically no bearing on the perception of coal (Frederichs *et al.*, 1983). With respect to nuclear energy a relationship between value orientation and risk assessment was also revealed in studies performed by Renn. Even if general value orientation – similar to the studies carried out by the Social Science Research Centre, Los Angeles (von Winterfeldt *et al.*, 1980) – is hardly directly related to the determining factors of risk perception, it

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nevertheless codetermines the perception process indirectly via the formation of related attitudinal patterns (Renn, 1981). With regard to perception of the nuclear energy risk, the perceived risk level is particularly influenced by five sociopolitical attitudes (*Figure 5*). Low confidence in statements by scientists and technologists combined with a high priority for environmental protection produce a more negative perception of nuclear energy risks at the outset. Conversely, confidence in science and technology and a low degree of environmental awareness represent an attitude that, from the start, tends to develop positive expected values. However, there is no deterministic relationship between attitudes in the sociopolitical field and those toward nuclear energy.

- (11) The credibility of the source of information about risks and risk sources has turned out to be a crucial factor in risk perception. If a person distrusts the source of information, he or she is more inclined to pay attention to counter-information and to demonstrate a risk-averse behavior in order to be on the safe side. In particular, scientific dissent and politicization with respect to risk sources lead to a risk perception process that is highly governed by sympathies and value commitments in favor of one of the involved parties. Symbolic beliefs are substitutes for instrumental considerations (Tubiana, 1979; Wünschmann, 1984). However, the perception of objects does not depend solely or even primarily on widely acceptable solutions within the scientific system. First, scientific dissent will only have an impact on public perception if scientists themselves regard the issue as political and therefore transfer the dispute into a public debate. Second, the general public will only be aware of any scientific dispute if its consequences affect either their own living conditions or their belief system. Thus it is essential that the perceived consequences of any technology are evaluated as salient with respect to the

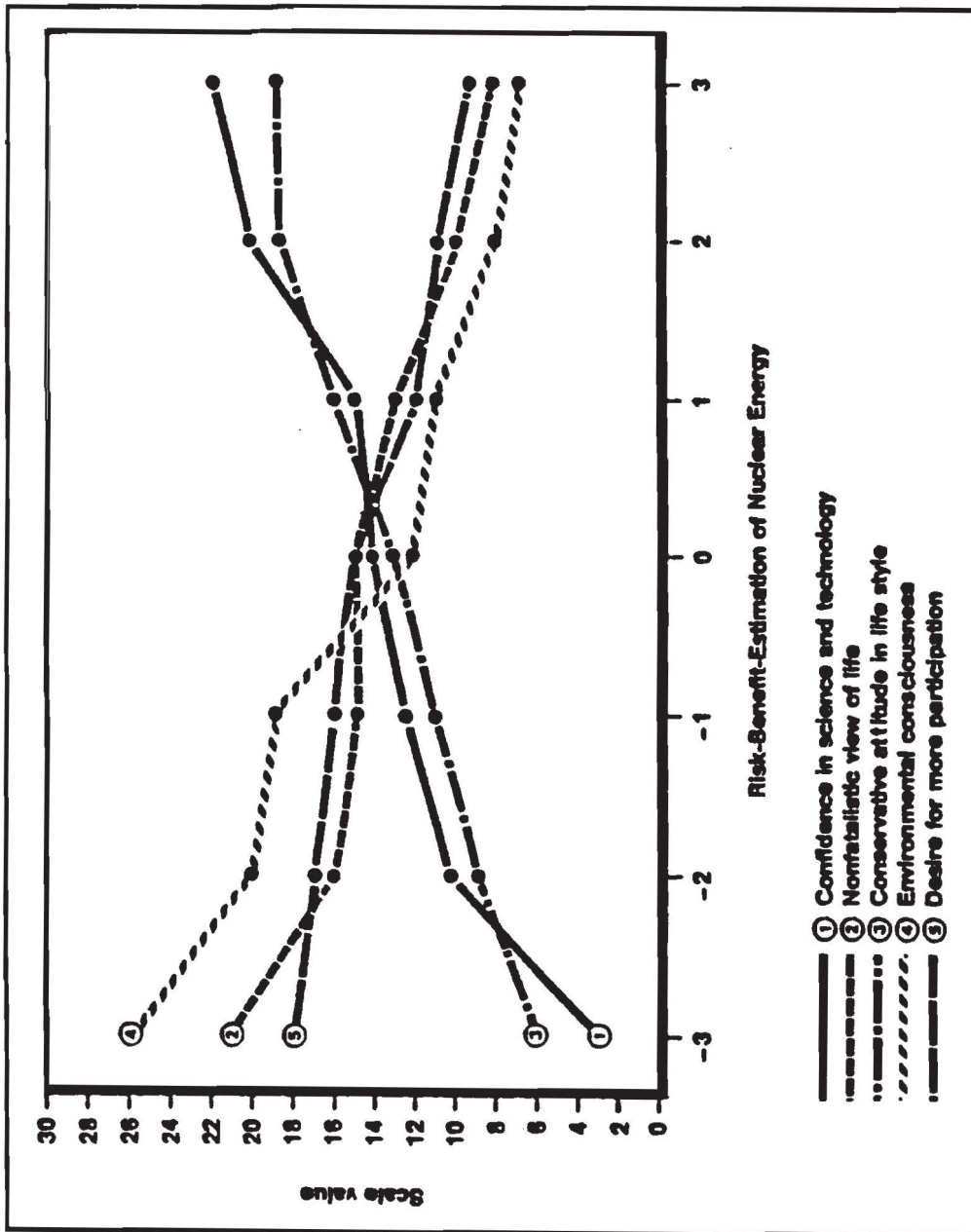


Figure 5 The perceived risk-benefit ratio of nuclear power as a function of five sociopolitical attitudes ( $x$  axis, degree of risk-benefit ratio;  $y$  axis, strength of attitude).

individual formation of attitudes before an issue gains political weight. Finally, empirical studies by Renn (1981) on the loss of credibility by social institutions involved in the peaceful use of nuclear energy show that, despite the loss of confidence in science and politics, a maximum degree of credibility continues to be given to scientists working in the field of nuclear research and in universities as well as to the pertinent politicians (e.g., Minister of Research and Technology). This statement applies to both proponents and opponents of nuclear energy.

#### **4 CONCLUSIONS**

The aim of this paper was to review the state of the art in the field of risk perception with specific emphasis on European studies. As in any review a selection has had to be made with respect to the concepts, the analytical frameworks, and the empirical results reported. The review is certainly biased by the author's subjective preferences and interpretations, but an attempt was made to include all relevant information and to put the results of the research studies in perspective. Only a small fraction of the empirical research conducted could be presented in order to keep the paper brief and concise, but enough cross references have been given for those who want to study the formation of risk perception more intensively.

What has been learned from the numerous studies of risk perception? Among the major results of the risk perception studies conducted by psychologists, sociologists, and decision analysts, the following have immediate impact on the process of risk management and policymaking:

- (1) The expected losses over time are only one, and even a minor, element of the public perception of risk. Even the catastrophe potential cannot be regarded

as decisive in the sense that the number of perceived victims in a disaster is related to the degree of the perceived riskiness. Rather, subjective probability regarding the strength of belief that a catastrophe can happen is one of the main characteristics that people apply in judging the magnitude of risk.

- (2) Two kinds of variables are found to be important for the process of risk perception: qualitative risk characteristics and beliefs about the risk source. People will pay special attention to risks that are perceived as dreadful, involuntary, unaccustomed, and personally uncontrollable, and will be eager to obtain more information about the risk source.
- (3) Beliefs about risk sources vary from risk to risk. There is no universal threshold for risk acceptance either for different risk sources perceived by a single individual or for a single risk source assessed by different individuals.
- (4) Social, psychological, and sociological studies show that judgments of risky technologies or activities depend not only on psychological factors like those mentioned above but also on reference group judgments, salient beliefs about the risk source, degree of loyalty toward official policymakers, and commitment to social values and cultural ideas. Since all these factors, including the psychological ones, are interrelated and sometimes reflect mere post-rationalizations of unconscious feelings and social constraints, it is very difficult to set up a reliable model of how people actually perceive and evaluate risks. What we know is what matters, and partly to what degree it matters, but analysts are still searching for a theory that can explain the process of people's judgment on risks.

What, in the light of these premises, are the main lessons for policymakers on risk management considering the results of perception studies so far?



Primarily, it has become evident that the artificially constructed contrast between the rational assessment of experts and the supposedly irrational assessment of laymen has not only disguised the true relationships in the current discussion about risk, but has also put considerable difficulties in the way of the dialogue between the two sides. The technological calculation of risk dimensions must be regarded as an important component of any decision concerning risk sources and is also an ideal instrument for constantly improving the safety measures for protecting the public. However, the public is not disputing the fact! To make calculations of this kind the sole criterion for "acceptability" and/or "desirability" of technologies or of other civilizing risk sources, however, contradicts the intuitive view of risk acceptance and is also unreasonable from political and social standpoints. This should not be misunderstood as a plea for substituting scientific risk assessment with risk perception analysis. The analysis of perception has also demonstrated that the assimilation of uncertainty and the intuitive mechanisms for coping with risks are biased by heuristics, personal experience, media coverage, and other factors. Modern societies cannot afford to substitute science with common sense.

If the purpose of science is to explain and predict phenomena, we can expect scientists to make a better job of prediction than other people. Otherwise science would be superfluous. Scientists have a better access to the collected general experience of society (empirical knowledge) and are better trained to use systematic and consistent models of extrapolating past experience (methodological knowledge). The superior degree of accuracy does not mean, however, that experts are not susceptible to cognitive biases, errors, or misperceptions, but that they are less so than all the other members of society [*cf.* the model of graduated rationality given by Renn (1981)].

Therefore, risk management has to incorporate the results of risk perception studies in two ways:

- (1) First, the dimensions of each risk source or class of risk sources that are perceived as potential violations of the individual's own values or interests.
- (2) Second, the prevalent trade-offs between conflicting values, e.g., cost versus environment, which reflects the desire of each citizen for the living conditions preferred in the future.

In a pluralistic society the values of each citizen should have the same impact on policymaking as those of experts or policymakers. The technical approach adopts those values that experts deem to be adequate with respect to the problem. However, such an adequacy does not exist. The decision analytic approach feeds in the values of the client, usually the regulator. His or her values are either homemade or reflect the regulator's perception of what the public really wants. Asking the public directly seems to be the optimal solution, but is not as easy as it sounds. Values and beliefs are interrelated. If beliefs are erroneous or their underlying cognitive heuristics are biased, many values formed in accordance with theory are distorted. Innovative survey methods combining attitude measurements, information, and participation have to be developed to meet this new challenge to social science. A first attempt in this direction has been made by a research team at the Nuclear Research Center, Jülich, and the University of Wuppertal who have used the method of "planning cells" to investigate the preferences of ordinary citizens for future policies on risk management (Dienel, 1980; Renn *et al.*, 1984).

Risk perception is a complex phenomenon that requires more investigations on a multidisciplinary scientific level. For the purpose of risk management it is essential to understand the structure of perception and to recognize the concerns

that underlie the overt resistance against modern technologies that impose risks on the public.

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