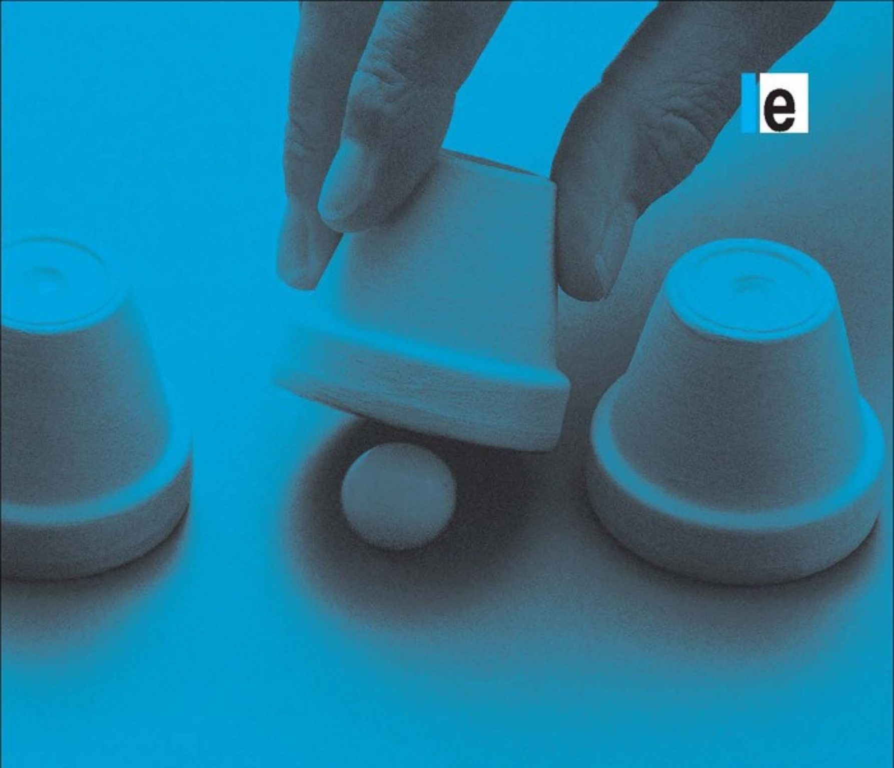

Risk Governance

Coping with Uncertainty in a Complex World

Ortwin Renn

Risk Governance

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Ortwin Renn

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Dedicated to my children Silvia, Marius and Fabian
so that they may enjoy a more sustainable world to live in

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Introduction

'Risk and society' has been a topic that has fascinated me from the beginning of my professional career. I still remember when, during my graduate studies at Cologne University, I visited my sociology professor Erwin K. Scheuch and asked for his advice in choosing a topic for my Masters thesis. He gave me two options: one, to write about the change in social welfare concepts in the now defunct German Democratic Republic (the former communist East Germany); or, two, to write about the protests against a nuclear power plant that were then starting in the small town of Wyhl in southern Germany. Had I selected the first option my professional life would probably have gone in a totally different direction. For no special reason I selected the second option, not knowing at that time that this topic would start a lifelong obsession with the issue of social responses to risk and uncertainty.

Why is this topic so fascinating? First of all, risk is paramount to our understanding of human agency. All social sciences are based on the assumption that human beings have agency and that they can choose from a variety of behavioural options. Agency presupposes that human beings are capable of acting in a strategic fashion by linking decisions with outcomes. Humans are goal oriented; they have options for action available and select options that they consider appropriate to reach their goals. Selecting options implies that humans consider and weigh the opportunities and risks that are linked with each option. Thinking about 'what could happen' is one of the major distinctions between instinctive and deliberate actions. German sociologist Niklas Luhmann has postulated that human behaviour can only be understood if we know and explore what options (or, in the words of Luhmann, what contingencies) the actors considered before making their choice (Luhmann, 1990). The many hypothetical futures that were not selected are often more important for understanding social responses to specific phenomena than the actual response to any particular phenomenon.

Second, risk plays a major role in most contemporary theories about modern or post-modern societies. Not by chance did Ulrich Beck call his famous book on reflexive modernity *The Risk Society* (Beck, 1986, 1992b). In this book, Beck made the following major claims (cf. summary in Renn et al, 2007, pp51–53):

- The unintended and often unforeseeable negative side effects of collective decisions, particularly those pertaining to the use of large-scale technology and industrial processes, outweigh the intended positive consequences or, at least, threaten to outweigh them. Collective actions cannot be legitimized by their positive intentions and the underlying technological promises alone, but rely more and more on institutional assurances of adequate risk management.
- Risk has replaced capital as the main resource for capitalist expansion. By spreading risks over a larger population and externalizing the unintended consequences of production to third parties, profits of private enterprises can be sustained in a competitive market situation.
- Risk acceptability is more dependent upon the perception of distributive justice than upon the perception of risk magnitude.
- Organizations in industry and governments have developed routines for taking up the task of providing risk management. As a result, however, these routines tend to de-emphasize responsibility and accountability.
- Technical risk assessments (based on the concept of combining probability and magnitude) constitute legitimization strategies for justifying the creation of ubiquitous risks and lure people into accepting threats to their lives and livelihoods that they would not accept on the basis of their intuitive feelings.

Beck's main points have caused a widespread debate about the nature of risk in modern societies, involving leading social scientists and risk professionals all over the world. As problematic as some of his assumptions may have been (as I will explain later in this book), the proposition that risk is an essential part of modern society has been adopted by many scholars and has inspired many analyses about the foundation of modernization and the evolution of governance structures relating to managing uncertainties in a world full of contingencies.

Third, risk is not just a fascinating academic subject; it has a direct impact upon our life. People die, suffer, get ill or experience serious losses because they have ignored or misjudged risks, miscalculated the uncertainties or had too much confidence in their ability to master dangerous situations. The institutional means of societies to deal with risks have direct, and often painful, consequences for each individual affected by collective actions and arrangements. Questions about the nature of risk, the social construction of risk issues, and the cultural difference in conceptualizing and understanding risk have influenced contemporary philosophical thinking and social science research. However, responses to these questions do not have only academic value; they influence the experience of harm among individuals and social groups. There are few areas in the social sciences where theoretical and often quite abstract concepts and ideas have forged a direct link with experienced physical consequences. Risk is a notable exception. It cannot be confined to the ivory tower of scholarly deliberations. It clearly affects the lives and livelihoods of humans all over the world.

Fourth, risk is a truly interdisciplinary, if not transdisciplinary, phenomenon. Risk is a popular topic in many sciences: aspects of risk are studied in the natural, medical, engineering, social, cultural, economic and legal disciplines. Yet, none of these disciplines can grasp the entire substance of this issue; only if they combine forces can one expect an adequate approach to understanding and managing risks. Investigating risks necessitates a multidisciplinary approach. Risk is like a polished gem with different facets: each facet reflects the light in different colours; but the whole gem can be appreciated only if the images of all the facets are being absorbed. Often, difficult questions about risks depend upon a transdisciplinary vision of the risk concept: representatives of several disciplines need to agree about a common methodology and research agenda. Risk has been one of the catalysts for this type of research. The most telling example is the research on risks referring to global climate change, where multiple disciplines need to develop integrative approaches to studying the environment and predicting changes that will have major implications for human well-being (van de Kerkhof, 2004).

Lastly, risk is a concept that links the professional with the private person. This may be true only for me. But I have personally benefited from my professional obsession over the last 30 years. Thinking about risks has changed my attitude towards life. I am less worried than many other people about bad things that could happen to me because I know how rare they are. At the same time, however, I have been practising prudent avoidance with respect to those insidious risks that create little benefit or thrill but could trigger considerable harm. I have developed a sense of calmness and tranquillity about my personal activities as I have acknowledged that my personal fate depends upon a combination of randomness (which I am unable to change) and of personal agency (where I am accountable, but not infallible). In addition, studying expert judgements and people's perceptions on risk has given me a healthy degree of scepticism with respect to professional expertise (including my own) and a good appreciation of people's intuition, without demonizing the first and idealizing the second. My basic conviction that ordinary citizens are able and willing to make difficult trade-offs and design reasonable policies for risk-taking has influenced and inspired my work on public participation. My critical appreciation for the hard sciences – fuelled by sincere admiration for their accomplishments and by cautious scepticism towards their claims of representing the truth – have enlightened my conceptual work on the nature of risk and the challenges that accompany our quest for objective representation of pending threats.

The main purpose of this book is to communicate much of the experienced enthusiasm and dedication that I feel about this topic to an audience who may be familiar with some aspects of risk but would like to have a more holistic or comprehensive picture. The idea behind this book is to illuminate as many of the facets of our polished gem as I am able to see. Although risks are normally associated with pain and harm, dealing with this issue can provide much satisfaction and even pleasure. As a physician may be able to understand a mysterious disease and thus treat it in all its complex symptoms, so thinking about risk helps a person to reveal much insight about one's own thinking, to explore hidden structures of mental processes and behaviour, and to gain more knowledge about institutional responses to common challenges. This book is meant as an invitation to follow me on these different alleys.

Each chapter is introduced by a text that is adapted from a recent document on risk governance that I prepared for the International Risk Governance Council (IRGC, 2005), which provides a systematic introduction to each phase of handling risk, starting with the pre-assessment and ending with communication and public participation. In this volume, the introductory part of each chapter explains the main terms, summarizes the major findings, and demonstrates the use of these findings for practical risk assessment or management purposes. After this introductory part, most chapters contain either one or two specific essays on the main topics that were covered in the introductory summaries. Readers who have little interest in the topic of one chapter might focus their attention on the introductory remarks only and ignore the essays that follow; other readers who would like to know more about the subject are invited to explore the content of the essays, which provide additional insights and often practical advice. The chapters on more specific areas are sandwiched between a general introduction into the field of risk research in the beginning and some final conclusions at the end. Since all chapters and essays can be read independently of each other, there is some replication that cannot be avoided.

In the tradition of the Earthscan Risk in Society series, most of the essays have been published before. But all essays have been revised, some of them considerably, not only to demonstrate that over the years I have accumulated more knowledge and wisdom, but also to make this book consistent, appealing and non-redundant. The sources of the original publications are mentioned in a note on the first page of each essay.

I would like to acknowledge the assistance of those individuals who have provided comments, critical remarks, inspirations, ideas and editorial improvements. I am particularly grateful to my colleagues Terje Aven, Chris Bunting, Robin Cantor, Jean-Pierre Contzen, Marion Dreyer, Alexander Jaeger, Andreas Klinke, Wolfgang Kroeger, Howard Kunreuther, Caroline Kuenzi, Ragnar Löfstedt, Granger Morgan, Warner North, Eugene Rosa, Pia-Johanna Schweizer, Katherine D. Walker and Marjolein van Asselt for their constructive criticism and suggestions. I am deeply indebted to the International Risk Governance Council (IRGC) for their financial support and the permission to use material, tables and figures from their publications. Financial support was also provided by the German Federal Ministry of Research and Technology. I would also like to thank Charlotte Reule-Giles for a thorough language editing of the entire manuscript and for helping me to make the text more readable. Last but not least I would like to express my

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Ortwin Renn
Stuttgart, Germany
2008

List of Acronyms and Abbreviations

AIDS	acquired immune deficiency syndrome
ALARA	as low as reasonably achievable
ALARP	as low as reasonably practicable
BACT	best available control technology
BSE	bovine spongiform encephalopathy
CFC	chlorofluorocarbon
CMR	carcinogenic, mutagenic or toxic to reproduction
EP	exceedance probability
EPA	US Environmental Protection Agency
EU	European Union
GIS	geographic information systems
GMO	genetically modified organism
IPCC	Intergovernmental Panel on Climate Change
IPCS	International Programme on Chemical Safety
IRGC	International Risk Governance Council
LNG	liquid natural gas
maximin	maximizing the minimum gain
MAU	multi-attribute utility
minimax	minimizing the maximum possible loss
NGO	non-governmental organization
NOAEL	no-observed-adverse-effect-level
NRC	National Research Council
OECD	Organisation for Economic Co-operation and Development
PBT	persistent, bio-accumulative and toxic
PCB	polychlorinated biphenyl
POP	persistent organic pollutant
PRA	probabilistic risk assessment
RAP	rational actor paradigm (based on rational choice theory)
REACH	Registration, Evaluation and Authorization of Chemicals

SARS	severe acute respiratory syndrome
SDS	safety data sheet
SEU	subjectively expected utility
SME	small- and medium-sized enterprise
UK	United Kingdom
US	United States
vPvB	very persistent and very bio-accumulative
WBGU	Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen (German Advisory Council on Global Change)
WHO	World Health Organization
WTO	World Trade Organization

1

What Is Risk?

Risk is more than risk: What are we talking about?[1]

Today's society seems to be preoccupied with the notion of risk. The recent examples – BSE in Europe, the Indian Ocean tsunami, the cyclone in Burma (Myanmar), to name just a few – have gained much attention from the public and have given rise to a growing discontent between the public's desire to see risks reduced and the actual performance of risk management institutions. What do we mean when we use the word risk? Is there anything special about risk that makes it such an important issue in contemporary politics?

All concepts of risk have one element in common: the distinction between possible and chosen action (Renn, 1992b). Philosophers call this contingency. At any time, an individual, an organization or a society, as a whole, faces several options for taking action (including doing nothing), each of which is associated with potential positive or negative consequences. If option A is not taken, a possible future pathway is (deliberately) excluded. Sometimes a decision can be reversed if the consequences turn out to be worse than expected and the original choice situation can be restored; but there is never a possibility to start all over again. A decision reversal always represents a new decision under new circumstances. Thinking about risks helps people to select the option that promises at least a marginal benefit compared to all other available options. Humans have the ability to design different futures (i.e. construct scenarios that serve as tools for the human mind in order to anticipate consequences in advance and to change, within the constraints of nature and culture, their course of actions accordingly). If the future were either predetermined or independent of today's human activities, the term 'risk' would make no sense. This may seem obvious to modern readers, but only in the context of fairly recent developments in our own culture, and contrasts sharply with more fatalistic views of nature and society.

If the contingent nature of our actions is taken for granted, the term 'risk' denotes the possibility that an undesirable state of reality (adverse effects) may occur as a result of natural events or human activities (definition originally in Kates et al, 1985, p21). This definition implies that humans can, and will, make causal connections between actions (or events). They can be altered either by modifying the initiating activity or event, or by mitigating the impacts. The definition of risk therefore contains three elements: outcomes that have an impact upon what humans value; the possibility of occurrence (uncertainty); and a formula to combine both elements. Outcomes can, in principle, be positive or negative, depending upon the values that people associate with them. For the purpose of this book and in accordance with our definition above, we will focus here on the negative outcomes of actions or events.

In addition to the strength and likelihood of these consequences, other aspects of risk need special attention – for example, the distribution of risks over time, space and populations. In particular, the timescale of adverse effects appearing in specific time intervals is very important and links risk governance to sustainable development (delayed effects).

Social constructivism versus realism

There is a major debate among risk professionals about the nature of risks: are risks social constructions or real phenomena? The issue here is whether technical risk estimates represent 'objective' probabilities of harm or only reflect the conventions of an elite group of professional risk assessors that may claim no more degree of validity or universality than competing estimates of stakeholder groups or the lay public.[2] Furthermore, different cultures may have different mental representations of what they regard as 'risks' independent of the magnitude or probability of harm. On first glance it is obvious that risks constitute *mental models* (OECD, 2003a, p67). They are not real phenomena, but originate in the human mind. Actors, however, creatively arrange and reassemble signals that they get from the 'real world', providing structure and guidance to an ongoing process of reality enactment.[3] Therefore, risks represent what people observe in reality and what they experience. The link between risk as a mental concept and reality is forged through the experience of actual harm (the consequence of risk) in the sense that human lives are lost, health impacts can be observed, the environment is damaged or buildings collapse. The invention of risk as a mental construct is contingent upon the belief that human action can prevent harm in advance.

The status of risk as a mental model has major implications for how risk is perceived. Unlike trees or houses, one cannot scan the environment, identify the objects of interest and count them. Risks are created and selected by human actors. What counts as a risk to someone may be an act of God to someone else or even an opportunity for a third party. Although societies have, over time, gained experience and collective knowledge of the potential impacts of events and activities, one cannot anticipate all potential scenarios and be worried about all of the many potential consequences of a proposed activity or an expected event. By the same token, it is impossible to include all possible options for intervention. Therefore, societies have been *selective* in what they have chosen to be worth considering and what to ignore (Douglas, 1990; Thompson et al, 1990; Beck, 1994, pp9ff). Specialized organizations have been established to monitor the environment for hints of future problems and to provide early warning of some potential future harm. This selection process is not arbitrary. It is guided by cultural values (such as the shared belief that each individual life is worth protecting), by institutional and financial resources (such as the decision of national governments to spend money or not to spend money on early warning systems against highly improbable but high-consequence events) and by systematic reasoning (such as using probability theory for distinguishing between more likely and less likely events or methods to estimate damage potential or distribution of hazards in time and space).[4]

Ultimately, whether the evidence collected for assessing and evaluating risks represents human ideas about reality or depicts representations of reality is more or less irrelevant for the distinction between evidence and values that is suggested throughout the risk governance framework that forms the basis of this book (IRGC, 2005). Those interested in going into greater depth on this issue will find it useful to explore further readings.[5]

The framework, hence, tries to avoid the naive realism of risk as a purely objective category, as well as the relativistic perspective of making all risk judgements subjective reflections of power and interests. What the framework emphasizes is that risk governance must deal with both the 'physical' and 'social' dimensions of risk. It is important to expand the set of criteria for assessing, characterizing, evaluating and managing risks beyond the largely technological or scientific factors that have dominated earlier models of risk governance. Public values, concerns and perceptions of risk are often equally important for identifying, understanding and managing risks and must be included. Whether these perceptions have a direct correspondence with the physical world is irrelevant as long as people feel that these perceptions matter to them or to the objects and persons whom they care about. Addressing these concerns may include changes in the physical world, such as adding an additional safety layer; but very often it may be more effective to improve trust in the risk operating systems or to provide more personal control over the extent of the risk. If specific perceptions are clearly in violation of the best scientific knowledge about the likely effects of events, technologies or human actions, it is the task of risk managers to provide evidence-based information that help people to understand the causal relationships that they may have misjudged. A vast majority of studies on risk perception and concerns tends to show, however, that most of the worries are not related to blatant errors or poor judgement, but to divergent views about the tolerability of remaining uncertainty, short-term versus long-term impacts, the trustworthiness of risk-regulating or risk-managing agencies, and the experience of inequity or injustice with regard to the distribution of benefits and risks. All of these concerns are legitimate in their own right and valid for the respective policy arena. They cannot be downplayed by labelling concerns as irrational fears. This is why the framework emphasizes the need for both risk assessment and concern assessment in the *risk appraisal* phase, as explained in Chapter 3.

Risk assessments are therefore 'mental models' that are based on observations and perceptions or social constructions of the world that can be justified by logical reasoning (reflecting varying degrees of knowledge and consistent with fundamental axioms of mathematics and probability) or can be verified by comparisons with what actually happens. Public values, perceptions and social concerns can act as the driving agents for identifying those topics for which risk assessments are judged necessary or desirable and for ultimately evaluating the acceptability or tolerability of those risks. Whether based on scientific predictions or public perceptions, estimates for the magnitude of risks, however, should reflect technical expertise as well as possible since the implications of taking action – for health, the environment or the economy – may be very real.

From there it follows that managing risks will inevitably be directed by relevance claims (e.g what matters to society and what are important phenomena that should receive our attention?), evidence claims (e.g. what are the causes and what are the effects?) and normative claims (e.g. what is good, acceptable and tolerable?). Identifying what is relevant and worth further investigation is clearly a task that demands both sufficient knowledge about impacts and a broad understanding of the basic values and concerns that underlie all procedures of selection and priority setting. This important stage of selection and framing forms a separate first phase of our framework, including several sub-tasks. After this first preliminary phase, the framework distinguishes between knowledge acquisition and evaluative judgements. This distinction is done in spite of the common understanding that providing evidence is always contingent upon existing normative axioms and social conventions. Likewise, normative positions are always enlightened by assumptions about reality (Ravetz, 1999). The fact, however, that evidence is never value free and that values are never void of assumptions about evidence does not compromise the need for a functional distinction between the two. In managing risks one is forced to distinguish between what is likely to be expected when selecting option X rather than option Y, on the one hand, and what is more desirable or tolerable: the consequences of option X or option Y, on the other. As a result, it is highly advisable to maintain the classic distinction between evidence and values, and to affirm that justifying claims for evidence versus values involves different routes of legitimization and validation. We maintain this distinction in the framework by having both *risk characterization* and *risk evaluation* as inputs to judgements about tolerability and acceptability.

SCOPE OF RISKS

Table 1.1 provides a systematic overview of the sources of risks or hazards that potentially fall within the scope of our risk definition. The purpose of this overview is to lay out the variety of sources of risks, rather than to claim that the categories proposed are exhaustive or mutually exclusive (see a review of classification in Morgan et al, 2000). In addition to the individual risk sources mentioned in Table 1.1, we have given special attention to the emergence of a new concept of risk, which the Organisation for Economic Co-operation and Development (OECD) has labelled '*systemic risks*' (OECD, 2003a). This term denotes the 'embeddedness' of any risk to human health and the environment in a larger context of social, financial and economic consequences, and increased interdependencies both across risks and between their various backgrounds. Systemic risks are at the crossroads between natural events (partially altered and amplified by human action, such as the emission of greenhouse gases), economic, social and technological developments, and policy-driven actions, all at the domestic and the international level. These new interrelated and interdependent risk fields also require a new form of handling risk, in which data from different risk sources are either geographically or functionally integrated within one analytical perspective. Handling systemic risks requires a holistic approach to hazard identification, risk assessment, concern assessment, tolerability/acceptability judgements and risk management. Investigating systemic risks goes beyond the usual agent-consequence analysis and focuses on interdependencies and spillovers between risk clusters.

Risk from a broader perspective

Risks appear in a broader context of how humans transform the natural into a cultural environment with the aim of improving living conditions and serving human wants and needs (Turner et al, 1990). These transformations are performed with a purpose in mind (normally a benefit to those who initiate them). When implementing these changes, intended (or tolerated) and unintended consequences may occur that meet or violate other dimensions of what humans value. Risks are not taken for their own sake; they are rather incurred, actively or passively, being integral to a specific activity. In this context, it is the major task of risk assessment to identify and explore, preferably in quantitative terms, the types, intensities and likelihood of the (normally undesired) consequences related to an activity or event. In addition, these consequences are associated with special concerns that individuals, social groups, or different cultures may attribute to these risks. They also need to be assessed in terms of making a prudent judgement about the tolerability or acceptability of risks. Once that judgement is made, it is the task of risk management to prevent, reduce or alter these consequences by choosing appropriate actions. As obvious as this distinction between risk and concern assessment (as a tool of gaining knowledge about risks) and risk management (as a tool for handling risks) appears at first glance, the *distinction becomes blurred* in the actual risk governance process.

Table 1.1 *Risks taxonomy according to hazardous agents*

Physical agents
• Ionizing radiation • Non-ionizing radiation • Noise (industrial, leisure, etc.) • Kinetic energy (explosion, collapse, etc.) • Temperature (fire, overheating, overcooling)
Chemical agents
• Toxic substances (thresholds) • Genotoxic/carcinogenic substances • Environmental pollutants • Compound mixtures
Biological agents
• Fungi and algae • Bacteria • Viruses • Genetically modified organisms (GMOs) • Other pathogens
Natural forces
• Wind • Earthquakes • Volcanic activities • Drought • Flood • Tsunamis • (Wild) fire • Avalanche
Social-communicative hazards
• Terrorism and sabotage • Human violence (criminal acts) • Humiliation, mobbing, stigmatizing • Experimentation with humans (such as innovative medical applications) • Mass hysteria • Psychosomatic syndromes
Complex hazards (combinations)
• Food (chemical and biological) • Consumer products (chemical, physical, etc.) • Technologies (physical, chemical, etc.) • Large constructions such as buildings, dams, highways, bridges • Critical infrastructures (physical, economic, social-organizational and communicative)

Source: adapted from IRGC, 2005, p20

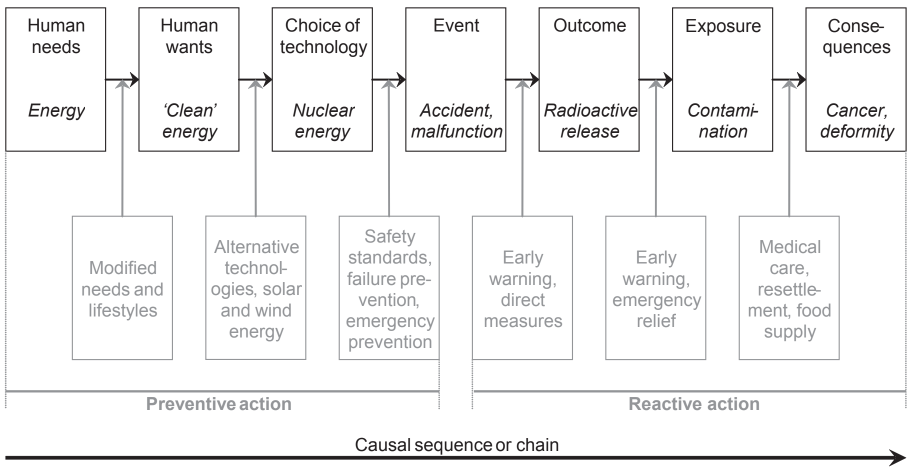

Figure 1.1 *Seven steps of a risk chain: The example of nuclear energy*

Source: adapted from Hohenemser et al, 1983 and from IRGC, 2005, p21

This blurring is due to the fact that assessment starts with the respective risk agent or source and tries to both identify potential damage scenarios and their probabilities, and to model its potential consequences over time and space, whereas risk management oversees a much larger terrain of potential interventions (Jasanoff, 1986, pp79f, 2004; NRC, 1996). Risk management may alter human wants or needs (so that the agent is not even created or continued). It can suggest substitutes or alternatives for the same need. It can relocate or isolate activities so that exposure is prevented, or it can make risk targets less vulnerable to potential harm. Figure 1.1 illustrates this larger perspective for technological risks and lists the possible intervention points for risk management.

Risk assessment and management are, therefore, not symmetrical to each other: management encompasses a much larger domain and may even occur before assessments are performed. It is often based on considerations that are not affected by, or are part of, the assessment results. In more general terms, risk management refers to the creation and evaluation of options for initiating or changing human activities or (natural and artificial) structures with the objective of increasing the net benefit to human society and of preventing harm to humans and what they value. The identification of these options and their evaluation is guided by systematic and experiential knowledge gained and prepared for this purpose by experts and stakeholders. A major proportion of that relevant knowledge comprises the results of risk assessments. However, risk managers also need to act in situations of 'non-knowledge' or insufficient knowledge about potential outcomes of human actions or activities. The most complex questions emerge, however, when one looks at how society and its various actors actually handle risk. In addition to knowledge gained through risk assessments and/or option generation and evaluation through risk management, the decision-making structure of a society is itself highly complicated and often fragmented. Apart from the structure itself – the people and organizations that share responsibility for assessing and managing risk – one must also consider the need for sufficient organizational capacity to create the necessary knowledge and to implement the required actions, political and cultural norms, and rules and values within a particular societal context, and the subjective perceptions of individuals and groups. These factors leave their marks on the way risks are treated in different domains and socio-political cultures.

WHY RISK GOVERNANCE?

During the last decade the term 'governance' has experienced tremendous popularity in the literature on international relations, comparative political science, policy studies, sociology of environment and technology, as well as risk research.[6] On a national scale, *governance describes structures and processes for collective decision-making involving governmental and non-governmental actors* (Nye and Donahue, 2000). Hutter (2006, p215) characterizes the move from governmental regulation to governance in the following manner:

> *This decentring of the state involves a move from the public ownership and centralized control to privatized institutions and the encouragement of market competition. It also involves a move to a state reliance on new forms of fragmented regulation, involving the existing specialist regulatory agencies of state but increasingly self-regulating organizations, regimes of enforced self-regulation … and American-style independent regulatory agencies.*

Governing choices in modern societies is seen as an interplay between governmental institutions, economic forces and civil society actors, such as non-governmental organizations (NGOs). At the global level, *governance embodies a horizontally organized structure of functional self-regulation encompassing state and non-state actors bringing about collectively binding decisions without superior authority* (Rosenau, 1992; Wolf, 2002, 2005). In this perspective, non-state actors play an increasingly relevant role and become more important since they have decisive advantages of information and resources compared to single states.

'Risk governance' involves the 'translation' of the substance and core principles of governance to the context of risk and risk-related decision-making (Gunningham et al, 1998). It includes, but also extends beyond, the three conventionally recognized elements of *risk analysis* (risk assessment, risk management and risk communication). It requires consideration of the legal, institutional, social and economic contexts in which a risk is evaluated, and involvement of the actors

and stakeholders who represent them. Risk governance looks at the complex web of actors, rules, conventions, processes and mechanisms concerned with how relevant risk information is collected, analysed and communicated, and how management decisions are taken. Encompassing the combined risk-relevant decisions and actions of both governmental and private actors, risk governance is of particular importance in, but not restricted to, situations where there is no single authority to take a binding risk management decision, but where, instead, the nature of the risk requires the collaboration of, and coordination between a range of different stakeholders. Risk governance, however, not only includes a multifaceted, multi-actor risk process but also calls for the consideration of contextual factors such as institutional arrangements (e.g. the regulatory and legal framework that determines the relationship, roles and responsibilities of the actors, and coordination mechanisms such as markets, incentives or self-imposed norms) and political culture, including different perceptions of risk. Thus, the framework includes several of these dimensions, including concern assessment and explicit discussion of stakeholder participation.

It is useful to differentiate between *horizontal* and *vertical governance* (Benz and Eberlein, 1999; Lyall and Tait, 2004*)*. The horizontal level includes the relevant actors in decision-making processes within a defined geographical or functional segment (such as all relevant actors within a community, region, nation or continent); the vertical level describes the links between these segments (such as the institutional relationships between the local, regional and state levels). Figure 1.2 provides a more explicit portrayal of the interactions between the horizontal and vertical levels of governance in the framework.

Horizontal levels

Vertical levels

	Governments/ agencies	Industries	Science and academia	Civil society/ NGOs
Local				
Regional				
National				
Supra-national				
Global				

Figure 1.2 *Levels of vertical and horizontal governance*

Source: reproduced with permission from Bunting et al, 2007, p13

Figure 1.3 *The 'technocratic' model*

Source: adapted from Millstone et al, 2004

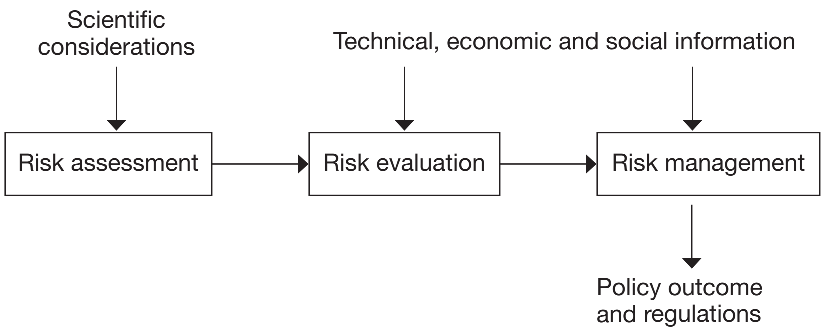

Figure 1.4 *The 'decisionistic' model*

Source: adapted from Millstone et al, 2004

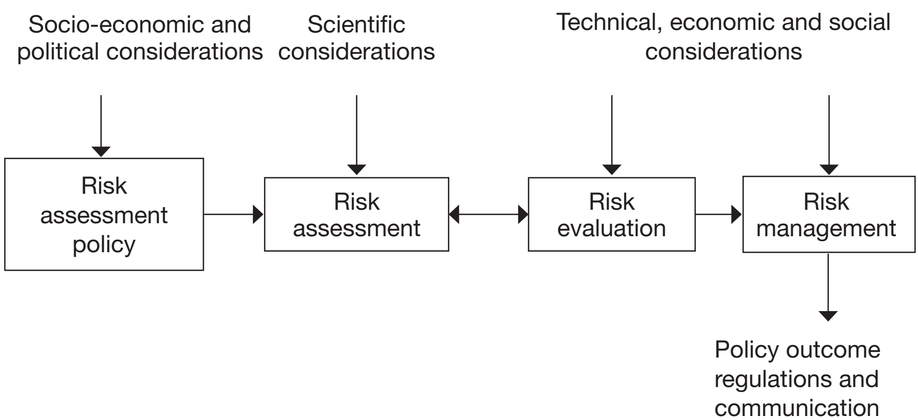

Figure 1.5 *The 'transparent' model*

Source: adapted from Millstone et al, 2004

The vertical governance axis defines the political arena, which ranges from the local to the global level. For example, any federalist government structure is designed along similar vertical governance lines. On each vertical level, different actors from the horizontal axis (governments, economic interests, academic expertise and civil society actors) can join the governance process and contribute either knowledge or values to the process.

The degree of involvement or intersection of these vertical and horizontal elements can depend strongly upon the governance model. Millstone et al (2004) suggest three broad categories of models, each progressively more inclusive of the actors representing the horizontal axis of governance (NRC, 1996) (see Figures 1.3 to 1.5):[7]

- *'Technocratic' model.* In this model, objective science is seen to directly inform policy-making; scientists are the best judges of the tolerability of risks and inform policy-makers directly about what they should do.
- *'Decisionistic' model.* This model corresponds closely, although not exactly, to that illustrated by the National Research Council's (NRC's) Red Book (NRC, 1983). In this model, policy-making requires inputs other than science in order to make decisions, and other legitimate factors (such as those relating to socio-political and economic objectives) need to be taken into account in addressing risks. In 1983, the Red Book established the division between the scientific aspects ('risk assessment') and political and value aspects ('risk management') within the overall process of risk analysis. This division, and several other aspects of the 'Red Book' model, have been adopted across a wide variety of risk management fields (Omenn, 2003).
- *'Transparent (inclusive) governance' model.* This model is inspired by the 1996 NRC report on risk characterization in which the interface between assessment and management has been stressed and in which science, politics, economic actors and representatives of civil society are invited to play a role in both assessment and management (NRC, 1996). Of special importance in this model are the inclusion of pre-assessment (in particular, framing) and the stage of characterization and evaluation.

It is this third model of transparent governance that we have chosen for our framework on risk governance. The following chapters will guide the reader through each stage of the risk governance framework.

Essay 1 *A Guide to Interdisciplinary Risk Research*[8]

Introduction

Risk has been a focal topic of many disciplines, professional activities and practical actions. Areas in which risks are being addressed include natural hazards, technological threats, working conditions, ambient health impacts, crime, terrorism, pollution and leisure activities. It is the purpose of this essay to review the variety of concepts of risk in different disciplines and application areas with a specific emphasis on the social sciences. This review has been inspired by similar attempts in the literature (Short, 1984; Bradbury, 1989; Renn, 1992b; Jaeger et al, 2001; McDaniels and Small, 2004; Zinn and Taylor-Gooby, 2006a). As one can expect from such a review, it is impossible to cover the whole array of risk concepts or to provide a complete picture of all the approaches that are suggested. In addition, the purpose of providing orientation is better served if similar approaches are pooled into one single category and more peripheral attempts to capture risks are subsumed under one heading. The following sections include a systematic analysis of risk approaches under a common framework guided by three leading questions.

These questions refer to the three elements that form the essence of risk: first, the outcomes that affect what humans value; second, the possibility of occurrence (uncertainty); and, third, a formula to combine these two elements into one concept. All current approaches to risk provide different conceptualizations of these three elements. In engineering and the physical sciences, for example, the term 'risk' refers to a functional relationship between probabilities and consequences (Morgan, 1990; Kolluru, 1995). In psychology, risk is rather seen as a function of subjectively expected utilities (Slovic et al, 1981a). The cultural and social understanding of risk is focused on mental models by which different social and cultural groups assign meaning to the experience of harm and hazard (Breakwell, 2007, pp72ff). All of these different risk concepts can be paraphrased in the following three questions:

1 What are undesirable outcomes, and who determines what undesirable means?
2 How can we specify, qualify, or quantify the possibilities of undesirable outcomes?
3 How do we aggregate different classes of undesirable outcomes into a common concept that allows comparison, the setting of priorities and effective risk communication?

These three questions – the scope of negative effects, the conceptualization of uncertainty and the rule of aggregation for practical purposes – serve in this essay as structural tools for distinguishing the different concepts of risk and for discussing their present contributions and future challenges. All approaches that will be discussed in the next sessions are illustrated in Figure 1.6 on page 15.

The past as a guidebook for the future: Technical risk assessments

Characteristics of technical risk assessments

The world of the insurance companies has a simple but very effective answer to these three questions. Their reference point is the expected value (i.e. the relative frequency of an event averaged over time). The undesirable events are confined to physical harm to humans or ecosystems, which can be objectively observed or measured by appropriate scientific methods. An application of this approach may be the prediction of fatalities in car accidents for the coming year. The expected value can be extrapolated from the statistical data about fatal accidents in previous years. This perspective of risk relies on two conditions: first, enough statistical data must be available to make meaningful predictions; second, the causal agents that are responsible for the negative effects must remain stable over the predicted time period (Häfele et al, 1990; Cohen, 1996). The resulting risk assessment is reduced to a single dimension representing an average over space, time and context.

The answers become more complex when the adverse effects cannot be observed as an immediate result caused by an agent (Kolluru, 1995; Bedford and Cooke, 2001). If we think of environmental risks such as dioxin, benzene or radioactive particles, the link between exposure and effect is often difficult to draw and is sometimes not even measurable. In such risk assessments, causal relationships have to be explored through modelling. Models represent plausible and – in an ideal world – empirically confirmed representations of complex and non-obvious cause–effect relationships. Models are not 'miniature' representations of reality, but purpose-driven constructions that are built to display special cause–effect pathways over many stations of complex interrelationships. In the field of medical risk, such models attempt to assess the likely impact of a specific agent – for example, acrylamide on human health (i.e. development of cancer). Based on toxicological (animal experiments) or epidemiological studies (comparing a population exposed to a risk agent with a population not exposed to the risk agent), researchers try to identify and quantify the relationship between a potential risk agent (such as dioxin or ionizing radiation) and physical harm observed in humans or other living organisms (WHO, 1977; Lave, 1987; NRC, 1991; IEC, 1993; Graham and Rhomberg, 1996). Risk assessments based on toxicological or epidemiological models can serve as early warning signals to inform society that a specific substance may cause harm to humans or the environment, even if the effects are not obvious to an unskilled observer. In addition, dose–effect investigations help risk managers to define standards in accordance with observed or modelled threshold values. If there is no threshold value, as in the case of most carcinogens, risk assessments provide information about the probability of harm depending upon the dose.

Another complication is experienced when people face technological risks (i.e. the possibility of technical malfunctions or human errors in handling such machines). As a tool to model such failures and their consequences, experts use probabilistic risk assessments in an attempt to predict the probability of safety failures of complex technological systems, even in the absence of sufficient data for the system as a whole

(Lowrance, 1976; Hauptmanns et al, 1987; Morgan, 1990; IAEA, 1995; Bedford and Cooke, 2001). Probabilistic risk assessments for large technological systems, for instance, include tools such as fault and event trees, scenario techniques, distribution models based on geographic information systems (GIS), transportation modelling and empirically driven human–machine interface simulations (IAEA, 1995; Stricoff, 1995; Kröger 2005). These tools have been developed to generate knowledge about cause–effect relationships, to estimate the strength of these relationships, to characterize remaining uncertainties and ambiguities, and to describe, in quantitative or qualitative form, other risk- or hazard-related properties that are important for risk management (IAEA, 1995; IEC, 1993). In short, probabilistic risk assessments specify what is at stake, calculate the probabilities for (un)wanted consequences and often aggregate both components into a single dimension by taking the integral over the loss-probability functions (Kolluru, 1995, pp2.3ff). However, more recent attempts in probabilistic risk assessment avoid the aggregation of the two components and leave it to the risk evaluation or management team to draw the necessary conclusions from the juxtaposition of loss and probabilities (Aven 2003; Kröger 2005). In addition, second order uncertainties are introduced via confidence intervals to make the confidence of probability judgements more explicit (Apostolakis and Pickett, 1998). Furthermore, the evolution of probabilistic risk assessments over the last two decades have broadened the scope of outcomes to include monetary and quantifiable social losses as well as the results of complementary analyses such as human reliability investigations.

Several problems are associated with this approach to calculating the risks of accidents (IAEA, 1995; Aven, 2003, pp106ff; Cullen and Small, 2004). It has proven difficult to model common mode failures (i.e. the simultaneous breakdown of technical components due to a common cause). Second, human–machine interactions are tricky to predict. They often rely on idiosyncratic events that defy systematic modelling. Similar problems arise when social disruptions or dysfunctional behaviour interact with technological systems, such as terrorist attacks, sabotage, social unrest, lack of safety culture or the breakdown of organizational order (e.g. intoxicated air pilots or drug-using nuclear power plant operators). More recent attempts to model human factors in risk assessments include methods such as Monte Carlo Simulation, narrative scenario building and expert Delphis in order to provide more reliable estimates of the potential interfaces between social context and technical performance (Forester et al, 2006). In spite of the progress made in reliability analysis, there is still considerable doubt about the predictive power of these models.

In spite of these difficulties, probabilistic risk assessments have been specifically valuable in detecting deficiencies in complex technical systems and in improving the safety performance of the technical system under consideration. Furthermore, probabilistic risk assessments are powerful instruments to characterize the uncertainties in a technical system and to improve cost-efficiency of safety devices and measures (see Figure 1.6). The normative implication of probabilistic risk assessments is obvious: since physical harm is perceived as an undesirable effect (at least for most people and society as a whole), technical risk analyses can be used to reveal, avoid or modify the causes that lead to these unwanted effects. They can also be used to mitigate consequences, if causes are yet unknown or impossible to change

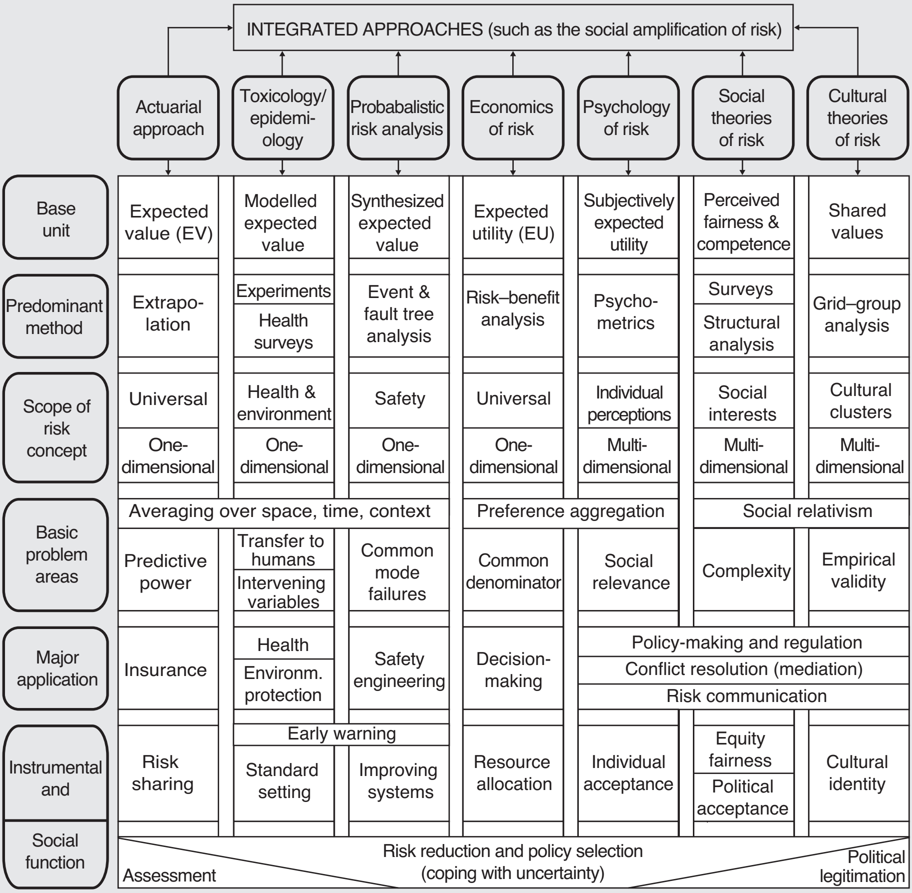

Figure 1.6 *Systematic classification of risk perspectives*

Source: adapted from Renn, 1992b and Renn et al, 2007, p25

because they may be remote from human intervention or too complex to modify. Their instrumental functions in society are, therefore, oriented towards risk sharing and risk reduction, through mitigation of consequences, standard setting, and improvements in the reliability and safety of technological systems. In addition, the data from technical risk analyses are crucial input for conducting risk–benefit analyses.

A critical review of the technical concepts and challenges for the future

The technical analyses of risk have attracted massive criticism from the social sciences (Hoos, 1980; Douglas, 1985; Freudenburg, 1988; Shrader-Frechette, 1991; Beck, 1992b; Reiss, 1992; Adams, 1995; Tierney, 1999; Zinn and Taylor-Gooby, 2006a, pp24ff). First, what people perceive as an undesirable effect depends upon their values and preferences (Dietz et al, 1996). Second, the interactions between human activities and consequences are more complex, sophisticated and unique than the average probabilities used in technical risk analyses are able to capture (Fischhoff et al, 1982; Zinn and Taylor-Gooby, 2006a, p25). Third, the institutional structure of managing and controlling risks is prone to organizational failures and deficits that may increase the actual risk (Perrow, 1984; Short, 1984; Short and Clarke, 1992). The interaction between organizational malfunctions and risk is usually excluded from technical risk analyses. Fourth, risk analysis cannot be regarded as a value-free scientific activity (Fischhoff, 1995; Gabe, 1995; Jasanoff, 1999). Values are reflected in how risks are characterized, measured and interpreted. Fifth, the numerical combination of magnitude and probabilities assumes equal weight for both components. The implication is indifference between high-consequence/low-probability and low-consequence/high-probability events with identical expected values. However, people show distinct preferences for one or the other (Slovic, 1987; Renn, 1990). Most people prefer a risk that will kill a few people at a time, rather than a risk that kills many people at once. Furthermore, technical risk analyses can provide only aggregate data over large segments of the population and long time duration. Each individual, however, may face different degrees of risk depending upon the variance of the probability distribution (Hattis and Kennedy, 1990; Nowotny and Eisikovic, 1990; Morgan and Henrion, 1990; Cullen and Small, 2004). A person exposed to a larger risk than the average may legitimately object to a risk policy based on aggregate calculations (Jasanoff, 1993, p127). The extent to which a person is exposed to a specific risk also rests on lifestyle factors and anecdotal knowledge, both of which are mostly unknown to scientists performing risk analyses.

How valid are the criticisms by social scientists? In my opinion, all the critical remarks are well taken and point to the problem that technical risk analyses represent a narrow framework that should not be the single criterion for risk identification, evaluation and management. Technical risk analyses rest on many conventions (Weinberg, 1972; IRGC, 2005), such as the selection rules for identifying undesirable effects, the choice of a probability concept and, in most cases, the equal weighting of probability and magnitude. All of these conventions in risk analyses can be defended through logical reasoning; but they represent only parts of what individuals and society experience as risk.

This does not mean, however, that technical risk analyses are unnecessary or less relevant than broader concepts of risk. They do serve a major purpose. After all, people get hurt or are killed in accidents, in natural disasters or due to pollution (Shrader-Frechette, 1991, p30). Technical risk analyses help decision-makers to estimate the expected physical harm. They provide the best knowledge about actual damage that is logically or empirically linked with each possibility of action (NRC, 1983). Cancer, for example, is caused by exposure to a harmful agent, such as benzene, and the effects are a function of the dose. In addition, for events that can be observed and repeated, probabilities are adequate tools to model their likelihood of occurrence in the future.

In terms of the three guiding questions stated above, technical analyses rely on relative frequencies or point estimates as a means of expressing probabilities. This concept aggregates data over space, populations and time. The undesired effects are confined to physical harm to humans and ecosystems, thus excluding social and cultural impacts. The narrowness of this approach constitutes both its weakness and its strength. Abstracting a single variable from the context of risk-taking makes the concept of risk one-dimensional, yet universal. Confining undesirable consequences to physical harm excludes other consequences that people might also regard as undesirable; but physical harm may be the only consequence that (almost) all social groups and cultures agree to be undesirable (HMSO, 1988; Kasperson, 2005a).

Looking at the prospects and limitations of technical risk analysis, it is obvious that the scientific communities in this field need to continue investing their efforts in order to improve the methodology for risk assessments. The main objectives are to standardize procedures and techniques to enhance the spectrum of risk events that can be modelled, and to ensure that risk managers are able to understand and wisely use the instruments that risk analysts have developed over the last decades. Technical risk analysis has matured to become a sophisticated and powerful tool in coping with the potential harm of human actions or natural disasters (Morgan, 1995).

The economic perspective: Risks represent losses of individual utility

As much as technical risk analysis is demanded by society, it does not question the need for economic, psychological and social science studies on risk. The exclusion of social context and meaning from technical risk analyses provides an abstraction that enhances the inter-subjective validity of the results, but at the price of neglecting the costs and other dimensions of the social processing of risk experiences (Brehmer, 1987; Tierney, 1999; Sjöberg, 2006). All risk concepts of the behavioural sciences have in common the principle that the causes and consequences of risks are mediated through social and mental processes.

The concept closest to the technical approach is the economic concept of risk. The major difference here is the transformation of physical harm or other undesired effects into what economists have coined 'utilities' (Just et al, 1982; Smith, 1986; Aven, 2003, pp52ff). The base unit of utility describes the degree of satisfaction, or dissatisfaction, associated with a possible action or transaction. Whether physical harm is evaluated as pleasure, indifference or pain remains irrelevant in the technical understanding of risk. Not so in economics: the relevant criterion is the subjective satisfaction with the potential consequences, rather than a predefined list of undesirable effects. The objective yardstick for measuring utility in classic economics is the amount of money that somebody is willing to pay for a change that provides a higher degree of personal satisfaction than remaining at the status quo. There are major debates in micro-economics today on whether the model of utility maximization is empirically valid (Jaeger et al, 2001, pp41ff; Selten, 2001; Taylor-Gooby and Zinn, 2006a, pp8f). It is not clear whether humans actually distinguish different degrees of utility – a precondition for reconstructing utility functions. More recent work suggests that human choice behaviour depends more upon simplified heuristics that correspond with satisfying rather than optimizing strategies (Gigerenzer, 1991, 2007; Gigerenzer and Selten, 2001).

The shift from expected harm to expected utility serves two major purposes. First, subjective (dis)satisfaction can be measured for all types of consequences, including symbolic, psychological or social effects that are deemed undesirable. Second, and more important, the common denominator 'personal satisfaction' allows a direct comparison between risks and opportunities across different options (Merkhofer, 1984). The question 'How safe is safe enough?' cannot be answered by the three technical concepts. The economic concept offers two main selection rules: a risk is acceptable if the corresponding benefit provides more utility than the risk detracts from the utility. Or, in case of concrete options: select the one option having the lowest risk among all options leading to identical benefits. Using utilities instead of physical harm provides a common 'exchange rate' that enables each individual to compare options with different benefit profiles, according to overall satisfaction (Derby and Keeney, 1981). Several economists delineate the collective utility by looking at past behaviour (revealed preferences); others use surveys or auctions to determine the balance between the utility lost by implementing the risk, and the utility gained by receiving fringe benefits. Others again conduct surveys and ask people directly, what they are willing to pay for imposing a risk on others, or what compensation they would demand for taking over a risk from others (expressed preferences).

If risks can be expressed in terms of utilities, which some authors contest (compare the debate between Kelman, 1981, and Butters et al, 1981; see Selten, 2001), they can be integrated within a decision process in which costs and benefits are assessed and compared. Since risks denote possible costs rather than actual costs, they have to be weighted by the probability of their occurrence. Furthermore, since risks and benefits may not materialize until years after implementing the desired option, the consequences have to be discounted over time (Hyman and Stiftel, 1988). Choosing the correct discount rate has been a major challenge to economists. Since market interest rates hardly reflect time preferences for collective risks, discount rates must be deliberately set according to theoretical reasoning or empirical surveys. There is also the ethical question of whether a loss of life or ecological damages can be discounted at all. Notwithstanding all these problems, economic theory attempts to integrate risk analysis as part of a larger cost–benefit consideration, in which risks are the expected utility losses resulting from an event or an activity. The ultimate goal is to allocate resources in order to maximize their utility for society (Smith, 1986; Shrader-Frechette, 1991).

The economic risk concept constitutes a consistent and coherent logical framework for situations in which decisions are being made by individuals, and in which decision consequences are confined to the decision-maker. In the risk area, both conditions are rarely met. First, most decisions on risks are collective decisions (public or meritocratic goods), which require the aggregation of individual utilities. How to aggregate individual utilities within a single societal welfare function remains an open problem in economics until this day. Second, many transactions between individuals imply the imposition of risks on third parties, who may not benefit, or only marginally benefit, from the transaction itself (MacLean, 1986). These problems are aggravated by the fact that utilities are often measured in monetary units, which are perceived as incommensurable with the risk of serious health impediments or even death (Baram, 1980). In spite of these criticisms, the economic approach serves several vital functions in risk policies (Pinkau and Renn, 1998, pp271ff):

- It provides techniques and instruments to measure and compare utility losses or gains from different decision options, thus enabling decision-makers to make more informed (but not necessarily better) choices.
- It enhances technical risk analyses by providing a broader definition of undesirable and desirable outcomes, which include non-physical aspects of risk.
- Under the assumption that market prices (or shadow prices) represent social utilities, it provides techniques to measure distinctly different types of benefits and risks with the same unit. Such balancing of risks and benefits do not necessarily require monetary units. Alternative expressions, such as 'quality-adjusted life years', may also serve as yardsticks for measuring the net utility balance.
- It includes a model for rational decision-making, provided that the decision-makers can reach agreement about the utilities associated with each option.

In terms of the three guiding questions, the economic concept of risk is based on (objective or subjective) probabilities, a social definition of undesirable effects based on individual utilities, and the treatment of these effects as real gains or losses to individuals or society. In contrast to the technical approaches, probabilities are not only conceptualized as relative frequencies, but also as strength of beliefs (Fischhoff et al, 1981). Furthermore, people show different preferences when combining subjective probabilities and utilities, depending upon their basic attitudes towards taking risks (Kahneman and Tversky, 1979).

Again, one might ask what the economic analysis of risk has contributed to our understanding of risk and the improvement of risk policies. First, the treatment of risk in economics has sharpened our vision for conceptualizing risk as a cost factor that can be exchanged, treated or mitigated just like any other cost factor. The mental processing of uncertainty is not confined to calculating expected values (probabilities multiplied by magnitude), but is part of an individual cost–benefit analysis, in which measures related to risk avoidance, prevention, reduction and mitigation can be systematically compared to each other. In addition, the economic concept includes risk attitudes such as risk aversion or risk proneness. Economic rationality implies that different risk attitudes are legitimate elements of any risk calculation (Luce and Weber, 1986). This is true for speculating on the stock market, as well as for coping with natural hazards.

Second, economic studies on risk have demonstrated the opportunities and limits of exchanging different types of costs and offering compensation (Kunreuther, 1995). Perceived risks to one's health or even life are almost impossible to compensate for with monetary return, at least in an industrial country with a high income level. At the same time, however, risk insurance, as well as liability laws, act as powerful incentives for risk managers to avoid future damages as a means of saving money. A large portion of the legal activities in the US is devoted to *ex-post* compensation of victims for being involuntarily exposed to a risk.

Risk perception: The wisdom of the lay public

The psychological perspective on risk expands the realm of subjective judgement about the nature and magnitude of risks in three ways. First, it focuses on personal preferences for probabilities, and attempts to explain why individuals do not base their risk judgements on expected values (Lopes, 1983; Luce and Weber, 1986). One of the interesting results of these investigations was the discovery of consistent patterns of probabilistic reasoning that are well suited for most everyday situations. People are averse to risk if they face potential losses, and are risk-prone if they expect even small gains (Kahneman and Tversky, 1979).

Second, more specific studies on the perception of probabilities in decision-making identified strong bias in people's drawing inferences from probabilistic information (Festinger, 1957; Kahneman and Tversky, 1974; Ross, 1977; Renn, 1990; Rohrmann and Renn, 2000; see also Chapter 4 and Essay 4 on risk perception in this volume). Risk managers and public health professionals should be aware of this bias because it is found in public perception and may be one of the underlying causes for the observed public response. For example, the frequent media coverage about mad cow disease, or bovine spongiform encephalopathy (BSE), and a potential link to a certainly fatal human disease has alarmed the public, and promoted a response of outrage based on the availability bias. Yet, the question remains: why do most people seem to underestimate the probability of contracting such a disease while amplifying the dread associated with the individual suffering from the disease? In order to understand this response, one needs to understand the associations that govern people's risk perception (Streffer et al, 2003, pp265ff; more information in Essay 4).

This brings us to the third major insight of risk perception research. Psychological research has revealed different meanings of risk, depending upon the context in which the term is used (Slovic, 1987; Drottz-Sjöberg, 1991; Boholm, 1998; Renn, 2004a). Whereas in the technical sciences the term risk denotes the probability of the effect multiplied by the magnitude of the effect, the everyday use of risk has different connotations among individuals, groups and cultures. The perception of risks is mainly influenced by four elements (Rohrmann and Renn, 2000):

1 intuitive heuristic and judgement processes, associated with probabilities and damages;
2 contextual factors relating to the perceived characteristics of the risk (e.g. familiarity or naturalness) and to the risk situation (e.g. voluntary work and personal controllability);
3 semantic associations linked to the risk source, the people associated with the risk, and the circumstances of the risk-taking situation;
4 trust and credibility of the actors involved in the risk debate.

Within the psychological domain of investigating risk perception, two major methodological approaches have been pursued: one through psychometric scaling exercises by which individuals rate risks on attributes such as voluntary, controllable, dreadful, familiar to them or known to science (Slovic, 1992; Rosa et al, 2000); and the other by mental models that reconstruct the mental associations of respondents between the risk and related subjects, such as actors involved, context and attitudes towards the source of risk (Bostrom et al, 1992; Atman et al, 1994; Morgan et al, 2001). Regardless of which of the two major methodological routes has been pursued, there is a clear consensus in the literature that the intuitive understanding of risk refers to a multidimensional concept that cannot be reduced to the product of probabilities and consequences. Risk perceptions differ considerably among social and cultural groups. However, it appears to be a common characteristic in almost all countries in which perception studies have been performed that most people form their beliefs by referring to the nature of the risk, the cause of the risk, the associated benefits and the circumstances of risk-taking (Renn and Rohrmann, 2000).

In terms of the three guiding questions, the psychological perspective on risk includes all undesirable or desirable effects that people associate with a specific cause. Whether these cause–effect relationships reflect real dangers or gains is irrelevant. Individuals respond according to their perception of risk, and not according to an objective risk level or the scientific assessment of risk. Scientific assessments influence the individual response to risk only to the degree that they are part of individual perceptions (Covello, 1983). Furthermore, relative frequencies or other (scientific) forms of defining probabilities are substituted by the strength of belief that people have about the likelihood of any undesirable effect occurring (Fischhoff et al, 1981). Both aspects are combined in a formula that normally puts more weight on the magnitude of the effects than on the probability of their occurrence. The main insight is, however, that effects and likelihood are enriched by the perceived presence of situational and risk-specific characteristics that depend upon properties, such as the degree of perceived personal control, the perception of a social rather than an individual risk, or the familiarity of the risk situation (Slovic et al, 1981a; Vlek and Stallen, 1981; Gould et al, 1988; Slovic, 1992; Vlek, 1996; Boholm, 1998; Renn and Rohrmann, 2000).

The focus on the individual and his/her subjective estimates is also the major weakness of the psychological perspective (Mazur, 1987a; Plough and Krimsky, 1987; Thompson et al, 1990; Wynne, 1992b; Jasanoff, 1999, 2004). The broadness of the dimensions that people use to make judgements and the reliance on intuitive heuristics and anecdotal knowledge make it difficult, if not impossible, to aggregate individual preferences, and to find a common denominator for comparing individual risk perceptions. Risk perceptions vary among individuals and groups. Whose perceptions should be used to make decisions on risk? At the same time, however, these perceptions reflect the real concerns of people, and include the undesirable effects that the technical analyses of risk often miss. Facing this dilemma, how can risk perception studies contribute to improving risk policies? According to Fischhoff (1985), they can:

- reveal public concerns and values;
- serve as indicators for public preferences;
- document desired lifestyles;
- help design risk communication strategies;
- represent personal experiences in ways that may not be available to the scientific assessment of risk.

In essence, the psychological studies can help to create a more comprehensive set of decision options, and provide additional knowledge and normative criteria to evaluate them (Fischhoff, 1994). Similar to the other perspectives, the psychological perspective on risk contributes valuable information for understanding risk responses and for designing risk policies, but it is limited in its comprehensiveness and applicability (Wynne, 1984; Jasanoff, 1999).

What are the new challenges of psychological risk research? There are three main targets for risk perception studies (Renn, 1997a):

1 Focus on inter-individual differences and commonalities among populations, nations and cultural groups.
2 Study the impact of the risk-taking context and its situational implications for risk perception and risk evaluation.
3 Improve our knowledge of the links between risk perception, attitudes towards risk objects and actual behaviour.

Risk perception has widened our view of the mental processing of risk information and of the common, as well as unique, coping mechanisms that people use in dealing with uncertain outcomes. These coping mechanisms may occasionally be misleading or may be inappropriate in many instances; but they do serve a vital role in providing a counterbalance to the purely technical analysis of risk assessments. There may be good reasons for evolution having provided human beings with a multidimensional and sophisticated (but, on each dimension, rather fuzzy) concept of risk. This concept favours cautious approaches to new risks and induces little concerns about risks to which everyone is already accustomed (Shrader-Frechette, 1991). It places relevance on aspects such as control and possibility for mitigation, both aspects that have been proven helpful in situations where predictions went wrong (Gigerenzer and Selten, 2001).

A further complication: Social processing of risk and institutional responses

Proposal for a taxonomy of social science approaches to risk

The risk world becomes even more complex with the sociological or cultural concepts of risks. The sociological perspectives include undesirable events that are socially defined and (in some cases) socially constructed. 'Real' consequences are always mediated through social interpretation and linked with group values and interests (Bradbury, 1989; Dietz et al, 1989; Short, 1989; Shrader-Frechette, 1991; Beck, 1992a; Wynne, 1992b; Luhmann, 1993a; Rosa, 1998; O'Malley, 2000; Sjöberg, 2006, p693). Possibilities for future events are not confined to the calculation of probabilities, but encompass group-specific knowledge and vision. Furthermore, possibilities are shaped by human interventions, social organizations, and technological developments (Freudenburg, 1988; Tierney, 1999; Short and Clarke, 1992). Ignoring the connections between social organizations and technological performance may seriously underestimate the likelihood of failures. Lastly, reality is seen as both a system of physical occurrences (independent of human observations) and constructed meanings with regard to these events and to abstract notions, such as fairness, vulnerability, and justice (Kasperson and Kasperson, 1983; MacLean, 1986; Linnerooth-Bayer and Fitzgerald, 1996).

The importance of social and cultural factors for risk experience is undisputed. What is missing, however, is a clear concept of how these factors influence social judgements about risks, individual behaviour and institutional responses (see, for example, Hutter, 2006; Sjöberg, 2006). Notwithstanding the frustrations that are likely to evolve when sociologists try to classify sociological schools of thought, the literature offers a wide variety of taxonomies, even in the narrow field of risk and disaster research (Kreps, 1987; Stallings, 1987; Bradbury, 1989; Short, 1989; Stallings, 1990; Renn, 1992b; Short and Clarke, 1992; Vlek, 1996; Jaeger et al, 2001; McDaniels and Small, 2004; Zinn and Taylor-Gooby, 2006a). They all use different frameworks and classification criteria. All sociological and anthropological concepts of risk, however, do have in common the notion that 'humans do not perceive the world with pristine eyes, but through perceptual lenses filtered by social and cultural meanings, transmitted via primary influences such as the family, friends, subordinates, and fellow workers' (Dietz et al, 1996). Beyond this consensus on the sociological perspective on risk, the field of sociological risk analysis can best be described as a patchwork of conceptual approaches guided by theories of human agency, system theories and structural approaches. Since the demise of the structural-functionalist school in sociology, no dominant camp has evolved, which leaves the field open to an array of competing approaches ranging from an adaptation of the rational actor approach to Marxist and post-modern analyses (Jaeger et al, 2001, pp288ff).

Rather than evaluate the existing reviews, this chapter ventures to add an additional taxonomy, shown in Figure 1.7 (based on an earlier version of this analysis in Renn, 1992b, and a similar approach in Zinn and Taylor-Gooby, 2006a). This taxonomy orders sociological approaches with regard to two dimensions: individualistic versus structural, and realist versus constructivist approaches. The major reasons for this classification are as follows:

- The classification is simple and straightforward – and, thus, open to criticism.
- The classification fits the overall framework of risk perspectives developed above.
- Most, if not all, social science concepts of risks can be grouped within the boundaries of these two dimensions.
- The two dimensions appear to be sufficient to distinguish between concepts that are clearly distinct from each other.

What are the meanings of the two dimensions? The two attributes '*individualistic*' and '*structural*' indicate the base unit of the analysis. The x-axis represents the normative continuum between an individualistic (agency-oriented) and structural (collective) focus when investigating risk debates. It is either focused on the individual or a social aggregate such as an institution, a social group, a subculture or a society.

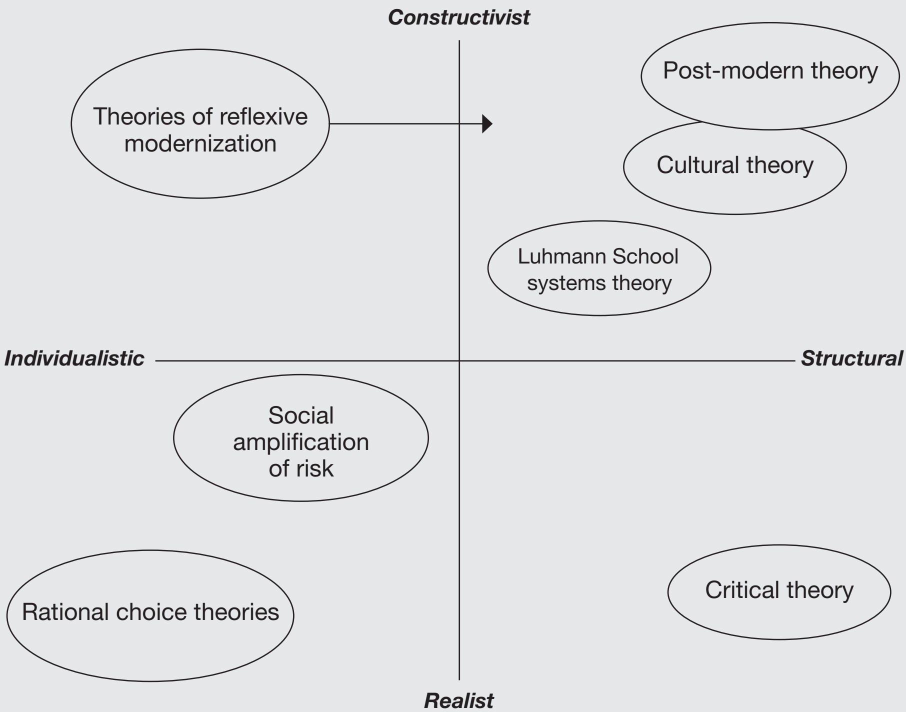

Figure 1.7 *Review of sociological approaches to risk*

Source: adapted from Renn, 1992b and Renn et al, 2007, p46

Structural concepts emphasize that complex social phenomena cannot be explained by individual behaviour alone, but that they rest on interactive (often unintentional) effects among individuals and between individuals and institutions.

The y-axis represents the continuum between the extreme positions regarding the foundations of knowledge (description). At the top appears the position that all knowledge is socially constructed; at the bottom is the opposite view that all knowledge is, and can be, directly experienced from a physical reality accessible through a combination of data collection and theoretical reasoning. 'Realist' and 'constructivist' concepts differ in their view of the nature of risk and its manifestations (see Introduction to Chapter 1). Whereas the objective concept implies that risks and their manifestations are real, observable events, the constructivist concept claims that risks and their manifestations are 'social artefacts' fabricated by social groups or institutions. Figure 1.7 indicates the location of some major theoretical approaches to the social processing of risk.

There are seven *social science-based theoretical approaches to risk* that are covered in this review (see a similar suggestion in Zinn and Taylor-Gooby, 2006a; Taylor-Gooby and Zinn, 2006b, p407):

- the *rational choice* approach (Renn et al, 1999, 2003; Jaeger et al, 2001);
- the *reflexive modernization* approach by Beck (1986, 1992b) and Giddens (1991, 2000);
- the *systems theory* approach of Luhmann (1986a, 1989, 1993a);
- the *critical theory* approach based on the seminal work of Juergen Habermas (1984, 1987a);
- the *post-modern* perspective introduced by Foucault (1982) and further developed by Ewald (1986), Burchell et al (1991) and Dean (1999);
- a *cultural theory* approach, originally introduced by Douglas (1966, 1985) and Douglas and Wildavsky (1982), recently re-presented by Adams (1995) and Lupton and Tulloch (2002);
- the framework of *social amplification of risk* as an example of an integrative framework that promises to link psychological, social and cultural risk theories (Kasperson et al, 1988, 2003; Renn et al, 1992; Breakwell, 2007, pp224ff).

These approaches are described in more detail in the following sections.

The rational choice approach

The notion of rational choice forming the philosophical basis for explaining risk has become the most popular theory of risk in economics and many social sciences (Jaeger et al, 2001, pp20ff). In its widest form (as a global view), it parts from the assumption that human beings are capable of acting in a strategic fashion by linking decisions with outcomes. The more elaborate version of the idea of rational choice, the rational actor paradigm (RAP), makes a whole set of further claims that are more specific (Dawes, 1988; Coleman, 1990). Many special theories on risk and uncertainty rely on the RAP concept and its propositions. These propositions refer to human actions based on individual decisions. Among the most important are:

- the atomistic view of rationality (all actions can be reduced to individual choices);
- analytical separation of means and ends (people, as well as institutions, can, in principle, distinguish between ends and means to achieve these ends);
- goal-attainment motivation (individuals are motivated to pursue self-chosen goals when selecting decision options);
- maximization or optimization of individual utility (human actors select the course of action which promises to lead to more personal satisfaction than any other available course of action);
- knowledge about potential outcomes (people who face a decision can make judgements about the potential consequences of their choices and their likelihood);
- human preferences (people have preferences about decision outcomes based on values and expected benefits);
- predictability of human actions if preferences and subjective knowledge are known (rational actor theory is not only a normative model of how people should decide, but also a descriptive model of how people consciously or subconsciously select options and justify their actions).

This set of fundamental assertions, linked to individual behaviour, is also transferred to situations of collective decision-making or collective impacts of individual decisions. Organizations, for example, are treated as 'virtual' individuals who act in accordance with the institutionalized preferences of the organization and its inherent rationale of selecting the most efficient means for reaching predefined goals (March, 1991; Jaeger et al, 2001, pp144ff). Underlying the individual as well as the collective interpretation of RAP is the basic assumption that all human actions can be described as problems of maximization or, in more contemporary versions of RAP, optimization. The social world is divided into a countless number of decision problems, each of which requires the generation of options for future actions and some kind of an algorithm to choose one among the available options. RAP assumes that individuals pursue the three requisite steps of decision-making: option generation, evaluation of consequences and selection of the most beneficial option. This sequence is meant to represent an individual or collective strategy to optimize one's own benefits.

RAP is closely linked to the technical concept of risk. Rather than assuming, however, the existence of objective probabilities and outcomes, RAP takes a radical individualist perspective. Rational is what the individual perceives as optimizing his or her outcomes when facing a decision (Jaeger et al, 2001, p245). Rational decision-making refers to a process for subdividing a decision problem into segments, starting with the simple structure of action alternatives, information, and preferences. It provides a formal framework for quantitative evaluation of alternative choices in terms of what is known about the consequences and how the consequences are valued (Hammond et al, 1999; Skinner, 1999).

In its simplest form, rational behaviour under uncertainty can be captured by the subjectively expected utility (SEU) model (Morgan and Henrion, 1990). This model is identical with the expected value model of the technical analysis (probability multiplied by damage); but it defines both factors in subjective terms (Kahneman and Tversky, 1984). Most psychological experiments demonstrate, however, only modest correlations between rationally predicted and intuitively chosen options (Tversky and Kahneman, 1974; von Winterfeldt and Edwards, 1986; Dawes, 1988). Furthermore, by asking people, in 'thinking-out-loud experiments', how they arrive at their decision, all kinds of rationales are articulated, of which only few have any resemblance with the prescribed procedures of rational actors (Earle and Lindell, 1984). In line with these empirical results, alternative models of bounded rationality have been developed (Tversky, 1972; Simon, 1976; Dawes, 1988; Gigerenzer, 1991, 2000, 2007; Gigerenzer and Selten, 2001; Jungermann et al, 2005). People seem to use simplified or bounded models of rationality, such as the lexicographic approach (choose the option that performs best on the most important attribute), elimination by aspects (choose the option that meets most of the aspects deemed important) or the 'satisficing' strategy (choose the option that reaches a satisfactory standard on most decision criteria) (see review of these strategies in Dawes, 1988, pp50ff).

Explanations based on RAP may help risk managers to understand why individuals behave in certain ways when they face uncertain outcomes of their action. Such an explanation, however, can only yield valid results if the individual perceives the risk problem as a problem of optimizing outcomes, and if the conditions of choice meet RAP assumptions. If risk behaviour is grounded on solidarity with others or motivated by reference group judgements, RAP does not make much sense. If the focus of social research is on collective risk behaviour, theories based on RAP are still less convincing. They may even serve the function of disenfranchising individual from political actions or restricting freedom since the actions are deemed 'irrational'. The main problem here is that RAP presupposes stable preferences and knowledge about outcomes beyond the individual aspiration level. Furthermore, there is the assumption that the sum of individual actions would tend to form an equilibrium. The evidence for all of this is extremely weak.

In terms of the three leading questions, RAP addresses outcomes as subjective expectations that individuals link with different consequences of decision options. The uncertainty of these outcomes are captured by the strength of subjective belief that these outcomes may or may not materialize. The aggregation of likelihood and outcome is modified by personal preferences or values of organizational culture. There are no universal yardsticks to evaluate risks, the evaluative judgement is always specific for the person or organization that makes the decision. A general agreement on risk, for example, can only be accomplished by searching for win–win situations where all individuals can gain additional benefits or by providing compensation to those who might suffer disbenefits (Kaldor-Hicks Criterion). The RAP perspective comes closest to the economic understanding of risk but is also compatible with most psychological models of risk taking.

The theory of reflexive modernization and the 'risk society'

The reflexive modernization approach combines the macro and micro levels and goes back to the seminal works of Ulrich Beck (1986, 1992a, 1992b) and Anthony Giddens (1990, 1991). The theory of reflexive modernization rests on the assumption that the meta-rationality of modernity (i.e. instrumental rationality, efficiency, justice through economic growth, and steady improvement of individual living condition through scientific and technical progress) has lost its legitimizing power. This new development of disenchantment rests on several developments within the transition from classic to reflexive modernity (cf. Giddens, 1994; Lash, 2000; Jaeger et al, 2001, pp209ff; Knight and Warland, 2005; Zinn and Taylor-Gooby, 2006a, pp39ff):

- *Individualization of lifestyles and social careers.* Individuals have more options available than ever before; but they lack social orientation and ontological security when faced with behavioural or moral dilemmas.
- *Pluralization of knowledge camps and values orientations.* Contemporary societies are characterized by parallel systems of competing knowledge claims, moral judgement codes and behavioural orientations.
- *Lack of overarching objectives and goals.* All collective actions are challenged as being interest-driven or incongruent with somebody's beliefs, values or convictions. This leads to the need for more legitimization; but there is hardly any reservoir for gaining legitimacy.
- *Dominance of negative side effects.* Most collective (and well-intended) actions lead to unintended negative consequences that often surpass the intended

benefits. Most citizens are, therefore, sceptical about the promises of collective actions as they expect negative side effects.

Giddens's analysis of reflexive modernity is closely related to his 'structuration' theory (Giddens, 1984). Giddens describes this approach as one of duality – a synergy between the actor agent and social structure. Giddens rejects the idea that individuals calculate the expected utilities of the various consequences of behavioural options. Instead, they orient themselves within a complex arrangement of traditions, individual routines and socio-cultural expectations. Each individual actor is part of the forces that shape the future context of actions for others. At the same time, each individual is bound to structural constraints that are the outcome of the past actions and choices of others. Such an open system would tend to be chaotic if society did not develop consistent patterns of behaviour that enable, as well as restrict, the available options for each individual: they act as invisible guidelines for individuals in choice situations. These patterns are not simply an aggregation of individual actions, but instead develop a structural logic of their own. For example, traditional norms do not promise maximum pay-off or even an improvement of individual satisfaction, but ensure system continuity and stability. Likewise, power structures are often cherished even by those who lack power, because they provide ontological security to society. The main argument that Giddens proposes is that individuals do have agency. They have choices to orient themselves within different social frames (such as traditions, special institutions, and system rationalities). But the frames constitute developments of structural forces that go beyond individual actions and their effects on others.

Beck's analysis develops this line of argument into a pointed critique of risk management in modern societies. He assumes that collective actions that impose risks on third parties cannot be justified any more by referring to collectively accepted goals, such as progress or economic development. These goals have lost their intuitive attractiveness, as individuals have become more exposed to the negative side effects of technological and social change (Beck, 1992a). In addition, the plurality of values and lifestyles makes it impossible to generate a collective understanding of 'what is good for society'. In this situation, organizations need external legitimization for pursuing their goals and objectives. Among the sources for legitimization are scientific, economic and political institutions (Beck, 1995; O'Brien, 1999). Risk management institutions, for example, rely on science and technology as a common reference for justifying collective action for imposing risks on third parties without their consent. Such exercise of risk imposition provides a narrow ribbon of legitimization to each partner within the economic transaction or social interaction, without being forced to be accountable for negative side effects.

In line with this argument, Beck regards technical risk assessment as one of the powerful strategies for both: the image of scientific reasoning provides the aura of universality, and the reference to technology supplies the promise of societal control. Beck's analysis points towards significant biases in technical risk assessments. He claims that risk assessors in science and government systematically underestimate the real threats, and that they rely on a methodology that is aimed at legitimizing ubiquitous exposure of society to incalculable risks.

Once risk management organizations are caught in the de-legitimization crisis, they might evolve into reflexive entities that are open to sail in a chaotic sea of fast-changing value systems, competing knowledge claims and institutional constraints (Beck, 1994). Individuals, on the other hand, orient themselves in accordance with reference group judgements, but are confused by the plurality of lifestyles and value systems. In the context of modernization, they need to gain ontological security and some stability of their life-world (Beck, 1992a, based on Giddens, 1984). These primary goals are constantly threatened by risk producers who impose risks on all members of society (without their consent) and, hence, destroy the basis of their own livelihood. Beck does not offer a solution to this problem other than the suggestion to place more trust in sub-political civil society actors, and to refuse licensing any technical facility that cannot insure its maximum losses (Beck, 1997, 1999).

In the light of social theory of risk and recent empirical research, several of Beck's assumptions have been challenged by many sociologists and philosophers (Alexander, 1996; Lupton, 1999; O'Malley, 2000; Stehr, 2001; Elliot, 2002; Münch, 2002; Boyne, 2003; Tulloch and Lupton, 2003; Mythen, 2005; Campbell and Currie, 2006; response by Beck et al, 1998). First, his characterization of technical risk assessments is rather doubtful. As explained earlier in the section on 'The past as a guidebook for the future: Technical risk assessments', calculating magnitudes and probabilities is not an ideological strategy to sell unacceptable risks to the public, but provides a coherent and consistent method for presenting information on the relative potential for harm to individual and social decision-makers. Multiplying both components (magnitude and probability) in order to receive a single risk number may, indeed, 'favour' high-consequence, low-probability risk-producing technologies; but even this is not necessarily the case. In the aftermath of Chernobyl, the nuclear proponents experienced a real dilemma, when opponents used their methodology of risk assessments to calculate the number of additional expected cancer cases in Western Europe. Multiplying a marginal increase of individual cancer probability by more than 30 million people exposed to small increases of radiation (using linear dose–response functions) resulted in a provocatively high number of more than 20,000 additional cancer cases for a time period of 50 years. The Department of Energy published these numbers under the protest of most radiation physicists (Hohenemser and Renn, 1988). Similar experiences were reported in the recent BSE case in Europe, where probabilistic risk assessment produced rather high numbers of potential victims. The methodology of probabilistic risk assessments may have its systematic biases, but it does not support only one interest in society. Furthermore, by knowing these biases, risk managers can use the main messages from these assessments and still correct for the potential biases that are, or may be, implicitly embodied in this method.

Second, Beck's notion of reflexive organizations, that organize constant feedback with the outside world and show flexibility and skills of fast adaptation to internal and external constraints, contrasts with some of the main findings of the research into high-reliability organizations (Weick, 1987; Roberts, 1989; Rochlin, 1993; Schulman, 1993). High-reliability organizations are entities that have a much better safety record than the average high-risk organization. Although redundancy in organizational control and constant feedback were identified as major elements of these organizations, they could hardly be classified as reflexive. Many of them belong to the military complex and others had been characterized by features such as stable hierarchies and restricted communication channels. Their main asset was their dedication to safety issues and a clear line of command and accountability. Furthermore, these organizations made clear distinctions between what they believe society demands from them and what they internally believe are necessary precautions. They behave largely like rational actors once the goals are set and the means are clearly defined and monitored.

Third, the impression of people suffering from ubiquitous risks imposed on them by capitalist interests is certainly not a recent development in the evolution of technology and private enterprises. Whether one agrees with this characterization of capitalism is not the point. The main problem is that imposition of risks on others has been a timeless experience of the poor during all of human history (Mythen, 2005). As long as political domination existed, there was at least an attempt to impose the negative side effects of one's own activity upon others. The claim that such risks are now ubiquitous rather than local does not make a major difference in the experience of inequities (Abbot et al, 2006, pp230f). The novel character of risk does not seem as novel as Beck claims (O'Malley, 2000). In essence, there are only a few reasons left why the risk society should be called the risk society.

Finally, the moderate realist perspective of Beck (1999, pp146ff) requires an answer to the pressing question of what kind of knowledge society should select, foster or develop in order to cope most effectively with the real threats (Campbell and Currie, 2006). If technical assessment is regarded as ideology, how can one tell whether a risk is real or not? This may not pose a difficult problem if clearly unwanted technologies are discussed. But what about genetically altered pharmaceuticals, waste reduction facilities, recycling stations, or liquefied-gas tanks? If these technologies imply real threats to people, would it not be wise to assess them as accurately as possible? Putting this burden on the insurance companies does not resolve the problem because they also need a methodology to assess risks. They must decide on some rationale whether to offer insurance or not. In a realist perspective, one may criticize the techniques or methods used in the technical communities to asses risks; but there is little justification to replace risk assessments by something else – for example, public perceptions.

In terms of the three leading questions, the theory of reflexive modernization addresses outcomes as a social construction of those who are deliberating different options for actions. These constructions are based on social and cultural orientations rather than factual expectations. The uncertainty of these outcomes are captured by the strength of subjective belief and the doubt about the ability of any knowledge system to provide accurate risk assessments. The aggregation of likelihood and outcome is part of a larger process by which genuine uncertainty prevails over the questions whether the desired outcome materializes in the first place or is overcompensated by negative side effects. The idea of rational decision-making is an illusion in this view of the world since modernity offers no firm anchor for making reliable and inter-subjectively valid predictions.

Systems theory

In a system theory perspective, risk is understood as a fundamental social construct that is closely linked to the particular rationality of subsystems in society. According to this theory (in particular, referring to Niklas Luhmann), human societies are organized as a variety of self-referential or autopoietic (self-organizing) systems which define their own reality as well as an image of the world outside (Luhmann, 1984, 1986b; see Bailey, 1994; Fuchs, 2001). Systems include functional entities such as the law, the economy and the political hierarchy. Since all systems and their subsystems depend upon internal order and systemic interactions with other systems in the outside world, they have generated special communication media (such as legal codes, money and power) to serve these needs. These media operate to ensure internal order and to provide the necessary exchange with external systems (Luhmann, 1982a). The sustainability of social systems depends upon the ability to exchange media. Media form the (binary) code of interaction within and between systems.

An important new feature to emerge in post-modern systems is the system-specific construction of risks and threats (Luhmann, 1990). Luhmann does not deny the possibility that systems can produce 'objective' knowledge about the world, but points out that each observer is imprisoned in a social system that provides constructed meaning, rationality and identity. Indeed, even the notion of individuality or agency, anointed by English-speaking social philosophy and some sociological theory with primacy, is an outcome of systems rather than a prime element in creating systems. It is, therefore, impossible for any system to predict accurately the outcome of its own activities beyond its own system boundaries since the consequences of these activities are co-determined by the actions of other systems, a feature Luhmann refers to as double contingency (Luhmann, 1982a, 1984). Each system is thus trapped in a web of external (double) contingencies and uncertainties.

A key feature of this construction is the distinction between risk and danger. Social systems and subsystems define the conditions for externalizing or internalizing 'threats to health and the environment' from one system or subsystem to another. In the terminology of Luhmann, hazards perceived as external threats to a system are called dangers, while hazards that pose internal (and thus manageable) threats are called risks. This seemingly trivial semantic distinction embeds a deep theoretical demarcation within Luhmann's framing. It addresses the recurrent contradiction where people perceive human life as becoming increasingly riskier, while at the same time other indicators of life chances, such as life expectancy, continue to improve in all affluent and even most developing countries.

From this perspective, neither hazards nor 'objective' threats have necessarily increased in terms of lives lost. Rather, social systems have increasingly internalized external threats – i.e. dangers – and have, thereby, transformed them into risks. Fates, acts of God, random events, catastrophes of all sorts, or capriciousness of nature remain as constructs for describing dangers. Similar to Beck and Giddens, Luhmann argues that the more social systems act to shape the future and influence fate, the more dangers are internalized and, axiomatically, the more risks are created. For example, climate – once thought a function of nature's caprice – is now viewed as significantly shaped by humans and is, therefore, a risk. With the rapid and uninterrupted growth in internalized dangers (risks), the orderly functioning of social systems is threatened.

Owing to the growing diversity of knowledge claims and social norms, social systems tend to circumscribe the experience of their members within their own system, limiting their exposure to external systems. Yet, they have no integrative system – or anything approaching a meta-system – at their disposal for dealing with the evolved plurality, diversity and complexity that interfere with inter-system communication. The potential for a specific phenomenon to be constructed as a risk in one system and a danger in another impedes communication between systems. Nuclear power illustrates this point: Shareholders of a nuclear power plant perceive the possibility of a nuclear accident as an external danger, not a risk (they typically live far from the plant and trust that the manager engineers who run the plant know what they are doing). Simultaneously, these shareholders worry about the risks of a stock market crash that could render their nuclear investment worthless (Luhmann, 1989). Typical residents around a nuclear plant may care less about the stock market, an external danger, but live under the fear that they are exposed to radiation or other unacceptable risks.

Since those who create risks expose others to hazards, there is always the potential for incongruence between the risk takers and risk bearers in Luhmann's perspective. The fact that this problem is real makes it independent of the perceived magnitude of risks or the (socially constructed) balance between risk and danger, as well as risk and benefit. This resultant dilemma is not the fault of risk management institutions as, for example, claimed by Beck (1992b) and Giddens (1994). Instead, systems and their managers are caught in the inevitable contradiction of devoting their energies to the regulation of risks, while it is external dangers (risks in other systems) that people fear most. To deal with this systemic dilemma, risk creators (and, as a means for exculpation, public risk managers) use formal tools of risk analysis to justify and legitimate the acceptance of risks, while risk bearers use perceptions of dread and consequences, cultural interpretations or competing professional judgements as a justification for rejecting dangers. Each line of reasoning is incompatible with the other, and there is no communication medium available for reconciling these opposing positions on risk-taking. Luhmann (1993a, p159) put it this way: 'With respect to the risk perspective in the future, neither consensual agreement on facts nor on values will be of any help; on the contrary, they will further aggravate the conflict.' As a consequence, the political system is unable to resolve risk conflicts. System functioning is, therefore, continually threatened, as is communication among systems.

The increasing multiplicity of systems and system agents – which markedly increases the number of contingencies – and the heightened degree of social and cultural complexity, and differentiation within and among systems, introduce additional uncertainties (conflicts between expected and experienced outcomes). The only opportunity for a communicative exchange between systems is to provide opportunities for conveying the rationale of one to the other. Although sceptical about the potential power of discourse, Luhmann (1989) still advocates deliberative dialogues between the various systems. Far from resolving or even reconciling conflicts, deliberation in this context has the potential to decrease the pressures for conflict, to provide a platform for making and challenging claims, and to guide the actions of the political system. It relieves tensions, but it will not resolve anything.

As much as systems theory is able to provide explanations for system behaviour when potential consequences are either uncertain or contested, it offers few clues of how contemporary societies reach closure on collectively binding standards or decisions (Renn, 2004b). Yet it is obvious that such decisions are made routinely.

For example, virtually all nations reach conclusions about tolerable levels of health risk and establish regulations for enforcing standards. In addition, the regulatory agencies of the political system are forced to establish standards and rules that cut across a variety of social systems. They select risks from multiple systems and conceptualize their commonality by defining the demarcation lines between dangers and risks. Autopoietic independence may, indeed, be the major goal of individual systems within a society; but the vitality and functionality of society as a whole rests on the effectiveness of inter-systemic communication – a form of communication that is common and often effective.

In terms of the three leading questions, systems theory stresses the importance of social or cultural frames for selecting outcomes and providing meaning to them. Depending on the reference system, risks refer to loss of money (economic system), power (political system), solidarity (social system), health (health care system) or legal security (legal system) among others. The impacts of these system-based risk targets are incompatible with each other and cannot be translated into a common currency. Neither money nor 'utils' as suggested by the economic risk concepts can serve as a common denominator for different types of risk experiences. The uncertainty of these outcomes is not provided by scientific calculation or subjective beliefs but by the system-specific rules for resolving complexity and contingency. The same is true for the aggregation of likelihood and outcome. The equal weighting of both components is a typical rule in the technical systems but not in the economic or legal system. Each system provides its own aggregation rules independent of individual preferences or scientific conventions.

Critical theory

Critical theory, particularly Jürgen Habermas's (1970b, 1984, 1987a) theory of communicative action and of communicative competence respectively (1975, 1984, 1987a), comprises a body of thought based on an extended criticism of modernity that emphasizes the contradictions and untoward consequences of advanced or late capitalism. It is based on a set of normative assumptions that are the most explicitly teleological among sociological schools of thought. Critical theory has been developed out of a branch of revisionist neo-Marxist political theory, and continues with its aim towards transformative socio-political action by explaining how the emancipation of all oppressed people and groups can be achieved at the political, social and psychological levels (Habermas, 1975; Forester, 1985; Agger, 1998). In both extending and reorienting critical theory, Habermas assumes people are rational, in the universal and substantive sense, and that they possess the uniquely human quality of communicative rationality.

Critical theory is partially based on a systems perspective, but assumes an overarching rationality that bridges the partial rationalities of other social systems and of the institutions found in a pluralist society (Habermas, 1991a). Critical theory suggests that, due to the decline in the Enlightenment belief of a universal rationality, new social norms and values need to be generated. The fundamental goal of these emergent elements of rationality is to provide collective orientations that do not conflict with personal aspirations and agency (Habermas, 1969, 1970b, 1989, 1991b;

McCarthy, 1971, 1973). The new form of universal rationality is communicative rationality. It embraces Weber's two forms of rationality – instrumental and value rationality – but is not identical with them. Communicative rationality is the result of argumentation on the basis of claims according to rules that can be specified for different types of statements (speech acts, as Habermas calls them) or discourses (e.g. therapeutic discourse or normative discourse). The exchange of arguments can produce this overarching rationality in a discourse setting in which arguments count, irrespective of their sources or the power of the actors involved. Communicative rationality allows actors to reach consensus on the basis of mutual understanding of facts, values, experiences and normative assumptions.

In contrast to systems theory, in which such new norms are part of an evolutionary process remote from any individual 'voluntaristic' influence, critical theory believes in integrative potential through a free and open discourse. Such discourse is not an arena for resolving conflicts about competing claims (as is practised in conflict-resolution models based on RAP), but as an arena for the establishment of commonly agreeable social norms or values. All participants voluntarily agree to accept the quest for common principles of evaluating validity claims and to comply with these principles via discourse because they perceive them to be intuitively valid and socially rewarding.

Citizens are quite capable of the rational assessment of their political worlds – and, by extension, their risk worlds. Similar concepts of communicative rationality have also been proposed by the new communitarians (Etzioni, 1968, 1991).

But Habermas argues that the present capitalist economic system has transformed an increasing number of genuine social relationships (in the terms of Habermas the 'life-world') into externally controlled actions, while the political system inherently suffers from a chronic shortage of public legitimacy since the political system must take actions more in service to the power distribution in society, rather than considerations of fairness or a rational balance between social benefits and risks (Habermas, 1975, 1991a).

Risks have emerged as dominating phenomena demanding political intervention and management. Decisions by the political system, based as they are on the exercise of power – rather than, e.g. a fairness doctrine – perpetuate an inequitable distribution of risks. The only viable solution to overcome this imbalance is to create a forum for open discourse, where all actors have the opportunity to argue their interests and to resolve their conflicts in an equitable and rational manner. The process of discourse must be fair, transparent and truthful (Webler, 1995; see Chapter 8 and Essay 9 in this volume).

Whatever the reasonableness of Habermas's theory, it offers little guidance for explaining mechanisms of selection for public participation, or the method for introducing and interpreting competing pieces of evidence, or the specific means for aggregating competing preferences, or for selecting the specific types of arenas where discourse should take place. Because of the episodic nature of social movements, discourse on a large scale is consequently intermittent and unpredictable – not a regular process with the capacity for addressing the growing number of risk management challenges (Pellizoni, 2001; Chilvers, 2008). Nevertheless, Habermas does establish the foundation to guide these details of action – sufficiently, so that there are a number of efforts to establish the procedures and arenas for communicative discourse (e.g. Renn et al, 1993; Renn and Webler, 1998; Renn, 1999a; Webler, 1999). While still experimental and while yet to attain the conditions outlined by Habermas, these efforts are guided by, consistent with and indicative of Habermas's evolutionary framework.

Critical theory is not specific about the three guiding questions concerning outcomes, uncertainty and aggregation. The main message of critical theory is that outcomes and side effects of human action can be addressed by a discursive activity linking instrumental, normative, expressive and communicative rationality. The world of RAP is only one element of this overarching rationality that includes socially rewarding experiences beyond individual utility. Altruistic considerations play a role in this comprehensive discourse, as well as personal relationships and cultural bonds. In contrast to the theory of reflexive modernization and systems theory, critical theory assumes a realistic potential for successful and meaningful interaction between systems and between risk creators and risk victims. Societies can effectively deal with complexity and contingency of risks if the discourse settings and the political conditions for discourse are appropriate. There is little mention of uncertainty in critical theory. One can assume, however, that uncertainties can be properly handled by being methodologically rigid when it comes to factual uncertainty and by being truthful and open when it comes to behavioural uncertainty (what will people do?) and by being consistent and ethically justified when it comes to normative uncertainty.

Post-modernism

Post-modern theorists have developed the most radical view on constructivism. Knowledge, moral norms and aesthetic values represent nothing more than power-induced constructions of groups who abuse claims of universality for reasons of influencing or manipulating others (Lyotard, 1984; Ewald, 1986; Foucault, 1991; Smart, 1996; Dean, 1999; see overview in Jaeger et al, 2001, pp221ff). Independent of the question of whether an objective reality exists, post-modernists believe that all claims towards an objective world are guided by personal interests and group-specific reasoning. They are interested in revealing the hidden power motives behind claims of individuals and groups to enforce behavioural, moral or cognitive norms on others. Risks are part of this game to legitimize power. Disguised by allegedly scientific rationale, people are coerced into accepting nuclear power, genetically modified organisms, industrial agriculture, nanotechnologies, etc. Fear is generated by reports on AIDS, new epidemics, bad nutritional behaviour, and so on. The effect of these truths and moral claims is to create conformity. However, conformity does not refer to a neutral common orientation for enabling collective order. It is shaped by the interests of those who define conformity and determine what is deviant behaviour. Similar arguments have been raised from a feminist perspective on risk: the way society frames and evaluates risks reveals hidden agendas about gender stereotypes and leads to inequalities between men and women (Harding, 1992).

The main purpose of the social sciences is not to provide additional truth claims from the social realm, but to provide evidence and indications for the hidden relationships between power and collective claims (Foucault, 1994). To deconstruct existing and powerful social constructions of truth, moral judgement and aesthetic values is the 'noble' goal of the science communities devoted to this school of thought.

Risk is not at the centre of post-modern thinking. Many post-modernists are radical individualists who believe that the individual is able to cope with contingencies and to arrive at the most appropriate balance of expected positive and negative outcomes. However, what is seen as risks and what as benefits, and to what degree, depends upon the framing of social forces (for an explanation of framing, see Tversky and Kahneman, 1987; adjustment to post-modern theory is explained in Tagg, 1992, pp170ff). Reducing the workforce of a factory can be framed as a benefit to the stakeholder, as a risk to the workers, as a healthy adjustment for the economy, and as a sign of negative selection for society as a whole. Depending upon the frame, individuals may change their balance sheets. When making prudent choices, individuals should be made aware of the many frames, be informed about the hidden interests and be radically truthful to their intuitions.

Post-modern theory has alerted risk analysts to the importance of framing and cultural biases in assessing and evaluating risks. However, they do not offer any substantial advice on how to make collective decisions and how to find closure once all perspectives and arguments are openly debated and justified by the adherents. Collective decision-making – e.g. to determine a level of acceptable risk – is alien to their thinking, although such decisions have to be made in society.

In terms of the three leading questions, post-modernists take the most radical position. Outcomes can only be seen from the perspective of each individual. There is no universal rationality. Any knowledge claims from scientific or regulatory authorities are interest-driven activities to maintain power. Uncertainty judgements in their eyes lend themselves to creating fear or confidence thus manipulating individuals to subordinate themselves under an allegedly common cause. Evoking fear helps to demand solidarity against a common threat; referring to confidence leads people to increased complacency, as they are told that more competent institutions make the 'right' decisions on their behalf. Finally, context conditions determine the legitimizing power of aggregation rules that in essence are arbitrary but framed in ways that they justify collective actions or restrictions of individual freedom. For example, the threat of terrorism is framed by political elites in a way that the likelihood is highly exaggerated (or the low probability of being affected downplayed) and the randomness of becoming a victim emphasized in order to legitimize restrictions of personal freedom, whereas the same elites emphasize the low probability of an accident and the remoteness of becoming a victim when they try to legitimize nuclear power stations.

Cultural theory of risk

Similar to the post-modern thinkers, cultural theories of risk treat risks as social constructs that are determined by structural forces in society. Issues such as health threats, inequities, fairness, control and others cannot be determined by scientific analysis, but only reconstructed from the beliefs and rationalities of the various actors in society (Douglas and Wildavsky, 1982; Rayner, 1987, 1992; Schwarz and Thompson, 1990; Thompson et al, 1990; Dake, 1991; Grendstad, 2000). The fabric and texture of these constructions reflect both the interests and values of each group or institution in the various risk arenas and the shared meaning of terms, cultural artefacts and natural phenomena among groups. Risk policies result from a constant struggle of all participating actors to place their meaning of risk on the public agenda and to impose it upon others. The need to compromise between self-interest (i.e. constructing one's own group-specific reality) and the necessity to communicate (i.e. constructing a socially meaningful reality) determines the range and limitations of possible constructs of reality. Technical risk analyses are not necessarily superior to any other construct of risk because they are also based on group conventions, specific interests of elites and implicit value judgements.

The cultural perspective on risk is more specific in identifying the dominant cultural patterns than most of the post-modern theorists when it comes to identifying different patterns that are supposed to determine individual and social responses to risk (for an overview, see Jaeger et al, 2001, pp183ff; Zinn and Taylor-Gooby, 2006a, pp37f). Organizations or social groups belonging to the *entrepreneurial* prototype perceive risk-taking as an opportunity to succeed in a competitive market and to pursue their personal goals. They are less concerned about equity issues and would like the government to refrain from extensive regulation or risk management efforts. This group contrasts most with organizations or groups belonging to the *egalitarian* prototype, which emphasizes cooperation and equality rather than competition and freedom. Egalitarians focus on the long-term effects of human activities and are more likely to abandon an activity (even if they perceive it as beneficial to them) than to take chances. They are particularly concerned about equity. The third prototype (i.e. the *bureaucrats*) relies on rules and procedures to cope with uncertainty. As long as risks are managed by a capable institution, and coping strategies have been provided for all eventualities, there is no need to worry about risks. The fourth prototype, the group of *atomized or stratified individuals*, principally believes in hierarchy; but it misses group identity and a system of social bonding. These people trust only themselves, are often confused about risk issues, and are likely to take high risks for themselves; but they oppose any risk that they feel is imposed upon them. At the same time, however, they see life as a lottery and are often unable to link harm to a concrete cause.

There has been an intensive debate in the social science community about the validity of these prototypical descriptions in terms of theoretical reasoning and empirical evidence (Nelkin, 1982; Funtowicz and Ravetz, 1985; Johnson, 1987; Bellaby, 1990; Shrader-Frechette, 1991; Rosa, 2000; Breakwell, 2007, pp72ff). First, many critics claim that cultural theory does not distinguish between individuals as carriers of cultural convictions and social aggregates. Second, the relationship between cultural prototype and organizational interest is seen as unclear and problematic. If cultural affiliation precedes interest, then what determines to which cultural prototype individuals, groups or organizations belong? Third, the selection of the five prototypes as the only relevant cultural patterns in modern society needs more evidence than the reference to tribal organizations (Douglas, 1985) or generic models of human interactions (Wildavsky and Dake, 1990). Furthermore, if prototypes are mixed in organizations, then the perspective (similar to many sociological concepts) is not falsifiable. Any observed behaviour is compatible with some mix of prototypes.

Fourth, the cultural perspective has not provided sufficient empirical evidence of its validity (Sjöberg, 1997).

As valuable as cultural studies on risk have been in showing the relativity of scientific reasoning in the social and cultural context of processing risk information, they also carry the danger of solipsism (i.e. the belief that all knowledge about the state of the world is relative to its spectator and thus not applicable to anyone else) (Rayner, 1987, pp6f; Searle, 1995; Rosa, 1998). This view of collective knowledge is not only theoretically difficult to defend, it is also empirically invalid. Even everyday experience tells us the opposite daily. Almost all cultures are concerned about avoiding physical harm and, without any doubt, modern societies are strongly concerned about health impacts and ecological damage.

The cultural theory of risk has its shortcomings and its merits. The reduction of cultural clusters to basically three important prototypes (entrepreneurial, egalitarian and bureaucratic) may be a valid and intuitively plausible hypothesis in analysing risk responses, but it should be treated as a hypothesis rather than the exclusive explanation. The emphasis on values and world views rather than interests and utilities (which in themselves are reflections of one world view) is a major accomplishment of this theory. Whatever the 'real' cultural patterns may be, cultural analysis has demonstrated to the risk professionals that the concept of risk assessment as well as the rationale behind it cannot claim universal validity and legitimizing power among all groups and cultures. There are varying world views that determine how different groups cope with the universal experience of potential outcomes of actions and events. Diverse world views include different knowledge structures and value systems. For example, the selection of physical harm as the basic indicator for risk may be seen as irrelevant for a culture in which violations of religious beliefs are perceived as the main risks to society.

In terms of the three leading questions, cultural theory of risk addresses outcomes as genuine expectations that different (sub)cultures associate with different consequences of decision options or events. In contrast to the post-modern theorists or system theorists the range of possible expectations is limited to a small set of cultural prototypes. These prototypes determine both what is selected as a desirable or undesirable outcome and how uncertain or certain these outcomes are being perceived. The aggregation of likelihood and outcome is also modified by the dominant beliefs within each cultural prototype. In particular, context variables such as perceived equity play a major role in forming an overall judgement about the acceptability of risks.

Social amplification of risk

The concept of social amplification of risk is based on the thesis that the social and economic impacts of an adverse event are determined by a combination of the direct physical consequences of the event and the interaction of psychological, social, institutional and cultural processes (Kasperson et al, 1988; Renn, 1991, Renn et al, 1992; Kasperson et al, 2003; Breakwell 2007, pp224ff). The scholars who developed this framework were motivated by the lack of integrative theories of risk and the inadequacy of the two main approaches at the time – psychometrics within the psychological risk concepts and cultural theory among the social science perspectives – to capture the complex risk experience of individuals and social entities. The framework of social amplification has been designed to include these alternative approaches and provide a consistent analytic structure for investigating psychological, social and cultural factors of risk perception and risk responses. Amplification in this framework includes both intensifying and attenuating signals about risk. Thus, alleged overreactions of target audiences receive the same attention as alleged 'downplaying'.

Social interactions can heighten or attenuate perceptions of risk (more information in Essay 4). By shaping perceptions of risk, they also influence risk behaviour. Behavioural patterns, in turn, generate secondary consequences that extend far beyond direct harm to humans or the environment. Liability, insurance costs, loss of trust in institutions or alienation from community affairs are a few such examples. Secondary effects such as these are important because they can trigger demands for additional institutional responses and protective actions. They can also – in the case of risk attenuation – impede the installation of protective actions.

The amplification process starts with either a physical event (such as an accident) or the recognition of an adverse effect (such as the discovery of the ozone hole). In both cases, individuals or groups will select specific characteristics of these events or aspects of the studies and interpret them according to their perceptions and mental schemes. These interpretations are formed into a message and communicated to other individuals and groups (Renn, 1991). Individuals in their role as multipliers or representatives of groups collect and respond to information about risks and act as 'amplification stations' through behavioural responses or communication. Amplification stations can be individuals in socially exposed positions, groups or institutions.

The behavioural and communicative responses are likely to evoke secondary effects that extend beyond the people directly affected by the original hazard event. Secondary impacts are, in turn, perceived by social groups or institutions so that another stage of amplification may occur to produce third-order impacts. The impacts may spread or 'ripple' to other parties, distant locations or other risk arenas. Each order of impact will not only disseminate social and political impacts, but may also trigger (in risk amplification) or hinder (in risk attenuation) positive changes for risk reduction.

In the framework, risk is conceptualized partly as a social construct and partly as an objective property of a hazard or event (Short, 1989, p405). This avoids the problems of conceptualizing risk in terms of total relativism or technological determinism. The experience of risk is not only an experience of physical harm, but also the result of a process by which individuals or groups learn to acquire or create interpretations of hazards. These interpretations provide rules for selecting, ordering and explaining signals from the physical world. Both processes may have physical consequences. Hazards may directly impact upon health. Communication about risks may result in changes in technologies, methods of land cultivation, or the composition of water, soil and air.

The social amplification concept is useful for selecting, ordering and classifying social phenomena and for suggesting causal relations that can be investigated empirically. It provides a heuristic tool for the analysis of risk experience. One can also think of it as a dynamic framework that allows for systematic interpretation of empirical data while attempting to integrate differing perspectives on risk. Several empirical applications have been reported, and the results have been used to refine the framework (Kasperson et al, 1988, 2003; Machlis and Rosa, 1990; Burns et al, 1993; Frewer et al, 2002a; Rosa, 2003; Masuda and Garvin, 2006). One review described it as a 'framework that, like a net, is useful for catching the accumulated empirical findings, and that, like a beacon, can point the way to disciplined inquiry' (Machlis and Rosa, 1990, p164).

The social amplification metaphor has evolved as an umbrella framework that provides ample space for social and cultural theories (Kasperson, 1992; Kasperson et al, 2003). It is not based on a nomological theoretical concept, but rather on the simple insight that social experiences of risk are only partially determined by the experience of harm or even expected harm. The distinction between individual, social or institutional amplification stations corresponds with the two traditions in risk perception: the individual processing of information and the social responses to risk based on experience of (dis)trust, the political arena conditions and cultural affiliations. It provides a more holistic picture of the risk perception process and takes into account psychological, sociological and cultural aspects. Yet it fails to provide a synthesis of the technical, natural science, economic, psychological and social science approaches to risk.

In terms of the three guiding questions, the social amplification process focuses on the parallel processing of social constructions and physical impacts in risk assessment. The outcomes are both real and constructed. Their relative importance varies from context to context and from culture to culture. Uncertainty is understood as an integral part of the frame that analysts and representatives of different groups use in characterizing risks. Most importantly, the aggregation process is governed by amplification and attenuation processes that depend on the characteristics of the risk and its embedding in a social and cultural context.

Synopsis of social science approaches

The social science perspectives on risk include a multitude of undesirable or desirable effects that people associate with a specific cause, leading to consequences for something that people value (Kasperson and Pijawka, 2005, p31). Individuals respond according to their perception of risk and not according to an objective risk level or the scientific assessment of risk (Sjöberg, 2006, p694). The main insight is, however, that focusing on effects and likelihood alone is merely of limited use for social orientation. First, maximizing outcomes may not be the main objective of social actions in situations where overarching social goals – such as building solidarity, demonstrating empathy or strengthening one's identity – are pursued. Second, even if the individual perceives the situation as one of personal choice, the inability to predict outcomes, the interferences of one's own action with the actions of others, and the presence of competing and conflicting values and preferences make it difficult, if not impossible, to base one's own decisions on the evaluation of expected outcomes (Jaeger et al, 2001, pp247ff). Third, even if evaluation of outcome is the preferred strategy, this optimization is not only governed by magnitude and probability, but is also enriched by the perceived presence of situational and risk-specific characteristics, such as the degree of perceived personal control, the perception of a social rather than an individual risk or the familiarity of the risk situation, and others (Boholm, 1998). Risk evaluation by individuals can, hence, be characterized by a functional relationship representing perceived violations of what humans value, perceived patterns of occurrence, and social context variables. Fourth, most people rely on information from third parties when they are faced with unknown risks. In this situation, they can either trust the information or not since they have no (empirical) way of proving one side wrong or the other. They have no lab at their disposal in order to investigate the risks of BSE, acrylamide, electromagnetic fields or genetically modified plants. They rely on trustworthy information from experts or risk managers. For risk professionals, it is therefore essential to build a trusting relationship with their target audiences. Trust, however, relies more on institutional arrangements, cultural traditions and symbolic interactions than on factual evidence (Löfstedt, 2005). Risk managers are, therefore, in need of good social science advice when it comes to building and sustaining trust and credibility.

Another major insight from the social science studies on risk has been the importance of procedure or due process for making decisions (Renn et al, 1993; Renn, 2004b; Lidskog, 2005; Kasperson, 2005b). People are not only concerned about the risks that are imposed on them, but also about the process by which the decision has been made. In particular, they demand that those affected by a decision will also have the opportunity to be involved in the decision-making process. While in many European countries the legal process of involvement is structured by law and does not leave many choices in the selection of processes or participants, the American tradition of participation is less rigid in structure and encourages public expectations that, without prior consent, decisions cannot be implemented. Insufficient public involvement is often a cause for litigation and political protest. Litigation, however, is not only costly and time consuming; it also results in often unsatisfactory resolutions of the conflict since the legal system is not prepared to adequately cope with problems in which highly technical aspects are at the centre of the controversy. In the US, and recently also in Europe, procedures of mediation have gained more and more popularity as a means of incorporating public concerns into the decision process without sacrificing technical expertise or rational reasoning (Amy, 1987). Mediation is also less expensive and time consuming than litigation. Risk managers should, therefore, be aware that risk reduction may not be at the heart of a risk controversy, but, rather, the process by which decisions on risks were made. In democratic societies, people demand procedural fairness and expect risk management institutions to demonstrate that fair procedures have been used (Linnerooth-Bayer and Fitzgerald, 1996).

In terms of the three guiding questions, cultural and sociological approaches imply that the definition of the desirability or undesirability of outcomes, the generation and estimation of possibilities, as well as the formulas to combine both aspects depend upon the social context and the cultural affiliation of the respective social group (Shubik, 1991; Kasperson, 2005a). Society is experiencing an increase in pluralism of values, lifestyles and knowledge systems (Beck, 1992b). Many philosophers and social scientists claim that communication between these pluralist groups has become more and more difficult and is likely to be impossible in the near future (Luhmann, 1990, 1997). Since the experience of risk spans the boundaries of confined social groups, communication is a prerequisite for risk management and policy implementation (Leiss, 1996; OECD, 2002). It is thus essential to provide semantic and organizational tools for creating a common language base among and between different groups, and to find new means of mediation and conflict resolution among the different stakeholders (Webler, 1995).

Where to go from here: An attempt to integrate risk concepts

What are the major lessons to be learned from this review of different disciplinary perspectives on risk and its function for risk analysis? Are there opportunities to integrate technical and social science perspectives on risk, and how should one go about it? Our analysis has shown that technical analysis provides society with a narrow definition of undesirable effects and confines possibilities to numerical probabilities based on relative frequencies derived from experiments, models, expert judgements, and so on. However, this narrowness is a virtue as much as it is a shortcoming. Focused on real health effects or ecological damage, technical analyses are based on a societal consensus of undesirability or desirability and a (positivistic) methodology that ensures equal treatment for all risks under consideration (Merkhofer, 1984). The price society pays for this methodological rigour is the simplicity of an abstraction from the culture and context of risk-taking behaviour. In addition, there is no universally accepted or rationally required strategy for evaluating different options with uncertain consequences. Whether one prefers the decision rules of expected values, qualified percentiles within the confidence interval, the maximin principle (maximizing the minimum gain) or other legitimate rules of selection depends upon personal preferences and values. There is more than one legitimate and rational answer to the question of handling uncertainty (Cullen and Small, 2004, p186). In a democratic society, scientists cannot claim more power in making this decision than anyone else.

The social science perspective on risk broadens the scope of undesirable effects, includes other ways of expressing possibilities and likelihoods, and expands the horizon of risk outcomes by referring to 'socially constructed' or 'socially mediated' realities. The social experience of risk includes the perception of actual damage; but it is more focused on the evaluation of the risk context, the non-physical impacts and the associations between the risk and social or cultural artefacts (Otway and von Winterfeldt, 1982). If all society cared about was to reduce the amount of physical harm done to its members, technical analyses and some form of economic balancing would suffice for effective risk management. Included could be the perspective of organizational sociology to make sure that technical safety measures are paralleled by institutional control and monitoring (Perrow, 1984; Freudenburg, 1992). The social sciences would only be needed to sell the risk management packages to the 'misinformed' public via risk communication. But society is not only concerned with risk minimization (Douglas and Wildavsky, 1982; Leiss, 1996; O'Malley, 1996).

People are willing to suffer harm if they feel it is justified or if it serves other goals. At the same time, they may reject even the slightest chance of being hurt if they feel the risk is imposed upon them or violates their other attitudes and values (Fischhoff et al, 1985; MacLean, 1986; Linnerooth-Bayer and Fitzgerald, 1996). Context matters. So does procedure of decision-making, and independence of outcome. Responsive risk management needs to take these socially mediated consequences into account. In particular, the social science perspectives on risk can enrich and inform risk management in the following manner (Fischhoff, 1994):

- identify and explain public concerns associated with the risk source;
- explain the context of risk-taking situations;
- identify cultural meanings and associations linked with special risk arenas;
- help to articulate the objectives of risk policies in addition to risk minimization, such as enhancing fairness and institutional trust, and reducing inequities and vulnerability;
- design procedures or policies to incorporate these cultural values within the decision-making process;
- design programmes for participation and joint decision-making;
- design programmes for evaluating risk management performance and organizational structures for identifying, monitoring and controlling risks.

The inclusion of the social science perspectives for normative use in policy-making faces two major drawbacks. First, the advice of social scientists will vary considerably depending upon the world view and approach taken by the individual expert. Second, unlike the technical or economic perspective, the social science concepts offer no common denominator for measuring cultural or social acceptability (Kasperson, 2005a). What constitutes a value violation for one group may be perfectly in line with the values of another. Who is going to decide which social construction of reality has more validity than another competing construction?

The first issue of theoretical pluralism is a benefit as much as a shortcoming. As demonstrated in the discussion on the social theories, risk behaviour cannot be explained in total by any of the major sociological theories, including the predominant rational actor approach. The choice of the appropriate theory may, first of all, rest on the assumptions of analysts, most notably whether they perceive risks as real threats or as social constructions. More relevant for our discussion here is the observation that different risk situations may require different theoretical frameworks for their analysis. If outcomes are known, preferences clear and personal actions can be performed without major interferences from others, the rational actor models basically provide an accurate explanation and prediction of risk behaviour. If preferences are unclear or need to be formed as a result of discursive processes, the theory of communicative action may furnish the most adequate basis for understanding risk behaviour and designing commonly shared risk management policies. If people have little knowledge about outcomes or expect large interferences, systems theory may offer some interesting theoretical ideas of how to identify orientation marks independently of perceived outcomes. In those cases where institutions need reassurance from their social and cultural environment, the theory of reflexive modernization may provide clues of what should be monitored and observed in order to develop a better match between performance and plural expectations of individuals and groups in society. Lastly, post-modern and cultural theory can assist risk managers and communicators in addressing different audiences and with what responses to expect given their cultural preferences and rationales.

Coping with the second problem of plural value input and the normative validity of social claims requires more than good social science and a receptive risk communicator. It is obvious that a simple or even complex algorithm of multidimensional decision-making would not resolve the potential conflicts between competing social constructions, although formal multi-attribute decision analysis may provide an excellent framework for structuring problems and decision options within a single social and cultural context (Gregory et al, 2001). There is also no impartial referee available to judge the appropriateness of cultural constructions. The only viable resolution of these conflicts in democratic societies is to initiate a discourse among the major parties involved in the decision-making process or affected by the decision outcomes (Stolwijk and Canny, 1991; Webler, 1999; Renn, 2004b; see Essay 9 on public participation in this volume). The 1996 report by the US Academy of Sciences on risk characterization has emphasized the need for such open discourses (Stern and Fineberg, 1996). A dialogue with the public can be organized, for example, in the form of advisory committees, citizen panels and formal hearings. Democratic values can provide the means by which to construct this dialogue, and the social science perspectives can help to make these forms of dialogue work (i.e. to make sure that each group can bring their own interest and values to the process and yet reach a common understanding of the problem and the potential solutions) (Fiorino, 1989b). Participation is not only a normative goal of democracy, it is also a requirement for rational decision-making in situations in which risks need to be evaluated (Jasanoff, 2004).

Risk management implies value judgements on three levels. The first set of value judgements refers to the list of criteria on which acceptability or tolerability should be judged (HMSO, 1988; IRGC, 2005); the second set of value judgements determines the trade-offs between criteria; and the third set of values should assist in finding resilient strategies for coping with remaining uncertainties. Using informed consent on all three value inputs does not place any doubt on the validity and necessity of applying the best technical expertise for defining and calculating the performance of each option. The magnitude of risks should reflect technical expertise in the best possible way since 'real' victims are at stake. Setting priorities within risk management, however, would imply having diverse social or political forces determine the criteria of judging tolerable levels of risk, where technical assessments are used as one important input, among others, in comparing different options. Public input is, therefore, a crucial contribution to determining the objectives of risk policies and to weighing the various criteria that ought to be applied when evaluating different options.

If such a joint effort were to be pushed on the public agenda of risk management, the notion of risk society and its connotation of risk legitimization, rather then risk reduction, would probably lose its intuitive attraction. The idea behind the risk society has definitely helped risk professionals to reflect on the meaning of risk and to pay attention to the social and cultural objectives of risk management in modern societies

(Dietz and Rycroft, 1987). Sociological analyses of risks addressed major weaknesses in the technical assessment of risk, as well as in management routines. As much as technical analysis is required to broaden the scope of research targets, as well as to improve their handling of uncertainty, the field of social sciences also needs to sharpen its analytic tools in risk analysis. The primary objectives of social science research is to inform policy-makers about public concerns, to develop better methods of mutual communication, and to provide models for the type of discourse required to bring technical analyses in line with the social and cultural needs of societies (Fischhoff, 1995; Chess et al, 1998; Jaeger et al, 2001, pp282ff; Renn, 2004b). The dual nature of risk as a potential for physical change and as a social construction demands a dual strategy for risk management. Public values and social concerns may act as the driving agents for identifying those topics for which risk assessments are judged necessary or desirable. The central task – of balancing the opportunities and risk of modern technologies and other human activities in accordance with the needs and visions of those who ought to be served – requires a plural, yet integrated, attempt to have technical and social sciences join forces to shape a humane future in line with best available knowledge and a consensus on social expectations.

2

Pre-assessment: Setting the Stage[1]

OVERVIEW OF THE RISK GOVERNANCE FRAMEWORK

The risk governance framework that we propose in this volume consists of four consecutive phases:

1 pre-assessment;
2 appraisal;
3 characterization/evaluation; and
4 management.

Risk communication accompanies all four phases. Each phase specifies activities that I believe are important elements for good governance. This simple framework is in line with almost all other competing concepts and ensures the compatibility of the framework with professional codices and risk governance legislation. Moreover, it has transformed the linear structure more commonly found in other contemporary conceptions of risk governance (RCEP, 1998; Prime Minister's Strategy Unit/UK Cabinet Office, 2002) into an open, cyclical, iterative and interlinked process, shown in Figure 2.1.

The four phases correspond to the two major challenges of risk governance: generating and collecting knowledge about the risk, and making decisions about how to mitigate, control or otherwise manage it. These two challenges are illustrated by the two activities portrayed on the horizontal axis: appraisal and management. However, there are two additional phases in which knowledge and values are closely intertwined: pre-assessment and characterization/evaluation. These two phases are located on the vertical axis and constitute interfaces between knowledge and values. During the phase of pre-assessment, the problem is framed and defined, and the terms of reference are specified. This task needs to be governed by societal values (stating the goals, objectives and contextual conditions) and inspired by what we already know about the hazard (suspected impacts, exposure, persistence and others) (Zinn and Taylor-Gooby, 2006b). Similarly, when looking at all the evidence collected and condensed in the phase of characterization/tolerability

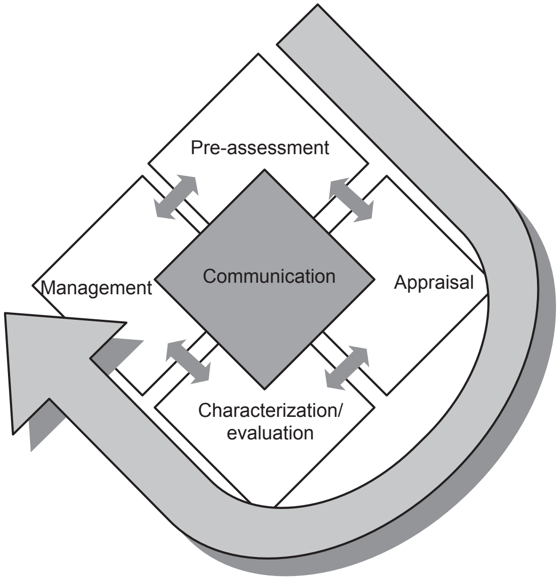

Figure 2.1 *The five elements of risk governance*

Source: adapted from IRGC, 2007, p6

judgement, a good understanding of this evidence, as well as a prudent judgement competence for making the necessary trade-offs between risk, benefits and other important impact categories, is essential for an effective governance process. This design of the four phases avoids the naive separation of facts here and values there, but also escapes the solipsism of post-modern relativity by honouring the analytical distinctions between the factual world and the world of values even if they clearly interact.

The pre-assessment phase

A systematic review of risk-related actions needs to start with an analysis of what major societal actors, such as governments, companies, the scientific community and the general public, select as risks and what types of problems they label as risk problems (rather than opportunities or innovation potentials, etc.). In technical terms, this is called **'framing'**. Framing in this context encompasses the selection and interpretation of phenomena as relevant risk topics (Tversky and Kahneman, 1981; van der Sluijs et al, 2003; Goodwin and Wright, 2004). The process of framing is already part of the governance structure since official agencies (e.g. food standard agencies), risk and opportunity producers (such as the food industry), those affected by risks and opportunities (such as consumer organizations) and interested bystanders (such as the media or an intellectual elite) are all involved and are often in conflict with each other when framing the issue. What counts as risk may vary among these actor groups. Consumers may feel that all artificial food additives pose a risk, whereas industry may be concerned about pathogens that develop their negative potential due to the lack of consumer knowledge about food storage and preparation. Environmental groups may be concerned with the risks of industrial food versus organic food. Whether a consensus emerges on what requires consideration as a relevant risk depends upon the legitimacy of the selection rule.

The acceptance of selection rules rests on two conditions: first, all actors need to agree with the *underlying goal* (often legally prescribed, such as prevention of health detriments or guarantee of an undisturbed environmental quality – for example, purity laws for drinking water); second, they need to agree with the *implications derived from the present state of knowledge* (whether, and to what degree, the identified hazard affects the desired goal). Even within this preliminary analysis, dissent can result from conflicting values, as well as conflicting evidence, and in particular from the inadequate blending of the two. Values and evidence can be viewed as the two sides of a coin: the values govern the selection of the goal, whereas the evidence governs the selection of cause–effect claims. Both need to be properly investigated when analysing risk governance; but it is of particular importance to understand the values shaping the interests, perceptions and concerns of the different stakeholders, as well as to identify methods for capturing how these concerns are likely to influence, or impact upon, the debate about a particular risk. The actual evaluation of these impacts should then be effected in the most professional manner, including the characterization of uncertainties (Keeney, 1992; Gregory, 2004; Pidgeon and Gregory, 2004).

A second part of the pre-assessment phase concerns the institutional means of *early warning and monitoring*. This task refers to institutions of government, business or civil society identifying unusual events or phenomena (e.g. disease registries, biodiversity indices, climate indices and environmental quality monitoring) in order to detect new emerging risks and to provide some initial insight into the extent or severity of these risks. Furthermore, public efforts are needed to monitor the environment for recurring risks (such as infectious diseases) or newly evolving risks. Many countries face problems in monitoring the environment for signals of risks. This is often due to a lack of institutional efforts to collect and interpret signs of risk and deficiencies in communication between those looking for early signs and those acting upon them. The 2004 tsunami catastrophe in Asia provides a more than telling example of the discrepancy between the possibility of early warning capabilities and the decision to install or use them. It is therefore important to look at early warning and monitoring activities when investigating risk governance.

In many risk governance processes, information about risks are pre-screened and then allocated to different assessment and management routes. In particular, industrial risk managers search for the most efficient strategy to deal with risks. This includes prioritization policies, protocols for dealing with similar causes of risks, and optimal models combining risk reduction and insurance. Public risk regulators often use pre-screening activities to allocate risks to different agencies or to predefined procedures. Sometimes risks may seem to be less severe, and it may be adequate to cut short risk or concern assessment. In a pending crisis situation, risk management actions may need to be taken before any assessment is even carried out. A full analysis should, therefore, include provisions for *risk screening* and the selection of different routes for selection, prioritization, assessment and management of risks. This aspect has been called *'risk assessment policy'* by the Codex Alimentarius Commission (2005). It is meant to guide the assessment process in terms of risk selection, defining priorities, and determining assessment and management protocols, including methods of investigation, statistical procedures and other scientific conventions used in assessing risks or selecting risk reduction options. A screening process may also be employed when characterizing risks according to complexity, uncertainty and ambiguity, as is explained later in this chapter.

Another major component of pre-assessment is the *selection of conventions and procedural rules* needed for a comprehensive appraisal of the risk (i.e. for assessing the risk and the concerns related to it; see below). Such conventions cover existing scientific, legal, political, social or economic conventions. Any such assessment is based on prior informed, yet subjective, judgements or conventions articulated by the scientific, legal or user community, or other policy-related bodies. Of particular importance are conventions that govern the risk assessment process. These judgements refer to the following (Pinkau and Renn, 1998; van der Sluijs et al, 2004, pp54ff):

- the social definition of what is to be regarded as adverse – e.g. by defining the no-observed-adverse-effect-level, for example for contaminants or additives in food (NOAEL);
- the selection rule determining which potentially negative effects should be considered in the risk governance process, knowing that an infinite number of potential negative outcomes can theoretically be connected with almost any substance, activity or event;
- the aggregation rule specifying how to combine various effects within a one-dimensional scale (e.g. early fatalities, late fatalities, cancer, chronic diseases and so on);
- selection of the testing and detection methods, which are currently used in risk assessment (e.g. the use of genomics for calculating risk from transgenic plants);
- selection of valid and reliable methods for measuring perceptions and concerns;

Table 2.1 *Components of pre-assessment in handling risks*

Pre-assessment components	Definition	Indicators
1 Problem framing	Different perspectives of how to conceptualize the issue	• Dissent or consent on the goals of the selection rule • Dissent or consent on the relevance of evidence • Choice of frame (risk, opportunity, fate)
2 Early warning	Systematic search for new hazards	• Unusual events or phenomena • Systematic comparison between modelled and observed phenomena • Novel activities or events
3 Screening (risk assessment and concern assessment policy)	Establishing a procedure for screening hazards and risks, and determining an assessment and management route	• Screening in place? • Criteria for screening: – hazard potential – persistence – ubiquity, etc. • Criteria for selecting risk assessment procedures for: – known risks – emergencies, etc. • Criteria for identifying and measuring social concerns
4 Scientific conventions for risk assessment and concern assessment	Determining the assumptions and parameters of scientific modelling and evaluating methods and procedures for assessing risks and concerns	• Definition of no-observed-adverse-effect-levels (NOAELs) • Validity of methods and techniques for risk assessments • Methodological rules for assessing concerns

Source: adapted from IRGC, 2005, p26

- determination of models to extrapolate high-dose effects to low-dose situations (e.g. linear, quadro-linear, exponential or non-linear functions or assumptions about thresholds or non-thresholds in dose–response relationships);
- the transfer of animal data to humans;
- assumptions about the exposure or definition of target groups;
- the handling of distributional effects that may cover inter-individual, inter-group, regional, social, time-related and intergenerational aspects.

These judgements reflect the consensus among experts or are common products of risk assessment and management (e.g. by licensing special testing methods). Their incorporation into guiding scientific analyses is unavoidable and does not discredit the validity of the results. It is essential, however, that risk managers and interested parties are informed about these conventions and understand their rationale. On the one hand, knowledge about these conventions can lead to a more cautious appraisal of what the assessments mean and imply; on the other hand, they can convey a better understanding of the constraints and conditions under which the results of the various assessments hold true.

In summary, Table 2.1 provides a brief overview of the four components of pre-assessment. It also lists some indicators that may be useful as heuristic tools when investigating different risk governance processes. The choice of indicators is not exhaustive and will vary depending upon risk source and risk target. Listing the indicators serves the purpose of illustrating the type of information needed to perform the task described in each step. The title 'pre-assessment' does not mean that these steps are always taken before assessments are performed. Rather, they are logically located at the forefront of assessment and management. They should also not be seen as sequential steps, but as elements that are closely interlinked. As a matter of fact, and depending upon the situation, early warning might precede problem framing and could benefit from 'non-systematic' findings and incidental/accidental reporting. Pre-assessment can be viewed as an opportunity for early prevention of more serious threats. Careful framing, screening and selection of rules are essential for reducing overall risk by preventing decision-makers from neglecting key risks or concerns and facing unpleasant surprises later on.

Essay 2 *Farewell to the 'Risk Society'? The 1986 Crisis and its Repercussions for the Politics of Risk*[2]

An anniversary revisited

The year 2006 marked the 20th anniversary of three major technical disasters: the Chernobyl catastrophe, the *Challenger* accident, and the pollution of the Rhine River after a fire destroyed a chemical storage building in Basle, Switzerland. These three events had lasting repercussions on public opinion. Even before 1986, many surveys in the US, Canada and most of Europe had shown an ambivalent position of most people with regard to the opportunities and risks of large technological systems.[3] Risk perception studies and investigations of popular attitudes towards technologies showed that people were concerned about the environmental and health-related impacts of large-scale technologies, but, at the same time, assigned a fair proportion of trustworthiness to the technical and political elite. Although trust had been eroding since Three Mile Island and the debate on nuclear waste, at least in the US (Bella et al, 1988; Kasperson et al, 1999), most Americans, as well as Europeans, were convinced that large-scale technologies such as nuclear power or waste incinerators were necessary, but highly unwanted, manifestations of modernity. Furthermore, opinion polls provided evidence that the 'culture of experts' was credited with know-how and problem-solving capacity; but they did less well in the human warmth and moral motivation stakes (Otway and von Winterfeldt, 1982; Barke and Jenking-Smith, 1993). The ecologists and technology critics, on the other hand, were seen as sincere and brave fighters with convincing arguments, but lacking in real technical knowledge. The lasting public image was the *rationality* of the science and technology expert versus the brave *morality* of the ecologist.

The technology camp seemed to have the stronger public support, and the representatives of the technical elite certainly seemed to dominate official policy. Their risk assessments provided sufficient reassurance that the intuitive perception of immanent threats was unwarranted. The technical elite was not only able to reassure the public that design criteria for large technologies and risk management practices would be sufficient to contain the catastrophic potential of these technologies, they were also successful in convincing governments or public management agencies that large-scale technologies had a legitimate role to play in modern society. The official line was: as long as the risk of a major catastrophe was small enough, society had to be able and willing to accept the remaining risks. Despite a large number of initiatives against the highly unpopular nuclear industry, despite persistent protests against the building of new chemical plants or the expansion of airports, despite new alternative movements springing up all over the place, the movers and shakers in the technology sector were able to influence Conservative, Liberal and Social Democratic parties in all Western countries. In Germany, more and more nuclear power stations became functional; in Switzerland, all referenda before 1986 decided in favour of keeping nuclear power stations in operation, and in Sweden, a referendum decided in favour of a limited-term operation of the existing nuclear power stations. Other European countries slowed down the pace of developing these unpopular technologies; but on the whole, there was no sign of a moratorium and even less of any political U-turns.

This picture changed dramatically after the three disasters in 1986. Supporters of large-scale technologies were on the defensive, while sceptics began to define the new thinking on risk. Now the experts were taken to task not only for lacking morality, but also for lacking rationality. An immediate consequence of this was that virtually all European countries, with the exception of France, deferred the development of nuclear energy. In Germany, after long and acrimonious arguments, the project of reprocessing nuclear waste was completely abandoned. Later, the new government of 1998 decided to phase out nuclear power altogether. In Austria, the building of nuclear power stations was stopped by a referendum, and in Switzerland a moratorium on further development of nuclear plants was enforced. But nuclear energy was not the only technology that fell into discredit after thorough scrutiny. There was a massive mood of non-acceptance towards the chemical industry, towards waste recycling plants and towards road-building schemes, airport expansions and, finally, the setting-up of the first laboratories and production plants for applying genetic engineering (Bastide et al, 1989; Hampel, et al, 2000; Sjöberg et al, 2000a). The magic words of the late 1980s were: decentralization, supply close to the consumer, renewable sources of energy, ecological farming methods, expansion of local public transport infrastructures, and development based on 'soft' technologies. This new perspective on risk was further expressed through tougher safety criteria and the rigorous implementation of the precautionary principle (Sand, 2000). The politics of risk were now based on the principle of 'better safe than sorry'. In the decade between 1986 and 1996, there was hardly anyone who wanted to be seen as a supporter of large technological plants. If there were any arguments in favour of using existing plants, they were based on purely economic reasoning. Extensive technological risk was tolerated, at best, as a transitional phenomenon. Large-scale technologies had inadvertently been put on the defensive: a number of technology experts disappeared and concealed their ambitious projects from the hostile *Zeitgeist*.

In essence, the decade between 1986 and 1996 was characterized by a clear defensive attitude of the risk assessment community, a growing distrust in scientific expertise and risk management agencies, and the formation of a powerful counter-elite, who challenged the official risk assessments of the former experts and demanded new directions in technological policies. Many people felt that the risk assessments of the pre-1986 period were discredited by the events of the year 1986.

Sociological reflection of the 1986 risk crisis

More by coincidence than by systematic marketing, two important sociological books on risk were published in 1986.[4] Both books had been written before the three accidents; but they appeared on the scene at the right time: *The Risk Society* by Ulrich Beck and *Ecological Communication* by Niklas Luhmann (both published in 1986). Although both authors represented different theoretical backgrounds and pursued a very different line of thinking, they offered an explanation for the obvious gap between the reassuring risk assessments of the technical elite and the experience of disasters by the public. Beck's book entered the bestseller list in Germany within six months, and Luhmann's work was reprinted several times despite the fact that people unfamiliar with the terminology of systems theory had a hard time understanding the language, let alone the message the book tried to convey. What was the reason for their immediate success?

In the tension between private values and perceptions and the official strategies of a 'culture of 'experts' that was recognized as rational but remained, nonetheless, rather unloved, the disillusioned populace found the basis for their newly bred scepticism in the analysis of the two German sociologists – something like an answer to their prayers. Their findings resonated with a population fed up with the seemingly unshakeable beliefs of the 'expertocracy' (Cohen, 1999).

Luhmann's central argument was that the 'culture of experts' had no more claim to intrinsic truths than any other branch of culture or science, and that the decision to make something acceptable was simply a product of selective perception, as well as a result of partial rationalization processes in society.[5] Based on the observation that life expectancy of individuals increases in modern Western societies while perceptions of security decrease, Luhmann introduced the distinction between danger and risks (Luhmann, 1990). Danger is what people are exposed to; risk is what they have chosen to dare. Since those who create risks expose others to dangers, congruency between the risk takers and the risk bearers is not possible. This problem is independent from the perceived magnitude of risks or the (socially constructed) balance between danger and safety. Risk management institutions are not at fault as Beck would claim, but are inadvertently caught in the inevitable dilemma of regulating risks while people fear dangers. In this dilemma, risk creators (and, as a means for exculpation, public risk managers) use probabilistic reasoning for justifying and legitimizing their risk-taking behaviour, while the victims – the risk bearers – will use perceptions of threat or alternative professional judgements as a justification for rejecting dangers. Both lines of reasoning are incompatible with each other, and there is no methodology available to reconcile the two different positions on risk-taking. This is the reason why the political system is unable to resolve risk conflicts.

Conversely, Beck's analysis pointed towards significant bias in technical risk assessments. He claimed that risk assessors in science and government systematically underestimate the real threats and rely on a methodology that is aimed at legitimizing ubiquitous exposure of society to incalculable risks. Beck argues that the experts operate within a strategy to legitimize political and economic interests by 'relativizing' the incalculable and unlimited risk exposures. The multiple association between probability and the extent of potential damage is, according to Beck, a strategy of immunization on the part of the technology enthusiasts against rationally valid arguments for reasonable precautions against risk and, above all, against empirical evidence. The logic of probabilistic analysis technique 'invites' accidents to happen at any time, even in conditions of minimal probability.[6] This makes the idea of *antidotes* – sequel to *The Risk Society* – particularly attractive, allowing new methods of rationalizing risk and providing ammunition to those who neglect the politics of risk prevention and follow the inexorable logic of expanding technological modernization (Beck, 1988). Perrow's work on organizations or Rayner's work on fairness made similar claims before 1986 (see Perrow, 1984; Rayner, 1984; review in Short and Clarke, 1992); but Beck succeeded in bringing different traditions and empirical findings of sociology together, and provided a consistent and rounded explanation for the confusing risk situation in the aftermath of three major disasters. In addition, by placing the risk society in the context of reflexive modernization, a subject that has been a top priority on the agenda of renowned European sociologists such as Giddens (1990, 1994) and Lash (2000; Lash and Urry, 1994), he managed to integrate the risk issue within an overarching sociological theme.

Beck's analysis has been a starting point for many new ideas in sociology. Although it took almost six years before both books were translated into English, the term 'risk society' became a general theme of sociological work during the late 1980s and throughout the 1990s. At a recent conference in Oxford on the sociology of risk, all 23 papers made explicit reference to at least one of Beck's publications. The concept of risk society has obviously been successful in becoming a prevalent and ubiquitous subject of international sociology. Moreover, Beck's interpretation of risk matches the predominant feelings and attitudes of most people in modern Western societies with regard to large-scale technologies and their proponents. Finally, the works by Beck and Luhmann contributed to a general shift of the risk issue away from the technical sphere to the social sciences. During times in which the risk debate centres around equity, distributional effects, organizational constraints and political legitimacy, rather than on magnitude and probability, technical risk professionals have only a limited role to play. Risk has become the domain of psychologists, sociologists and policy analysts.

Nobody has expressed this new paradigm in a more pronounced manner than Sheila Jasanoff of Harvard's Kennedy School of Government (Jasanoff, 1999, p150):

> *I have suggested that the social sciences have deeply altered our understanding of what 'risk' means – from something real and physical, if hard to measure, and accessible only to experts, to something constructed out of history and experience by experts and laypeople alike. Risk in this sense is culturally embedded in texture and meaning that vary from one social grouping to another. Trying to assess risk is therefore necessarily a social and political exercise, even when the methods employed are the seemingly technical routines of quantitative risk assessments.... Environmental regulations call for a more open-ended process, with multiple access points for dissenting views and unorthodox perspectives.*

The Empire strikes back: The revenge of the technical elite

During the first decade after the environmental disasters of 1986, technical risk professionals were forced into a defensive position. Many technical professionals were either hibernating in their own communities or trying (sometimes desperately) to incorporate public outrage into their decision or assessment models. However, after 1996 the wind changed direction again.

The previously rejected opinions of experts re-emerged with a certain amount of *Schadenfreude*, announcing that the disasters of 1986 were not such terrible disasters after all. The Rhine has recovered from the Schweizerhalle accident much more quickly than even the most optimistic opinions would have dared to predict. Until very recently, there were no more disasters associated with space flights to mirror the *Challenger* episode. And, according to toxicologist experts, even the great reactor accident of Chernobyl caused fewer deaths than the public was led to believe.

In the spring of 1996, the European Environmental Foundation and the Ciba-Geigy Foundation invited experts from all over the globe to St Petersburg for a symposium on the ecological and health consequences of Chernobyl (the proceedings are published in Lake et al, 1997). Convincing statistical and scientific reports soon reduced the expected horror vision of thousands of cancer deaths to 1000 new cases of cancer of the larynx. With immediate specialist treatment, cancer of the larynx is not usually fatal and chances of recovery are very good. No significantly higher occurrence of leukaemia and no other health problems related to being exposed to radiation (one should, however, mention the fate of the so-called 'liquidators', who suffered serious diseases or even death as a result of their clean-up operation at the reactor site!). The famous US radiation expert Malvin Goldberg warned of the consequences of added psychological pressure that the awareness of risk can bring to an illness. Risk scientists saw it as their sworn task to 'tell the whole truth' in situations where people would perceive a terrible threat, which in the objective opinion of most experts simply did not exist. Only this would be a real help to people.

Thus, the seemingly apocalyptic incidents of the year 1986 become just an episode in the succession of tragic, but ultimately natural, events – such as dams breaking, hurricanes, floods and earthquakes. So, have we come full circle? Are we hailing the end of the risk society? It looks as if many risk scientists are once again reverting to style: the politics of risk have to be measured in real damage expected to be caused per unit of time.

This impression was echoed at the 1996 annual European Society for Risk Analysis conference in Guildford, the UK. Assembled members nearly choked on their canapés when they listened to their lunchtime speaker, the president of their international headquarters, risk researcher John Graham, who had been invited to give the lunchtime address (Graham, 1996). Instead of showering them with the usual pleasantries, Graham launched an attack on his social scientist colleagues. He argued that far more people than necessary are dying because environmental and health policies are based on the irrational fears of laypeople, rather than on objective risk calculations conducted by experts. In this way, great risks such as nicotine and even the pollution of homes from radon are played down, while negligible risks, such as the development of dioxin in incineration processes, are blown up into catastrophes. This trend is made worse by the growing (false) notion of democratizing specialist knowledge. Out of an understandable wish to conform with an egalitarian *Zeitgeist*, social scientists who work in the area of risk analysis are opening a veritable Pandora's box that will lead to a complete fudging of the differences between reality and what is perceived as reality. What is needed, however, is to turn away from that pleasing illusion of equality between expert knowledge and lay perception. He stressed that the perception of risk by laypeople could not play a central part in the political process of risk regulation.

This speech was not only aimed at sociologists such as Beck or Luhmann, but it attacked the great number of risk psychologists who, since the end of the 1960s, had raised the popular perception of risk to the status of an object of research. These psychologists were able to prove scientifically that the experts' preferred way of perceiving risk as a result of probabilistic analysis technique is diametrically opposed to the intuitive perception and evaluation of risk (see the classic article by Fischhoff et al, 1978; see also Slovic et al, 1981a; Fischhoff, 1985). While scientific risk analysis aims at assessing the average expected damage per unit of time, according to lay perception, qualitative notions such as voluntary consent to risk-taking, control over risk, the question of risk distribution across different parts of the population and, above all, the potential for disaster (the worst possible scenario, independent of the probability of its occurring) carry far more weight when it comes to perceiving and evaluating risk (Boholm, 1998; Rohrmann and Renn, 2000). In order to resolve this conflict between risk assessment and risk perception, many analysts from the field of social sciences advocated mutual coexistence based on implicit consensus among risk scientists, which, until recently, has been accepted worldwide: for a rational politics of risk, it is necessary to recognize both elements – scientific risk assessment and risk perception by laypeople – as two legitimate parts of the process. Thus, risk managers were looking for a politics of risk that would pursue a third way beyond expert opinion and lay perception. The risk psychologist Peter Sandman, influential adviser to the US government and industry, found a simple formula for this need: risk is to be understood as a function of expert risk analysis and public outrage (Sandman, 1988).

The concept of the coexistence of analysis and perception matched the theory of post-modern thinkers about scientific truth claims and their illusion of objectivity. Any opinions or truths can be seen as acceptable depending upon one's perspective; competing demands on truth, justice and fairness can be dealt with only on a proportional basis (Liberatore and Funtowicz, 2003; Jasanoff, 2004, pp41–42). Luhmann had diagnosed modern society's inability to fully integrate the variety of social life designs and rules into a reasonably balanced concept. If this were true, then society would have no choice but to live with pluralist concepts of risk. In the post-modern world, the culture of experts has no more clout than any other culture. Truth and morality are thus negotiable, and risk becomes a question of individual and collective perception (for a review, see Jaeger et al, 2001, pp193–208). If there is an influential group of people who add risk to a particular technology, then this risk has to be minimized, if at all financially viable, no matter how beneficial this will prove according to expert statistics. If necessary, technology has to be sacrificed on the altar of acceptability, as the case of nuclear energy shows. In such a situation, attitudes towards risk and risk politics are largely an end product of a process of social mobilization and communication.

The promise of coexistence lost its attraction in the course of the 1990s. After more than a decade, memories of the three accidents of 1986 were fading and the old fears were losing their power. And times have changed. The call to return to technical expertise, rather than to be guided by public concerns, appeared in a multitude of risk publications and speeches (Breyer, 1993; Graham and Wiener, 1995; Coglianese and Lazer, 2003). The sudden revitalization of an old concept about the significance and role of science and technical expertise for risk analysis and management did not occur by chance. There were several reasons for this new development:

- Funds for risk reduction became an increasingly scarce resource compared to the 1980s and early 1990s. As long as risk managers had large budgets to spend, it was relatively easy to please both camps: the experts and the public. Money was spent simultaneously on the top entries of the experts' and the public's list of risk reduction priorities. After the collapse of the new economy, governments were forced to place more emphasis on efficiency. Every penny spent on minimizing risk today would be used at the cost of realizing another objective that society demands. The cost of improvements to environmental quality rose even higher (due to diminishing marginal utility). At the same time, there was no money for other essential areas, such as education on preventive health care. One example has been the debate about tougher limits to electromagnetic radiation, whose implementation would cost millions (Kunsch, 1998; Kemp and Greulich, 2004). There was no doubt among the experts: no evidence of a health risk. Policy-makers became convinced that implementing tougher measures would overshoot the target in a situation of money problems. In times of tighter budgets and less public attention to environmental issues, risk managers were unable and unwilling to please both 'clients' simultaneously (for the US, see Zeckhauser and Viscusi, 1996; for Germany, see Renn, 2006a). Facing the choice between respecting perceptions or following the advice of hard-nosed scientists, many policy-makers opted for scientific advice, even when facing strong public opposition.
- Pleasing the public turned out to be more difficult than first anticipated. During the 1970s and 1980s, data on public risk perception were often collected on a highly aggregate level (Slovic et al, 1980; a critical review at the time was Otway and Thomas, 1982). The priority list of public concerns was normally based on the average values of individual risk perceptions that reflected either estimates of small groups of respondents or mean values of larger samples. Most risk managers were not aware that these mean values tended to obscure the substantial variance found among individuals. More sophisticated research designs revealed a wide array of risk estimates among individual and social groups, and a variety of risk priorities depending upon group affiliation, personal values and social orientations.[7] Which estimate should then be used for risk management purposes: the average of all groups, the mean value of all respondents with college degrees, the average of all women (since they tend to respond more cautiously than men to most technological risks)? The gap between experts and the public has been transformed into numerous gaps among experts and among publics (Fischhoff, 1996). Confused by this spectrum, many risk managers have abandoned the idea of public input altogether and have returned to the safe haven of institutional or technical expertise.

- Public opposition to technologies and other risk-inducing activities became less pronounced than in previous years. Many former opponents of technology became professionals in risk management and adopted at least parts of the risk assessment methodology of their former foes (Dietz et al, 1989). In Western Europe, particularly in Germany, many risk issues were absorbed by the environmental movement and the Green parties. Similar to the delegation of social concerns to professional groups in the past, many environmentalists delegated their risk-related concerns to professional caretakers of environmental risks. With the success of the Green parties shaping policies from inside the political system, there came the need to compromise and to forge political deals. Once adapted to the language and reasoning of the administrative and political elite, representatives of the Green parties experienced a growing distance between themselves and their more fundamentalist clientele, who, for their part, diverted much of their energy from risk issues (except for all nuclear problems) to issues of sustainable development (such as Agenda 21) or became actively involved in local siting controversies, which tend to have little influence on national or even regional politics (Brion, 1988; Rosa, 1988). With less public support, the concerns of environmentalists and other public groups became less visible in the political arena and, as a result, less important for designing risk policies.
- The vision of society's capacity for unlimited growth proved to be an illusion. The debate on risk and the environment did some pioneer work to facilitate this realization. As early as 1972, the Club of Rome pointed to the limits of economic growth (Meadows et al, 1972, 1992). The dream of continuing growth and increasing wealth was replaced with the nightmare of looming ecological breakdown. For two decades, society appeared to have considered only the ecological limits. During the late 1990s, other limits became visible and palpable in all areas of society: the limits of the welfare state, the limits of economic development (in Germany, the catch phrase is *Standort Deutschland*: Germany as an economic player), the limits of social integration and the limits of developing a more pluralist morality. Money saving, cost efficiency and priorities became the key policy concepts in an economy that has to compete in the global marketplace (Marshall, 1999).
- A politics of risk that tries to satisfy all societal demands for risk minimization was no longer feasible in the face of competing objectives and globalization (Coglianese, 1999). With a globalized economy came the problem of growing mobility in industry. If potentially risky plants are not built at home, there are a number of applicants offering a location abroad. Any toughening of ecological conditions will cause industry to locate in a more tolerant region at the cost of losing jobs at home. For example, when Ciba finally gave up the long struggle with the people of Basle in Switzerland to accept a biotechnical plant, moving it to a site in France near Basle, the citizens of Basle had to come to the painful realization that not only had they lost a large number of jobs and a hefty tax income in this victory, but they were also bearing a large share of the (remaining) risk because of the proximity of the plant. The most ironic outcome was that, in the event, the companies Ciba and Sandoz (synonymous with Schweizerhalle in 1986) merged to become Novartis.

At the end of 1990, the pendulum appeared to swing back to a new era of expert domination in risk policies. At the same time, however, many policy analysts and social scientists warned that ignoring public perception may not only alienate those who feel part of the decision-making process and violate democratic principles, but might also underestimate the potential input into the decision-making process that the public is capable of providing to risk management. If risk managers failed to find a practical procedure of integrating expertise and perception, the re-emerging conflict between the professional risk assessor and the risk bearer would continue to 'haunt' risk managers and prevent society from managing risks in accordance with rational criteria of risk reduction and fair burden-sharing.

The situation today

Starting with the new millennium, the risk debate has moved towards the field of social risks – in particular, terrorism, sabotage, mobbing, depression, suicide and other difficult-to-grasp causes of potential harm (OECD, 2003a). This change in focus has also taken away much heat from the debate about expertise versus perception, the debate about social constructivism versus realism, and science-based versus concern-based policy responses. The new social risks made the old distinctions almost obsolete. In contrast to the plausible assumption that risk consequences are real and their causes are somehow socially constructed, some of the new risks tend to reverse this relationship: the resulting risk symptoms appeared to be socially or psychologically constructed, while many of the causes were quite real (for many psychosomatic diseases). Social constructions such as fundamentalist convictions and religious beliefs turned out to be the main drivers for new risks, while the realization of these risks in terms of bombs and violence were straightforward in their (physical) cause–effect relationship. Probabilistic modelling proved only partially helpful in coping with these risks, and it was clear that social science expertise was badly needed to help understand the mental causes and social reasons for these risks.

Yet, the most dramatic change in thinking about risk came with the emergence of a new type of risk called systemic risks (IRGC, 2005). Systemic risks have evolved from increased vulnerabilities and interconnections between geographic areas, as well as functional dependencies between the various sectors of society such as the physical world, the economy, social relationships and political cultures. Globalization and world trade have augmented the potential for systemic risks to become the major challenge of risk governance in the years to come. The main drivers for this development are:

- increase of population and population density;
- increase of population exposed to natural hazards and technological risks (there has been a dramatic increase in losses, due to natural disasters over the last four decades; during the last decade, natural hazard disasters have resulted annually in an average of 79,000 fatalities, with 200 million people affected, without even counting the 300,000 Asian tsunami victims and the more than 80,000 victims of the earthquakes in Pakistan) (OECD, 2003a, p14);

- increased use of hazard-prone land for productive purposes (for example 40 of the 50 fastest growing urban centres in the world are located in earthquake-endangered areas) (Randall et al, 1996);
- increased interdependencies between technical, social and cultural hazards;
- expected increase of hazard intensity due to climate change and other human interventions into geochemical cycles (IPCC, 2001);
- changes in the social definition of what is regarded as detrimental or hazardous (Freudenburg, 1993);
- growing diversity with respect to lifestyles and subcultures within societies (Sklair, 1994).

At a time when disaster potential is on the increase, the coping mechanisms of many societies appear to have become less effective. In parallel with a rise in hazard potential, vulnerability has increased due to:

- the speed of urbanization (probably two-thirds of the world's population will live in cities after 2020) (Jones and Kandel, 1992);
- insufficient response in building infrastructure to cope with expanding urbanization (OECD, 2003a, pp44ff);
- coupling of independent risk sources (interaction of natural disasters with chemical, technological, lifestyle and social risks) (Renn, 1997a);
- increase of mobility and cultural de-rooting (loss of traditional management capabilities) (WBGU, 2000);
- increase in social pressures and conflicts;
- lack of capacity for mitigation and contingency management (IFRC, 2000).

Given these recent challenges, the world is in urgent need of organizing a concerted effort to deal with systemic risks. In particular, new methodological as well as institutional solutions involving the different levels of risk governance at the local, national, international and global level are required as a means of providing adequate tools for limiting and managing these risks.

The central question for risk managers, such as governmental agencies, corporate risk managers or insurance companies, is how to design suitable approaches and instruments, as well as to develop adequate risk assessment practices in order to understand the impacts of systemic risks and to assess and evaluate their contribution to health-related, environmental, financial and political risks (and, of course, opportunities). In addition, the link to strategic policy concerns as they relate to economic development and governance must be clarified. These new systemic risks are highly complex with regard to their ripple effect on different levels of the physical and social world. They are characterized by wide-ranging uncertainties in relation to long-term effects, and they are faced with numerous viewpoints, opinions and convictions as far as their evaluation by different actors is concerned (Renn et al, 2002). One of the most challenging topics here is the interpenetration of physical, environmental, economic and social risks. Risk management is not only a task for risk management agencies, but also an imperative mandate for organizations dealing with financial arrangements and compensation.

It is not sufficient any more to look into probabilities and damage functions when investigating risks. Risks may trigger off additional ripple effects that promulgate through a whole sequence of secondary and tertiary impacts (for an explanation of the original idea of secondary and tertiary effects by amplification, see Kasperson, 1992; Kasperson et al, 1988, 2003). The tendency of systemic risks to trigger off ripple effects across traditional policy boundaries has fuelled much concern and fear, particularly in relation to financial institutions. Complex cause–effect chains have already made environmental insurance policies a lottery for many companies. The more risks turn out to be systemic, the less pronounced are the boundaries between the traditional confines of risk assessment, risk perception and social coping mechanisms.

There is another aspect that risk managers need to take into consideration. Systemic risks are likely to be transboundary or even global (Linnerooth-Bayer et al, 2001). There is much concern and fear in public perception when it comes to complex global interconnections. The recent, often violent, demonstrations against global multinational organizations or institutions demonstrate the cultural divide between those who believe they will benefit and those who believe they will lose ground from a global governance model. This links back to social risks that have their roots in societal changes with respect to identity, justice and legitimacy.

The promises of new developments and technological breakthroughs need to be balanced against the potential evils that the opening of Pandora's box may entail. This balance is not easy to find as opportunities and risks emerge in a cloud of uncertainties and ambiguities (see Chapter 3 on these two issues). The dual nature of risk as a potential for technological progress and as a social threat demands a dual strategy for risk management. Public values and social concerns may act as the driving agents for identifying those topics for which more refined assessments are judged necessary or desirable. As much as new scientific assessment methods are needed to broaden the scope of research targets, as well as to improve the handling of uncertainty, the expertise of social sciences is necessary to inform policy-makers about new social trends and emerging public concerns, to develop better methods of social foresight, and to provide models for improved risk communication, mandated to bring technical analyses in line with the social and cultural needs of societies. There is no shortage of new problems and challenges in contemporary risk management.

A way out of the risk dilemma

How, then, can one get priorities right in the politics of risk? Who should decide where limited money resources should go? How can modern societies cope with systemic risks on a global level? How should the old divide between social and natural sciences in understanding and managing risk be overcome?

The obvious answer is that we need more cooperation and integration. We cannot allocate money to all risks and need to set priorities. So, if the experts pronounce in favour of noise protection and in ignoring electromagnetic waves, while lay opinion perceives a greater risk in electromagnetic waves, the compromise of 'something for everybody' becomes an impossibility. New strategies must be found.

Such binding strategies will only be possible once we overcome the old assumption that layperson and expert are always in opposition. If everything is based on an average mean value of lay and expert findings – something that some social sciences tend to do – we will, indeed, find a deep rift between these two groups. But this rift obscures the fact that in expert circles, and within the great mass of laypeople, there is an enormous variety of opinions and assessments. Every lay perception has its opposite; every expert has a counter-expert. Different assessments arise depending upon the make-up of a particular group of experts, even if the final decision is made solely by experts. Some of the more constructivist science theorists hold that expert opinion is interchangeable. This is not the case, but expert judgements on risks are by nature uncertain since chance rules over many outcomes. Scientific risk assessments provide ample opportunities for different interpretations on what the risk numbers mean and what actions one should take in view of these numbers. In the same way as the number 0 may come up twice during a game of roulette without any kind of manipulation of the ball or the wheel, two large-scale reactor accidents are not positive or negative proof of such an accident happening once in a thousand years or even once in a million years. It is impossible to predict individual outcome when you only know the odds, and knowledge alone is a limited single resource for determining priorities. Varying levels of knowledge are in competition with each other, and determining which among all the competing claims represents the truth is ultimately not feasible. It is thus impossible to expect an unequivocal expert answer to an urgent question of risk, even if we were prepared to use sound science as a guideline for general risk policies.

At the same time, it is equally unhelpful to base the determination of priorities in the politics of risk on a generalized lay perception. The differences in risk perception among laypeople are as extensive as among experts, and we find the same problem in deciding which lay opinion will be the dominant one when it comes to judging risk. When people talk about risk, they are driven by personal or professional interest. If truth is replaced by interest, however, bargaining power is going to determine what is regarded as truth. This kind of replacement is a breeding ground for fundamentalism, with one side wanting to abolish any possible risk to the environment (jeopardizing the economy in this endeavour), while the other side wants to redefine risk as opportunity without taking ecological issues into account at all. Between these two extreme positions there is hardly any room for compromise other than the strategic kind, where the argument ends up with a philosophy of 'You give me your risk and I will give you mine.'

What is needed to establish the necessary priorities? How can we break this deadlock in determining the rationality of the politics of risk? Is it possible to integrate lay and expert findings? Can we even legitimize the politics of risk?

- We have to let go of the post-modern concept of knowledge being a random social construct and of the idea that there are no predominant criteria for truth or quality. The reality is that people suffer and die as a result of false information. It is particularly important to be quite clear about the limits of legitimate information in a situation of systemic risks, where environmental and technological decisions have far-reaching consequences and where our knowledge is severely limited, particularly regarding secondary and tertiary impacts. It is precisely the fuzziness of systemic risks that demands that we set clear boundaries between what scientific evidence can support and what appears to be nonsense or absurd. If we have no clear boundaries, there will be room for pseudo-scientific legitimization of practically any fear of risk, no matter how far- fetched. We now have a number of methods and techniques at our disposal, such as the meta-analysis or the Delphi technique, and they allow us a fair overview of legitimate knowledge without needing to resort to a jury with overall power of legislation (Webler et al, 1991; Gregory, 2004). The scientific establishment itself has to limit the range of legitimate knowledge because it is bound by scientific rigour and has access to appropriate conflict-resolution procedures, and thus is equipped to resolve competing claims to truth.

- Expert opinion and lay perception need to be perceived as complementing, rather than competing with, each other. In this author's experience of designing public participation exercises on risk acceptance, I have never come across lay participants who insisted on their own perception of acceptable risk being used as a common standard for a collective decision. On the contrary, the first question is usually on the range of expert assessments and their professional evaluations. Once these questions are answered, participants address the political problem of how to deal with the remaining risks and uncertainties that cannot be resolved. Acceptability cannot be set apart from expertise; furthermore, only the best expertise enables prudent judgements to be made about acceptability. The very essence of responsible action is to make viable and morally justified decisions in the face of uncertainty based on a range of expert assessments. These assessments have to be embedded into the context of criteria of acceptable and fair risk, risk distribution and precautionary measures. It is these criteria that most precisely reflect the main points of lay perception. For a rational politics of risk, it is therefore imperative to collect both ethically justifiable evaluation criteria and standards, and the best available systematic knowledge that inform us about the performance of each risk source or risk reduction option on the self-chosen criteria.
- Ultimately, decisions on acceptable risks have to be based on a subjective mix of factual evidence, attitudes towards uncertainties and moral standards. An educated and equitable decision is only possible by discussing these three elements. This is what makes the polarization of the two camps, with experts brandishing rationality, on one side, and counter-experts claiming the moral high ground, on the other side, particularly damaging. Risk management is intrinsically bound up with the knowledge and moral assessment of the expected consequences. There are no logical, factual or scientific guidelines on the question of acceptability of nuclear technology, genetic engineering or waste disposal by incineration. A discourse without a systematic scientific basis is nothing but empty waffle, while, on the other hand, a discourse that disregards the moral aspects of available options will aid and abet amoral actions.

There are, at present, three different types of risk discourse in our society. The first type is subject to the strategy of fear and is rooted in the thinking of the last decade, which conjures up a bleak vision of a technology that is anything but safe, threatening breakdowns, setbacks and, ultimately, catastrophe. In this *communication of fear*, identity is forged by doom-mongers who outdo each other in conjuring up doomsday scenarios, raising a collective self-pity to the status of a post-modern philosophy. A discourse of this type has a paralysing effect on society and restricts activities that encourage the generation of information, as well as debates on ethics. Directly opposed to this is the discourse of risk acceptance. Here, all danger is dismissed as a figment of people's imaginations and there is no limit to the opportunities provided by technology. This type of discourse could be called the *communication of opportunity*: the dominant idea is to ignore objective limits to actions, to see any risk and ambivalence as a challenge. Subjects such as ecological crises, the limits of the welfare state, the struggle of the individual to find meaning, and the moral maze – to name but a few – are seen by this philosophy of opportunity as nothing but superficial red herrings that offer potential for technical and political action. Believers in this kind of thinking require nothing but optimism in order to roll up their sleeves and get on with it. But this discourse ends in permanent self-delusion, often blaming scapegoats who have 'blocked social progress' with their pessimism and their technophobia.

Both the fear and the opportunity types of communication cannot do justice to the complex issues of the politics of risk, particularly systemic risks. I truly believe that the only sensible approach is the design discourse, which allows for the creative perception of real opportunities based on knowledge of inherent boundaries. A healthy fear of the uncertain and an acknowledgement of the boundaries of creative design, on the one hand, and an active power fuelled by positive concepts of the future, as well as an awareness of the necessary technical and organizational backup, on the other hand, will help technological activity (in this situation of uncertainty) to achieve a healthy balance between 'making things happen' and 'allowing things to happen'. Our society is in need of more creative discourse as the only appropriate way of working through the problems and opportunities of future technological development, enabling us to deal wisely with inherent contradictions and uncertainties.

We are still far away from having such design discourses embedded within our political culture. The problem has not been the lack of a culture of debate; rather, it is linking results with official politics, as well as winning public approval. What, then, have we learned from looking back at those three grave accidents of 1986? Accepting technological risk is inevitable in modern industrial societies. However, risk is not entirely unpredictable. It is a product of human decisions. If there is any freedom of choice, the possible options have to be weighed up against each other and the chosen option has to be morally justified. Expert knowledge is an integral part of this decision. Such a process of risk analysis needs a structural framework in which to develop. The answers cannot be found in 'expertocracy' or in plebiscite politics. Instead, they lie in a discourse that emerges from a societal network in which experts, economic and political decision-makers, and risk-bearing citizens can analyse how much risk they regard as acceptable to society. This can happen in the context of well-structured, constructive dialogues that fulfil the task of linking up expert and empirical knowledge, resolving expected conflicts in an exemplary way that sets a precedent for further debate. There are attempts being made at this type of debate. But we need many more of such efforts to heal the breach between knowledge and morality in the politics of risk.

3

Appraisal[1]

Components of appraisal

The term *risk appraisal* has sometimes been used in the risk governance literature to include all knowledge elements necessary for risk characterization and evaluation, as well as risk management (Stirling, 1998, 2003). For society to make prudent choices about risks, it is not enough to consider only the results of (scientific) risk assessment. In order to understand the concerns of the various stakeholders and public groups, information about both risk perceptions and the further implications of the direct consequences of a risk – including its social mobilization potential (i.e. how likely is it that the activity will give rise to social opposition or protest?) – is needed and should be collected by risk management agencies. In addition, other aspects of the risk-causing activity that seem to be relevant for characterizing and evaluating risk and selecting risk reduction options should be gathered and fed into the analysis. Based on such a wide range of information, risk managers can make more informed judgements and design the appropriate risk management options (Clark, 2001). Risk appraisal thus includes two major components:

1. the scientific assessment of the risks to human health and the environment; and
2. the scientific assessment of related concerns, as well as social and economic implications.

The appraisal process is (and should clearly be) dominated by scientific analyses; but, in contrast to the traditional risk governance model, the scientific process includes both the natural/technical as well as the social sciences, including economics. We envision risk appraisal as having two process stages: first, natural and technical scientists use their skills to produce the best estimate of the physical harm that a risk source may induce (as described in the following section); second, social scientists and economists identify and analyse the issues that individuals or society as a whole link with a certain risk. For this purpose, the repertoire of the social sciences, such as survey methods, focus groups, econometric analysis, macro-economic modelling or structured hearings with stakeholders, may be used (Leinfellner and Köhler, 2007).

Based on the results of risk assessment and the identification of individual and social concerns, this second process stage also investigates and calculates the *social and economic implications of risks*. Of particular interest in this context are financial and legal implications (i.e. economic losses and liabilities), as well as social responses, such as political mobilization. These secondary implications have been addressed by the concept of *social amplification of risk* (Kasperson et al, 1988, 2003). This concept is based on the hypothesis that events pertaining to hazards interact with psychological, social, institutional and cultural processes in ways that can heighten or attenuate individual and social perceptions of risk and shape risk behaviour. Behavioural patterns, in turn, generate secondary social or economic consequences that extend far beyond direct harm to human health or the environment, including significant indirect impacts, such as liability, insurance costs, loss of confidence in institutions, or alienation from community affairs (Burns et al, 1993). Such amplified secondary effects can then trigger demands for additional institutional responses and protective actions, or, conversely (in the case of risk attenuation), place impediments in the path of needed protective actions. Secondary impacts, whether amplified or not, are of major concern to those who are obliged to take over the costs or cope with the consequences of being accountable.

Risk appraisal intends to produce the best possible scientific estimate of the physical, economic and social consequences of a risk source. It should not be confused with direct stakeholder involvement, which adds social perspectives for evaluating risks or risk reduction measures. Involvement by stakeholders and the population is only desirable at this stage if knowledge from these sources is needed to improve the quality of the assessments.

Risk assessment

The purpose of risk assessment is the generation of knowledge linking specific risk agents with uncertain but possible consequences (Lave, 1987; Graham and Rhomberg, 1996). The final product of risk assessment is an estimation of the risk in terms of a probability distribution of the modelled consequences (drawing on either discrete events or continuous loss functions). The different stages of risk assessment vary from risk source to risk source. Many efforts have been made to produce a harmonized set of terms and conceptual phase model that would cover a wide range of risks and risk domains (as stated, for example, in: NRC, 1982, 1983; Stern and Fineberg, 1996; Codex Alimentarius Commission, 2001; European Commission, 2000a, 2003a). The most recent example is the risk guidance book by the International Programme on Chemical Safety (IPCS) and the World Health Organization (WHO) (IPCS and WHO, 2004). Although there are clear differences in structuring the assessment process depending upon risk source and organizational culture, there is an agreement on three core components of risk assessment:

1 identification and, if possible, estimation of hazard;
2 assessment of exposure and/or vulnerability;
3 estimation of risk, combining the likelihood and the severity of the targeted consequences based on the identified hazardous characteristics and the exposure/vulnerability assessment.

It is crucial to distinguish between hazards and risks. Correspondingly, *identification* (i.e. establishing cause–effect link) and *estimation* (determining the strength of the cause–effect link) need to be performed for hazards and risks separately. The estimation of risk depends upon an exposure and/or vulnerability assessment. *Exposure* refers to the contact of the hazardous agent with the target (individuals, ecosystems, buildings, etc.). *Vulnerability* describes the various degrees of the target to experience harm or damage as a result of the exposure (e.g. the immune system of a target population, vulnerable groups, structural deficiencies in buildings, etc.). In our view, understanding the vulnerability of a target – whether it is a system, an individual, a community, etc. – is an important part of estimating risk.[2] Vulnerabilities can increase risk, either by influencing the likelihood of some event or the severity of the consequences, should it occur, or both. Decisions about how to manage risks must then also include consideration of ways to reduce vulnerabilities. The issue of vulnerability necessitates a clear distinction between an 'agent', such as an earthquake or a chemical, and the 'risk absorbing system', such as a building or an organism. Vulnerability refers to the quality of the risk-absorbing system to withstand or tolerate different degrees or compositions of the agent to which it may be exposed. For example, a building may be constructed in such a way that it can withstand seismic pressures up to an intensity of *X*; or an organism can be vaccinated so that the outbreak of a specific virus will not harm its health. A risk-absorbing system may include a complex chain of interacting elements, starting with a physical entity such as a complex of buildings and ending with the availability of effective disaster relief organizations.

The basis of risk assessment is the systematic use of analytical – largely probability-based – methods that have been constantly improved over the past years. Probabilistic risk assessments for large technological systems, for instance, include tools such as fault and event trees, scenario techniques, distribution models based on geographic information systems (GIS), transportation modelling and empirically driven human–machine interface simulations (IAEA, 1995; Stricoff, 1995). Regarding human health, improved methods of modelling individual variation (Hattis, 2004), dose–response relationships (Olin et al, 1995) and exposure assessments (US EPA, 1997) have been developed and successfully applied. The processing of data is often guided by inferential statistics and is organized in line with decision–analytic procedures. These tools have been developed to generate knowledge about cause–effect relationships, to estimate the strength of these relationships, to characterize remaining uncertainties and ambiguities, and to describe, in quantitative or qualitative form, other risk- or hazard-related properties that are important for risk management (IEC, 1993; IAEA, 1995). In short, risk assessments specify what is at stake, calculate the probabilities for (un)wanted consequences and aggregate both components into a single dimension (Kolluru and Brooks, 1995, pp2.3f). In general, there are five methods for calculating probabilities:

1 collection of statistical data relating to the performance of a risk source in the past (actuarial extrapolation);
2 collection of statistical data relating to components of a hazardous agent or technology (this method requires a synthesis of probability judgements from component failure to system performance – known as probabilistic risk assessment, or PRA);
3 epidemiological or experimental studies that are aimed at finding statistically significant correlations between an exposure of a hazardous agent and an adverse effect in a defined population sample (probabilistic modelling);
4 experts' or decision-makers' best estimates of probabilities, particularly for events where only insufficient statistical data are available (normally employing Bayesian statistical tools);
5 scenario techniques by which different plausible pathways, from the release of a harmful agent to the final loss, are modelled on the basis of worst and best cases or estimated likelihood for each consequence at each node.

All of these methods are based either on the past performance of the same or a similar risk source, or on an experimental intervention. The possibility that the circumstances of the risk situation vary over time in an unforeseeable way and that people will thus make decisions regarding changing hazards – which, occasionally, may even change in an unsystematic, unpredictable manner – leads to unresolved or remaining uncertainty (second-order uncertainty). One of the main challenges of risk assessment is the systematic characterization of these remaining uncertainties. They can partly be modelled by using inferential statistics (confidence interval) or other simulation methods (such as Monte Carlo); but often they can only be described in qualitative terms.

In this respect, risk analysts have introduced a crucial distinction between *aleatory* and *epistemic uncertainty* (Rosa, 2008, pp109ff):

- *Aleatory uncertainty*. Decision and risk analysts refer to aleatory uncertainties as 'those that stem from variability in known (or observable) populations and, therefore, represent randomness in samples' (Paté-Cornell, 1996; Aven and Vinnem, 2007, pp39ff). A simple example of this type of variability is represented by the distribution of possible values from the roll of a fair set of dice. A random process gives rise to any possible value at any point in time; but in the long run, with a large enough sample (or rolls of the dice, in our example), the distribution of possible values can be well characterized. Collecting additional information or increasing the sample sizes can help to characterize this distribution more precisely; but neither option can reduce its fundamental parameters.

- *Epistemic uncertainty*. Epistemic uncertainty arises from 'basic lack of knowledge about fundamental phenomena' (Paté-Cornell, 1996).[3] The impacts of global warming have been considered to be very uncertain for precisely these reasons. Epistemic uncertainty can, in principle, be reduced by the generation of additional knowledge, the collection of larger samples, or other forms of research appropriate to the particular issue. As scientists have begun to better understand some of the fundamental science underlying climate change, many have become less uncertain about its potential impacts.

In reality, what is often loosely referred to as 'uncertainty' is some combination of the contribution of aleatory and epistemic uncertainty. What is their relevance regarding risk assessment? For the risk assessor, these distinctions between types of uncertainty can be helpful in developing an approach to characterizing uncertainty. If the assessor knows that some fundamental random process gives rise to an outcome, as in the case of the role of a dice or in the combinatorics that predict genetic variability in some trait, this may be a starting and ending point for characterizing uncertainty (in the case that he or she is certain that aleatory uncertainty or variability tells the whole story). If the assessor does not know if such a random process is actually responsible, or is otherwise unsure about the actual parameters of the process, epistemic uncertainty exists and the analyst may need to collect more data or use expert judgement to characterize the extent of epistemic uncertainty. Bayesian analysis, in which probabilities are defined as degrees of belief, can be used for this purpose. Degrees of belief, also known as subjective probabilities, are grounded in all available evidence, as well as in judgements about how good or relevant that evidence is, and thus can combine both aleatory and epistemic uncertainties (Paté-Cornell, 1996).

In the end, epistemic uncertainty may not be reducible. In this case, risk managers have to face the trade-offs implicit in taking actions that have uncertain outcomes. Because different stakeholders might value those outcomes differently, or have different tolerance for risks, they may argue for alternative decisions. This issue will be re-addressed when we treat the next phases of our governance circle: evaluation and risk management.

There is no doubt that risk assessment methods have matured to become sophisticated and powerful tools in coping with the potential harm of human actions or natural events (Morgan, 1990). Its worldwide application reflects this degree of predictive power and professionalism. At the same time, there are new challenges in the risk field that need to be addressed by the risk assessment communities. These challenges refer to the following (see similar lists in: Brown and Goble, 1990; Hattis and Kennedy, 1990; Greeno and Wilson, 1995; Renn, 1997a):

- widening the scope of effects for using risk assessment, including chronic diseases (rather than focusing only on fatal diseases, such as cancer or heart attack); risks to ecosystem stability (rather than focusing on a single species); and the secondary and tertiary risk impacts that are associated with the primary physical risks;
- addressing risk at a more aggregated and integrated level, such as studying synergistic effects of several toxins or constructing a risk profile over a geographic area that encompasses several risk-causing facilities;
- studying the variations among different populations, races and individuals, and getting a more adequate picture of the ranges of sensibilities with respect to environmental pollutants, lifestyle factors, stress levels and impacts of noise;
- integrating risk assessment within a comprehensive technology assessment or option appraisal so that the practical value of its information can be phased into the decision-making process at the needed time, and so that its inherent limitations can be compensated for through additional methods of data collection and interpretation; and
- developing more forgiving technologies that tolerate a large range of human errors and provide sufficient time for initiating counteractions.

Table 3.1 lists the three generic components of risk assessment and provides an explanation for the terms, as well as a summary list of indicators that can be used in the different risk contexts for performing the respective task. The choice of indicators is not exhaustive and serves the purpose of illustrating the type of information needed to perform the task described in each step. The three components are normally performed sequentially; but, depending upon circumstances, the order may be changed. Often, exposure assessments are conducted before hazards are estimated. If, for example, exposure can be prevented, it may not be necessary to perform any sophisticated hazard estimate.

Concern assessment

In a recent draft document published by the UK Treasury Department (2004), the authors recommend a risk appraisal procedure that includes the results of risk assessment, but adds information about concerns. This information should be derived from direct input from data on public perception and the assessment of social concerns. The document offers a tool for evaluating public concerns against six factors that are centred around the hazard(s) leading to a risk, the risk's effects and its management:[4]

Table 3.1 *Generic components of risk assessment*

Assessment components	Definition	Indicators
1 Hazard identification and estimation	Recognizing the potential for adverse effects and assessing the strength of cause–effect relationships	• Properties such as flammability, etc. • Persistence • Irreversibility • Ubiquity • Delayed effects • Potency for harm • Dose–response relationships
2 Exposure/ vulnerability assessment	Modelling diffusion, exposure and effects on risk targets	• Exposure pathways • Normalized behaviour of target • Vulnerability of target
3 Risk estimation	*Quantitative*: probability distribution of adverse effects *Qualitative*: combination of hazard, exposure and qualitative factors (scenario construction)	• Expected risk value(s) (individual or collective) • Percentage confidence interval • Risk description • Risk modelling as a function of variations in context variables and parameters

Source: adapted from IRGC, 2005, p29

1 perception of familiarity and experience with the hazard;
2 understanding the nature of the hazard and its potential impacts;
3 repercussions of the risk's effects on equity (intergenerational, intra-generational and social);
4 perception of fear and dread in relation to a risk's effect;
5 perception of personal or institutional control over the management of a risk;
6 degree of trust in risk management organizations.

A similar list of appraisal indicators was suggested by a group of Dutch researchers and the Dutch Environmental Protection Agency (van der Sluijs et al, 2003, 2004). During the late 1990s, the German Advisory Council on Global Change (WBGU) has also addressed the issue of risk appraisal and developed a set of nine criteria to characterize risks beyond the established assessment criteria (WBGU, 2000). These are:

1 *Extent of damage:* adverse effects in natural units (e.g. death, injury, production loss, etc.).
2 *Probability of occurrence:* estimate of relative frequency, which can be discrete or continuous.

3 *Incertitude:* taking into account uncertainty in knowledge, in modelling of complex systems or in predictability when assessing risk.
4 *Ubiquity:* geographical dispersion of damage.
5 *Persistence:* duration of the damage
6 *Reversibility:* can the damage be reversed?
7 *Delay effects:* latency between initial event and actual damage.
8 *Equity violations*: unfair distribution of benefits and risks.
9 *Potential for mobilization:* the broad social impact (e.g. will the risk generate social conflict or outrage?).

After the WBGU proposal was reviewed and discussed by many experts and risk managers, it was suggested that the compact 'mobilization index' should be expanded and divided into three major elements:[5]

1 *psychological stress and discomfort* associated with the risk or the risk source (as measured by psychometric scales);
2 *potential for social conflict and mobilization* (degree of political or public pressure on risk regulatory agencies);
3 *spillover effects* that are likely to be expected when highly symbolic losses have repercussions in other fields, such as financial markets or loss of credibility in management institutions.

When dealing with complex, uncertain and/or ambiguous risks it is essential to complement data on physical consequences with data on secondary impacts, including social responses to risk and insights on risk perception. The suggestions listed above can provide some orientation for the criteria considered. Depending upon the risk under investigation, additional criteria can be included, or proposed criteria can be omitted.

Generic challenges of risk appraisal

The act of appraising risks and concerns is confronted with three major challenges that can be best described by the terms 'complex', 'uncertain' and 'ambiguous'. These three challenges are not related to the intrinsic characteristics of hazards or risks themselves, but to the *state and quality of knowledge available* about both hazards and risks. Since risks are mental models, the quality of their explanatory power depends upon the accuracy and validity of their (real) predictions. Unlike some other scientific constructs, validating the results of risk assessments is particularly difficult because, in theory, one would need to wait indefinitely to prove that the probabilities assigned to a specific outcome were correctly assessed. If the number of predicted events is frequent and the causal chain obvious (as is the case with car accidents), validation is relatively simple and straightforward. If, however, the assessment focuses on risks where cause–effect relationships are difficult to discern, effects are rare and difficult to interpret, and variations in both causes and effects obscure the results, then the validation of the assessment results becomes a major problem. In such instances, assessment procedures are needed to characterize the existing knowledge with respect to complexity, remaining uncertainties and ambiguities (WBGU, 2000, pp195ff; Klinke and Renn, 2002).

Complexity refers to the difficulty of identifying and quantifying causal links between a multitude of potential causal agents and specific observed effects. The nature of this difficulty may be traced back to interactive effects among these agents (synergisms and antagonisms), long delay periods between cause and effect, inter-individual variation, intervening variables, and others. Risk assessors have to make judgements about the level of complexity that they are able to process and about how to treat intervening variables (such as lifestyle, other environmental factors, psychosomatic impacts, etc.). Risk knowledge can, therefore, be classified according to the degree of complexity of the assumed causal relationship. On the one end of the complexity scale, risks are simple and straightforward. A simple case could be illustrated by a drug that treats a serious disease effectively. The metabolic pathway is well understood, the dose response well defined and there are no side effects. The decision about whether, and how, to treat the disease is clear. But simple does not always mean benign. It could also be that the drug has serious side effects and that these effects are well known. Such a drug may still be prescribed if the benefits outweigh the probability of serious side effects and no alternative is available. On the other end of the spectrum are highly complex relationships. Examples of highly complex risk include sophisticated chemical facilities, the synergistic effects of potentially toxic substances, failure risk of large interconnected infrastructures, and risks of critical loads to sensitive ecosystems. If we take up the drug example again, age, health status, dietary factors, and genetic variation in key metabolic enzymes might all play a promoting or inhibiting role in mediating the efficacy of the drug on the disease. Change in one or more factors might reduce the efficacy of the drug in treating the disease in some individuals, or in other cases might cause some individuals to experience serious side effects. So long as this network of relationships is known and the inter-individual variation in the population is well characterized, the decision on how to treat a particular patient can still be made. It may, however, require more tests and information to ascertain the status of the patient with respect to the additional mediating factors. Complexity requires sophisticated modelling, which often defies common-sense or intuitive reasoning. Yet, if resolved, it produces a high degree of confidence in the results.

Uncertainty is different from complexity, but most often results from an incomplete or inadequate reduction of complexity in modelling cause–effect chains. Whether the world is inherently uncertain is a philosophical question that is not pursued here. It is essential to acknowledge in the context of risk assessment that human knowledge is always incomplete and selective, and, thus, contingent upon uncertain assumptions, assertions and predictions (Funtowicz and Ravetz, 1992; Laudan, 1996; Bruijn and ten Heuvelhof, 1999). It is obvious that the modelled probability distributions within a numerical relational system can only represent an approximation of the empirical relational system that helps elucidate and predict uncertain events (Cooke, 1991). It therefore seems prudent to include additional aspects of uncertainty (Morgan and Henrion, 1990; van Asselt, 2000, pp93–138; van der Sluijs et al, 2003). Although there is no consensus in the literature on the best means of disaggregating uncertainties, the following categories appear to be an appropriate means of distinguishing between the key components of uncertainty:

- *target variability* (based on different vulnerability of targets);
- *systematic and random error in modelling* (based on extrapolations from animals to humans, or from large doses to small doses, statistical inferential applications, etc.);
- *indeterminacy or genuine stochastic effects* (variation of effects due to random events – in special cases, congruent with statistical handling of random errors);
- *system boundaries* (uncertainties stemming from restricted models and the need for focusing on a limited amount of variables and parameters);
- *ignorance or non-knowledge* (uncertainties derived from lack or absence of knowledge).

The first two components of uncertainty qualify as epistemic uncertainty and, therefore, can be reduced by improving existing knowledge and advancing current modelling tools. The last three components are genuine uncertainty components and can be characterized, to some extent, by using scientific approaches, but cannot be completely resolved. The validity of the end results is questionable and, for risk management purposes, additional information is needed, such as a subjective confidence level in risk estimates, potential alternative pathways of cause–effect relationships, ranges of reasonable estimates, loss scenarios and others. Examples of high uncertainty include many natural disasters, such as earthquakes, possible health effects of mass pollutants below the threshold of statistical significance, acts of violence – such as terrorism and sabotage – and long-term effects of introducing genetically modified species into the natural environment. To illustrate a highly uncertain risk, we can use the drug example again. What happens if the clinical trials for the drug were conducted predominantly in one population with a particular age, health, dietary and genetic profile, and then use of the drug is extended to another population, perhaps in a developing country, which differs in critical ways from the first population? Greater uncertainty may exist about the amount of disease reduction that will be achieved or about the incidence and severity of side effects that might be observed. Another problem might be the interaction with lifestyle factors that were not included in the original tests, such as sleep deprivation, depression or hyperactivity. Decisions now must be informed by careful consideration of the uncertainties that characterize both benefits and risks.

Interpretative and normative ambiguity comprises the last component in this context. Whereas uncertainty refers to a lack of clarity over the scientific or technical basis for decision-making, interpretative and normative ambiguity arises when differences exist in how individual actors or stakeholders value some input or outcome of the system as a result of divergent or contested perspectives on the justification, severity or wider 'meanings' associated with a given threat (Stirling, 2003). The term '*ambiguity*' may be misleading because it has different connotations in everyday English language.[6] In relation to risk governance, it is understood as 'giving rise to several meaningful and legitimate interpretations of accepted risk assessments results'. It can be divided into *interpretative ambiguity* (different interpretations of an identical assessment result – for example, as an adverse or non-adverse effect) and *normative ambiguity* (different concepts of what can be regarded as tolerable, referring for example to ethics, quality-of-life parameters, and distribution of risks and benefits). A condition of ambiguity emerges where the problem lies in agreeing on the appropriate values, priorities, assumptions or boundaries to be applied to the definition of possible outcomes. What does it mean, for example, if neuronal activities in the human brain are intensified when subjects are exposed to electromagnetic radiation? Can this be interpreted as an adverse effect, or is it just a bodily response without any health implication? Many scientific disputes in the fields of risk assessment and management do not refer to differences in methodology, measurements or dose–response functions, but to the question of what all of this means for human health and environmental protection. High complexity and uncertainty favour the emergence of ambiguity; but there are also quite a few simple and highly probable risks that can cause controversy and, thus, ambiguity.

Examples for high interpretative ambiguity include low-dose radiation (ionizing and non-ionizing), low concentrations of genotoxic substances, food supplements and hormone treatment of cattle. Normative ambiguities can be associated, for example, with passive smoking, nuclear power, pre-natal genetic screening and genetically modified food. The drug example may shed some further light on the meaning of ambiguity. For instance, what if the drug in our example has side effects but is the most affordable alternative for a serious disease in the new population seeking treatment? Health authorities or drug manufacturers might be reluctant to authorize use of the drug while individuals might be willing to risk the side effects. Another example might be that individual users perceive hardly any personal benefit with the drug – for example, a vaccination; but from a public health perspective, such a drug delivery is regarded as essential. What the 'right' decision is, and who gets to make it, is not so clear.

Most risks are characterized by a mixture of complexity, uncertainty and ambiguity. Passive smoking may be a good example of low complexity and uncertainty, but high ambiguity. Nuclear energy may be a good candidate for high complexity and high ambiguity, but relatively little uncertainty. Endocrine disrupters could be cited as examples for high complexity, uncertainty and ambiguity. The following chapters will use the distinction of complexity, uncertainty and ambiguity to derive risk management strategies, to inform risk communication, and to structure risk participation.

Essay 3 *The Precautionary Approach to Risk Analysis*[7]

Introduction

Protest against the manifestations of technology has been present since the time of the Industrial Revolution (Sieferle, 1985; Renn, 1987). The introduction of trains, steamboats, motorcars and electric lights was always met with scepticism and public discomfort (von Winterfeldt and Edwards, 1984). The history books are full of accounts of people's rejection of technological changes. Just to cite one example: in 1824 the daily newspaper of the German city of Augsburg purchased a printing machine driven by a steam engine (Mittelstraß, 1998, p3). The editor proclaimed that he would rather write all of his editorials in the park than ever enter the print shop again; another employee terminated his contract with the company and declared his life was endangered. Even pedestrians decided to avoid the street in which the building was located. Although history has recorded numerous examples of unwarranted anxieties, there have been equally worrisome accounts of overconfidence in allegedly fool-proof safety measures and human abilities to cope with disasters (Harremoës et al, 2001). The responses to the change of technology over time seem to oscillate between courage and caution, and between overconfidence in the human ability to manage risks and the paralysis of immobility in the light of pending opportunities and threatening hazards.

Most former critics of technological changes have learned over time that cultural evolution rests on innovation and that innovation implies risk-taking. Opportunities rise out of uncertainties. American sociologist Aaron Wildavsky called the drive towards zero risk the highest risk of all (Wildavsky, 1990). Most technical experts, on the other hand, have learned that good models of risk analysis and stringent methodology in designing technologies can serve only as approximations towards a safer society. Strategies of resilience and flexibility need to accompany safety improvements and to ensure control, monitoring and public communication (Kolluru, 1995).

This essay focuses on the role of precaution in risk assessment and risk management. What does precaution mean and how can it be implemented? What are the consequences of precaution in terms of how precaution relates to scientific input and regulatory deliberation? The essay uses the example of chemical risk regulation in Europe to demonstrate the actual use of precaution in European risk management. Finally, it addresses some normative conclusions at the end.

The different meanings of precaution

The precautionary principle remains one of the most contested strategies in both risk assessment and risk management. Its most common definition, as found in the Rio Declaration on Environment and Development, states that:

> *In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.* (UN, 1992)

The principle is now applied in an increasing number of national jurisdictions, economic sectors and environmental areas, and constitutes a crucial principle for policy-making in the European Union (de Sadeleer, 2002).

Despite the intensity of the policy attention, however, there remain a number of serious ambiguities and queries concerning the nature and appropriate role of the precautionary principle in governance (Cross, 1996, 1998; Morris, 2000; Majone, 2002; Löfstedt, 2004; Marchant and Mossman, 2004). These are addressed – if not resolved – in a burgeoning academic (Sand, 2000; Fisher, 2001; Klinke and Renn, 2001; Stirling, 2003; van Zwanenberg and Stirling, 2004) and more policy-oriented (O'Riordan and Cameron, 1994; Stirling, 1999; Gee et al, 2001; O'Riordan et al, 2001) literature. In understanding the debate, it is helpful to distinguish three positions towards risk analysis (see also Resnik, 2003):

- Within the first frame of *scientific risk analysis*, risk management relies on the best scientific estimates of probabilities and potential damages, and uses expected values as the main input to judge the tolerability of risk, as well as to design risk-reduction measures that are cost effective, proportional to the threat and fair to the affected population. In this frame, precaution may best be interpreted as being conservative in making risk judgements and choosing cautious assumptions when calculating exposure or determining safety factors (of 10, 100 or more) to cover inter-individual variability. In addition, as Martin Peterson (2007) points out, 'the precautionary principle can be interpreted [in this frame] as an analogous epistemic principle which prescribes that it is always more desirable to avoid false negatives than false positives when it comes to assessing risks'.
- Within the frame of *precaution*, the concept of risk is seen from the perspective of pervasive uncertainty and, in particular, ignorance and non-knowledge. Precautious risk management entails ensuring prudent handling of decision options in situations of high uncertainty about causes and effects, and of high vulnerability of the population under risk. Instruments of precaution include minimization requirements, such as the principle of 'as low as reasonably achievable' (ALARA) or 'as low as reasonably practicable' (ALARP), diversification of risk agents, containment in time and space, and close monitoring. In the words of Andrew Stirling (2007): 'Precaution does not automatically entail bans and phase-outs, but calls instead for deliberate and comprehensive attention to contending policy or technology pathways.'
- The third frame of *deliberation* has been advocated as an alternative or an addition to purely analytical procedures of both assessing and managing risks. The task of risk management here is to organize, in a structured and effective manner, the involvement of stakeholders and the interested public in designing risk management strategies based on each stakeholder's knowledge (epistemic community) and value system. This strategy can go along with both the risk

analysis and the precautionary approach, but has been advocated either as an independent path to risk management or, more often, as a policy-oriented implementation of the precautionary approach (van den Daele, 2000).

During the recent past, advocates of scientific risk analysis and precaution have launched a fierce debate over the legitimacy of their approaches. One side argues that precautionary strategies ignore scientific results and lead to arbitrary or inconsistent decisions (Cross, 1996; Peterson, 2007). The precautionary belief that it is better to be safe than sorry could, therefore, be interpreted as a mandate to ban everything that might result in negative side effects. Such a rule would logically apply to any substance or human activity and would lead to total arbitrariness (Majone, 2002). Accordingly, the principle has been labelled as ill-defined and absolutist, and is considered to lead to increased risk-taking, to be an ideology, to be unscientific, or to marginalize the role of science (Sandin et al, 2002). Some analysts claim that using the precautionary principle runs the risk that science might be held 'hostage to interest group politics' (Charnley and Elliott, 2002); others contest that policy-makers could abuse the precautionary principle to protect economic interests and to impede world trade (Majone, 2002).

Conversely, advocates of the precautionary approach argue that it does not automatically imply an immediate ban, but rather a step-by-step diffusion of risky activities or technologies until more knowledge and experience are available (Fisher, 2001; Stirling, 2003). They have accused their critics of ignoring the uncertainty and ambiguity of most hazardous situations, and relying on data that often turn out to be insufficient for making robust judgements. They also claim that risk assessment techniques pretend to meet a high standard of scientific validity, rigour and reliability that cannot be sustained under scrutiny. Too many unpleasant surprises during the past few decades would therefore justify a more cautious and humble approach to claiming knowledge about possible risks (Gee et al, 2001).

The third approach has found wide acceptance among social scientists and risk analysts from academia, but has had little impact on institutional risk analysis (Renn, 2004b). There are isolated examples of community participation in risk decisions, such as in the US Superfund programme that cleans up contaminated waste sites, or US legislation negotiated among regulators, industry and non-governmental organizations (NGOs) (Coglianese, 1997). In recent years, policy-makers have acknowledged more and more that public participation provides many advantages because it transforms difficult issues of uncertainty into topics that can be negotiated. 'If society participates in the production of policy-relevant scientific knowledge, such "socially robust" knowledge is less likely to be contested than that which is merely reliable' (Funtowicz et al, 2000). Accordingly, the European Union (EU) has highlighted the need for more stakeholder involvement and participation in risk management (European Commission, 2001b). However, how to implement this in day-to-day risk management is still under dispute. Many scholars have also questioned the value of deliberative approaches in some settings, arguing that 'when there is trust in the regulator, a top-down form of risk communication (information transfer) may be better than dialogue'(Löfstedt, 2004; similar arguments in: Rose-Ackerman, 1994; Coglianese, 1997).

Since the application of the precautionary principle may have lasting implications and repercussions on regulatory decisions and international trade, the stakes in this debate are not merely theoretical or academic. Depending upon the approach chosen, regulatory actions may vary considerably and shape economic competitiveness, public health levels and environmental quality.

Political relevance

The precautionary principle has been adopted in a variety of forms at international, EU and national level. It is applied across an increasing number of national jurisdictions, economic sectors and environmental areas. It has moved from the regulation of industry, technology and health risk to the wider governance of science, innovation and trade. As it has expanded in scope, so it has grown in profile and authority. In particular, as Article 174(2) in the European Commission Treaty of 2002 states, precaution now constitutes a key underlying principle in European Community policy-making (European Commission, 2002a). The 2000 Communication on Precaution of the European Commission provides evidence for the high significance that the precautionary principle has gained as a guiding policy of the EU in areas such as environmental, consumer and health protection. The document states in the first section: 'Applying the precautionary principle is a key tenet of its policy, and the choices it makes to this end will continue to affect the views it defends internationally on how this principle should be applied' (European Commission, 2000, p3). As Elisabeth Fisher (2002) points out, the communication specifies some of the major conditions and requirements for applying the principle. There are two conditions mentioned: 'The measures, although provisional, shall be maintained as long as the scientific data remain incomplete, imprecise, or inconclusive, and as long as the risk is considered too high to be imposed on society' (European Commission, 2000, p21). In addition to the presence of remaining uncertainty, the EU communication lists the condition that the risk must be too high to be imposed on society. This relates to the requirement of proportionality that is being mentioned as one of the major requirements of applying the principle.

The European Commission's communication highlights three important issues in developing the precautionary principle (Fisher, 2003). Each of these constitutes a means of ensuring that decision-making pursuant to the precautionary principle is not arbitrary (Articles 13, 16 and 22). First, the precautionary principle 'should be compatible with the classic division of risk analysis: risk assessment, risk management, risk communication'. In the communication, the precautionary principle is largely understood as belonging to the stage of risk management; but it should also guide the risk assessment process. The 'implementation of an approach based on the precautionary principle should start with a scientific evaluation, as complete as possible, and, where possible, identifying the degree of scientific uncertainty at each stage of the risk governance process'. Second, the European Commission's communication highlights the need for 'proportionate, non-discriminatory and transparent actions'. It further stresses the benefit of using cost–benefit analysis, based on best scientific data. The communication also points out the need to 'involve all interested parties as early as possible and to the greatest possible extent'. Third, and finally, the communication allows for a wide range of risk management initiatives (Article 16). In particular, such measures need not be of a legally binding nature and, as noted above, should be able to be revised (Fisher, 2003).

In the aftermath of a series of formative public health controversies, economic calamities and political conflicts (such as those involving BSE and genetically modified crops), precaution is of great salience or importance in many fields, including the regulation of chemical, biological and ecosystem risks. Since the application of the precautionary principle has been associated with stricter and more rigid regulations, environmental groups have usually rallied around the precautionary approach, while most industrial and commercial groups have been fighting for the assessment-based approach. Again, the issue is not resolved, and the debate has become even more pronounced with the defeat of the European Community in the World Trade Organization (WTO) settlement of hormones in beef. The European Community failed in providing sufficient evidence that the precautionary approach could justify the restriction of imported beef treated with hormones.

It is also interesting to note that the assessment-based approach has been widely adopted by the official US regulatory bodies, while the precautionary approach has been widely advocated by the EU regulatory bodies. There are, however, also numerous elements of precautionary approaches interspersed within the actual practices of US regulatory agencies, just as there are judgements about magnitudes of risk in the actual practices of regulators in the EU. A strict dichotomy between 'precautionary' in Europe and 'assessment based' in the US is therefore too simple to describe actual practice (Elliott and Renn, in press).

Precaution in action: The European approach to chemical regulation – Registration, Evaluation and Authorization of Chemicals (REACH)

Regulations of chemicals in the EU

In the past, EU legislation distinguished between so-called 'existing' and 'new' chemicals, using 1981 as a cut-off date. 'Existing' substances were those introduced before 1981; 'new' chemicals were those that had been introduced since 1981. Of the roughly 30,000 substances produced annually at a volume of more than 1 tonne, only 140 had been sufficiently tested for their effects. The requirement to prove risk was up to public authorities in the member states (ISI and Oekopol, 2004). Until the new regulation of REACH was introduced, chemicals had to be notified and tested in production volumes as low as 10kg per year, while there were no such provisions for existing chemicals. This had encouraged the continued use of 'existing' untested substances and had inhibited research and development and innovation. The number of new chemicals put on the market since 1981 reached only around 3000, while the number of 'existing' chemicals in 1981 amounted to 100,106. It had been up to the public authorities in the EU member countries to determine whether any of them needed examining and, in the affirmative, to do so. These procedures used to be lengthy and cumbersome. For example, between 1993 and 2003, a total of 140 high-volume chemicals had been singled out for risk assessment. Only a very limited number completed the process before the new regulation of REACH took effect.

In the White Paper on the Strategy for a Future Chemicals Policy, published in February 2001 (European Commission, 2001b), the European Commission outlined its new strategy for ensuring a high level of chemicals safety and a competitive chemicals industry through a system for the Registration, Evaluation and Authorization of Chemicals – the so-called REACH system. The newly enacted regulation replaces over 40 existing directives and regulations. Under the new REACH system, companies that manufacture or import more than 1 tonne of a chemical substance per year are required to register it in a central database. The EU expects from the new regulation an improvement in protecting human health and the environment, while maintaining the competitiveness and enhancing the innovative capability of the EU chemicals industry (European Commission, 2003b). More specifically, the EU expects the following advantages with the newly enacted REACH system:

- protection of human health and the environment;
- maintenance and enhancement of the competitiveness of the EU chemical industry;
- prevention of fragmentation of the internal market;
- increased transparency;
- integration with international efforts;
- promotion of non-animal testing;
- conformity with EU international obligations under the WTO.

On 29 October 2003, the European Commission adopted the REACH proposal for a new EU regulatory framework for chemicals (European Commission, 2003a, p644). The proposal has been forwarded to the European Parliament and the EU's Council of Ministers for adoption under the so-called co-decision procedure. The final decision was made in late 2006.

Former Environment Commissioner Margot Wallström has characterized REACH as follows:

> *REACH is a groundbreaking proposal. Once adopted, it will allow us to take advantage of the benefits of chemicals without exposing ourselves and the environment to risks. Thus, it will create a win–win situation for industry, workers and citizens, and our ecosystem. It will give Europe's citizens the high level of protection that they have the right to expect. The EU will have one of the most progressive chemicals management systems in the world.* (European Commission, 2003a)

REACH requires companies that produce and import chemicals to assess the risks arising from their use and to take the necessary measures to manage any risk that they identify. The objective is to reverse the burden of proof from public authorities to industry for ensuring the safety of chemicals on the market. REACH has also been designed to treat existing and new chemicals in the same way and to streamline bureaucratic procedures by simplifying the registration process. The newly established REACH system focuses on:

- substances of high concern, including those that are carcinogenic, mutagenic or toxic to reproduction (CMR), persistent, bio-accumulative and toxic (PBT), or very persistent and very bio-accumulative (vPvB);
- streamlining the licensing and authorization process by only requiring essential safety and use information for chemicals manufactured or imported in volumes of 1 to 10 tonnes per year;
- encouraging research and innovation by lengthening the trial period, raising the threshold for the registration of research substances (from currently 10kg to 1 tonne) and simplifying the regulation for downstream users;
- preventing increased bureaucracy for downstream enterprises by utilizing existing systems for the exchange of safety information (i.e. safety data sheets, or SDSs).

Table 3.2 lists the main differences between the former and the new chemical regulation in the EU.

Table 3.2 *Comparison between the former system and REACH*

Former system	Registration, Evaluation and Authorization of Chemicals (REACH)
The burden of proof is on the authorities: they need to prove that the use of a chemical substance is unsafe before they impose restrictions.	It is for industry to prove that the chemical can be used safely, and how it can be done. All actors in the supply chain will be obliged to ensure the safety of the chemical substances that they handle.
Notification requirements for 'new substances' start at a production level of 10kg. Already at this level, one animal test is needed. At 1 tonne, a series of tests, including other animal tests, have to be carried out.	Registration will be required when production/import reaches 1 tonne. As far as possible, animal testing will be minimized.
It is relatively costly to introduce a new substance on the market. This encourages the continued use of 'existing' untested chemicals and inhibits innovation.	Innovation of safer substances will be encouraged under REACH through more exemptions for research and development; lower registration costs for new substances; and the need to consider substitute substances for decisions on authorization and restrictions.
Public authorities are obliged to perform comprehensive risk assessments that are slow and cumbersome.	Industry will be responsible for assessing the safety of identified uses, prior to production and marketing. Authorities will be able to focus on issues of serious concern.

Source: European Commission (2003a)

Registration and authorization of chemicals

The main element of REACH is to force all companies to register chemicals that were manufactured or imported in quantities of more than 1 tonne per year and per manufacturer/importer in a central database. Some groups of substances would not have to be registered (such as certain intermediates, polymers and some chemicals managed under other EU legislation). The registration process includes:

- The intrinsic properties and hazards of each substance (such as physico-chemical, toxicological and eco-toxicological properties). This information – if not already available – can be obtained by various means, such as computer modelling and epidemiological studies, or through testing.
- The use(s) of the substance identified by the importer or manufacturer or by their customers. A report is compiled assessing risks for human health and the environment, and how these risks are adequately controlled, for the identified uses of substances produced or imported in volumes of 10 tonnes or more per year per manufacturer or importer (known as chemical safety reports). For lower volumes, safety information produced for the safety data sheets will be submitted as part of the technical dossiers.

The information required is proportional to production volumes and the risks that a substance poses. The safety information will be passed down the supply chain. To cope with the large number of 'existing' substances, a phased approach is proposed. The deadlines for registration are set according to the volume of the substance on the market or the hazard. The shortest deadlines apply to very high-volume substances (above 1000 tonnes), and carcinogenic, mutagenic or reproduction toxic substances above 1 tonne. These will have to be registered within three years.

The newly established European Chemicals Agency has been mandated to manage the database, receive the registration dossiers, and be responsible for providing non-confidential information to the public. Within the REACH regime, the European Chemicals Agency would check the validity of the dossiers provided by the company (particularly with regard to data from animal tests). The main purpose of this compulsory evaluation is to minimize animal testing. Second, the agency and the respective risk management authorities can evaluate any substance where they had justified reasons to suspect that there was a risk to human health or the environment. For both types of evaluation, the outcome could be a request for further information. The agency will make the final decision on requests for further information if all member states agree. In case of disagreement, the European Commission can make the final decision.

In the new EU-wide impact assessment, the direct costs of REACH to the chemicals industry are estimated at a total of some €2.3 billion (Euros) over an 11-year period, representing a saving of 82 per cent of costs from the initial draft. The costs to downstream users of chemicals are estimated at €2.8 to €3.6 billion over a period of 11 and 15 years, respectively – if the market reacts as expected with 12 per cent of substances being withdrawn because continued production would not be profitable. Costs could rise to €4 billion to €5.2 billion if industry faced higher supply chain adaptation costs. These estimates include the direct costs passed on from the chemicals sector to downstream users. The total costs for the chemicals industry and the downstream users are thus estimated to be €2.3 billion to €5.2 billion. The anticipated benefits to the environment and human health are expected to be significant. An illustrative scenario put the health benefits in the order of magnitude of €50 billion over a 30-year period.

Public consultation

In May 2003, the European Commission presented a draft of the proposed regulation on the internet to gather further comments on the workability of REACH. Some 6000 replies were sent in. The main contributors were industry associations and individual companies, as well as environmental and animal rights NGOs. A number of member states also provided comments, alongside several countries outside the EU. In addition, many individuals, including workers, expressed their opinions. The main comments referred to the following points (European Commission, 2003b; RPA and BRE Environment, 2003; BDI, VCH and VDI, 2004; BUND, 2004; KPMG, 2005):

- concern that the inclusion of polymers in the system would overburden it and add costs;
- calls for protection of the commercial confidentiality of data;
- calls for publicly accessible data about risks of chemicals and the right to access information about chemicals used in products;
- a desire for a clearer and more effective role for the proposed Chemicals Agency, particularly with regard to handling registrations, and in ensuring uniformity and consistency in evaluation decisions taken by member states;
- calls to include the principle of substitution of dangerous substances by safer alternatives in the proposal;
- a desire to ensure a level playing field for articles produced inside the EU and in developing countries.

The comments have resulted in several changes in order to make the proposed new system less costly, less bureaucratic and more workable, while reinforcing the guarantees for health and environmental protection. In addition, a high-level expert group was established to investigate the impacts of the proposed REACH regulation. The report (European Commission, 2005) lists the following conclusions:

- There is limited evidence that higher volume substances are vulnerable to withdrawal following the REACH registration requirements. However, lower volume substances under 100 tonnes are most vulnerable to being made less or non-profitable by the REACH requirements.
- There is limited evidence that downstream users will be faced with a withdrawal of substances of greatest technical importance to them.
- Small- and medium-sized enterprises (SMEs) can be particularly affected by REACH's awareness of their more limited financial capacity and lower market power in terms of passing on costs.
- Companies may be able to gain business benefits from REACH, even in the international context of fierce competition.

The report has been commented upon by EU Commissioner for the Environment, Stavros Dimas (*RadTech News*, 2005):

> *All the parties concerned will recognize that we have gone to great lengths to explore and assess the practical impact of REACH. The results of these studies are reassuring – the costs and impacts of REACH are manageable. There is, however, no reason to become complacent. We need to continue putting all efforts in development of specific guidance and tools to facilitate implementation, which will be helpful for all companies, in particular SMEs, and alleviate most of their concerns.*

Many national agencies and stakeholder groups have voiced their concerns in numerous papers and statements. A synthesis study by the Fraunhofer Institute and Oekopol (ISI and Oekopol, 2004) arrived at the conclusion that:

> *REACH will improve the knowledge about properties of existing chemical substances related to environment and health.... However, to a large extent, the interviewed companies do not expect these REACH mechanisms to result in business benefits. More concretely, none of the companies expects that customers will be willing to pay a higher price for 'safe products' with paper documentation according to the REACH standard.*

The report lists several proposals for improvement, particularly related to the establishment of one consolidated database and the assessment of exposure data. Environmental groups; such as German BUND; welcomed the REACH initiative, but saw a major need for improvement with respect to transparency and openness of information, to the strengthening of the authorization process and to the exclusion of imported products from the REACH regime (BUND, 2004).

Link to precaution

The REACH proposal has been explicitly linked to the EU's precautionary principle. The proposal is based on Article 95 of the EC Treaty, in keeping with the objective of safeguarding the internal market, while ensuring a high level of health, safety, and consumer and environmental protection. The precautionary principle (Article 174.2 of the treaty in combination with Article 6 and Article 95.3) has been cited as guidance for drafting the REACH provisions.

The provisions within REACH, however, do not directly relate to any of the commonly used definitions of precaution. There is only reference to the issue of burden of proof. The document states that the burden of proof is reversed so that the chemical companies have to provide both information and assessments. This documentation requirement, however, is not a reversal of proof in the strict sense. The proposal does not oblige companies to prove that their chemicals are safe; it rather compels companies to provide the data and the information allowing regulators to form a balanced judgement about the tolerability or acceptability of the respective risk. It is not the burden of proof that is reversed, but the burden of cost.

It is also worth noting that the terms uncertainty characterization and management are not explicitly mentioned in the document (only in the technical annex). The thrust of the proposal is to include the existing chemicals in the regulatory regime, to provide traceability and to build up a database for the vast amount of new and existing chemicals (WWF and EEB, 2003). The actual assessment and evaluation process underlying the authorization procedure is not further specified in the document. However, from the data that is required one can make some implicit assumptions. Much of the required information relates to hazards, not to risks. The underlying rationale here is that, because of the uncertainties with regard to exposure, it is assumed that all chemicals above 1 tonne will expose some individuals or ecosystems during their lifetime. The exclusion of small quantities and commodity chemicals that are tightly controlled within chemical facilities demonstrate the reasoning behind the regulation. Rather than relying upon exposure data, authorization may concentrate only upon hazards. The proposal, however, remains vague about the underlying criteria and decision rules when it comes to explaining the process by which a substance is authorized or not.

Given the vagueness of the REACH proposal regarding tolerability criteria, the EU commissioned a report by a consortium of scholars to define the criteria and procedures that could be used for the authorization process based on the precautionary principle. The report, called PrecauPri, was completed in 2003 (Renn et al, 2003; summary in Renn et al, 2005) and includes a pre-assessment phase for assessing and managing chemical risks (Müller-Herold et al, 2003, 2005). This phase provides for a screening stage in order to identify chemicals that require special attention or even to eliminate substances of high concern at an early stage. For the screening stage, a filter series approach was developed and applied (Figures 3.1. and 3.2). Each filter is designed to screen for a particular threat scenario.

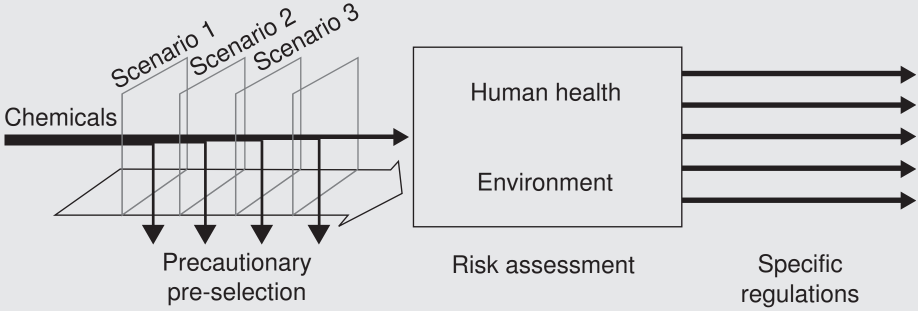

Figure 3.1 *Extended assessment scheme for chemicals according to the PrecauPri report*

Source: adapted from Renn et al, 2005, p15

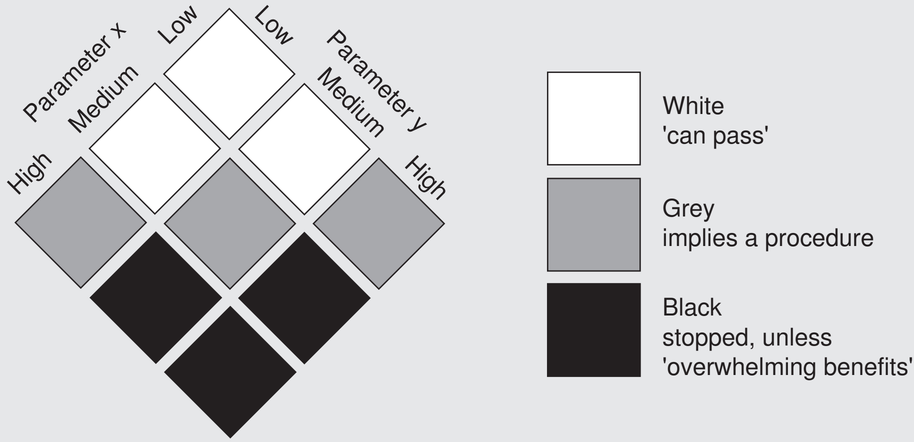

Figure 3.2 *Two-parameter filter with three grades*

Source: adapted from Renn et al, 2005, p15

Precautionary filters can be conceptualized as classification schemes with three outcomes: white ('may pass'), grey ('needs further consideration') and black ('should be stopped'). For filters based on two assessment parameters – with each parameter having the grades high, medium or low – the outcomes are defined using these grades of the two parameters (see Figure 3.2):

- white: medium/low, low/low, low/medium;
- grey: high/low, medium/medium, low/high;
- black: high/medium, high/high, medium/high.

If a substance is classified as 'black' by at least one filter, it triggers preventive measures: such a chemical should be eliminated – with the possible exemption of 'life-saving' pharmaceuticals or some intermediates in industrial synthesis if contained under extreme safety standards. Chemicals not classified as 'black' enter the normal chemical risk assessment process.

This proposal was introduced as an addition to the REACH framework for finding a fast, non-bureaucratic and inexpensive way of including precautionary measures within the REACH regime. The filters that were tested in the report were based on assessment parameters, such as potential for long-range transport, persistence and bio-accumulation, and were applied to three types of substances: persistent organic chemicals, high-production volume chemicals and a group of non-referential test chemicals. So far, the European Commission has not adopted this amendment to the REACH regime and is not likely to do so in the foreseeable future.

Conclusions

Taking a closer look at the risk regulation about chemicals in Europe demonstrated that the application of the precautionary principle does not conflict with the use of best available science and the need for regulatory clarity. Even the new REACH legislation by the European Union does not substitute risk assessments with a pure 'better safe than sorry' attitude. On the contrary, the REACH system puts most emphasis on a scientific assessment of hazards and risks for both existing and new chemicals, and places the burden of providing these assessments on industry. REACH is more concerned with traceability than looking for precautionary methods when dealing with uncertainty.

Any regulatory regime based on precaution is faced with the question of how to make regulatory decisions under cases of uncertainty or even ignorance. It may be helpful in this respect to resort to a differentiation that Resnik (2003, p332) has proposed:

- *decisions under certainty:* the outcomes of different choices are known;
- *decisions under risk:* probabilities can be assigned to the outcomes of different choices;
- *decisions under ignorance:* it is not possible to assign probabilities to the outcomes of different choices.

A similar distinction has been made by Stirling (2003). One of the main conclusions has been that using precaution for the first two cases is neither necessary nor prudent, given that regulation needs to meet both objectives of protecting public health and the environment, and securing economic welfare. The legitimate realm of using precaution is in the case of ignorance or other forms of remaining uncertainties (such as system boundaries or truly stochastic events). In order to avoid misunderstanding, some analysts have proposed avoiding the term precaution and replacing it with the more adequate term of *principle of insufficient reason* (see Peterson, 2003, p71). This is the place where precaution is required.

In my view, the main purpose of precaution is to avoid irreversible decisions. Although highly critical about the use of the precautionary principle itself, policy analyst Giandomenico Majone concedes that it does have its function in risk analysis – namely, where 'losses (or utilities) are unbounded' and where it is 'clearly impossible to calculate expected values' (e.g. when there is a threat of 'serious and irreversible damage'; Majone, 2002). In these cases, it is prudent to proceed so that a decision can be reversed quickly if outcomes or probabilities turn out to be higher than expected. In such cases, banning is only one regulatory option; other options include containing the risk, setting boundaries to ubiquitous spreading or bio-accumulation, developing alternatives and/or minimizing exposure. Such a prudent approach to risk management would certainly be supported by representatives of all camps in this debate.

4

Risk Perception[1]

Basic insights into risk perception research

Since risk is a mental model, there are numerous construction principles for conceptualizing risk. Different disciplines within the natural and social sciences have formed their own concepts of risk; stakeholder groups, driven by interest and experience, have developed their specific perspective on risk; and last, but not least, representatives of civil society, as well as the general public, respond to risks according to their own risk constructs and images. These images are called '*perceptions*' in the psychological and social sciences, and they have been intensely researched in relation to risk – as have their underlying factors (Covello, 1983; Slovic, 1987; Boholm, 1998; Sjöberg, 1999a; Rohrmann and Renn, 2000). Risk perceptions belong to the contextual aspects that risk managers need to consider when deciding whether or not a risk should be taken, as well as when designing risk reduction measures.

First of all, it is highly important to know that human behaviour is primarily driven by perception and not by facts, or by what is understood as facts by risk analysts and scientists. Most cognitive psychologists believe that perceptions are formed by common-sense reasoning, personal experience, social communication, and cultural traditions (Brehmer, 1987; Drottz-Sjöberg, 1991; Pidgeon et al, 1992; Pidgeon, 1998). In relation to risk it has been shown that humans link certain expectations, ideas, hopes, fears and emotions with activities or events that have uncertain consequences. People do not, however, use completely irrational strategies to assess information, but – most of the time – follow relatively consistent patterns of creating images of risks and evaluating them. These patterns are related to certain evolutionary bases of coping with dangerous situations. Faced with an imminent threat, humans react with four basic strategies: *flight, fight, play dead* and, if appropriate, *experiment* (on the basis of trial and error) (Marks and Nesse, 1994).

In the course of cultural evolution, the basic patterns of perception were increasingly enriched with cultural patterns. These cultural patterns can be described by so-called *qualitative evaluation characteristics* (Slovic, 1992). They describe properties of risks, or risky situations going beyond the two classical factors of risk assessment, on which risk is usually judged (i.e. level of probability and degree of possible harm). Here, psychologists differentiate between two classes of qualitative perception patterns: on the one hand, *risk-related patterns*, which are based on the properties of the source of risk; on the other, *situation-related patterns*, based on the idiosyncrasies of the risky situation (Fischhoff et al, 1978; Slovic, 1987, 1992; Breakwell, 2007, pp26ff).

One example of a risk-related pattern is the perceived 'dread' of the consequences of a possibly harmful event. If, for example, people are riding in a car and are thinking about possible accidents, they will always be under the impression that they would, with high probability, get away unscathed in a car accident ('fender-bender mentality'). However, if the same people are sitting in an airplane, they will be under the impression that, if something happens here, there is no getting away. This feeling of apprehension does not subside even if they know the odds and are convinced that statistically many more people die in car accidents than in airplane crashes. Situation-related patterns of perception include aspects such as 'voluntariness' and the ability to exercise personal control (review in Breakwell 2007, pp29ff). If someone is of the opinion that he can control the risk, he will perceive it as less serious. This mode of thinking frequently takes effect where eating habits are concerned. People believe that they can easily do without sweets, alcohol, or other food considered unhealthy, if only they wanted to. However, mostly harmless chemical food additives are perceived as a threat to one's health. With regard to collective risks, people show special concern for risks that they believe are not adequately controlled by public authorities (as in the case of genetically modified organisms, or GMOs).

Considered together, these qualitative evaluation characteristics can be subdivided into a limited number of consistent risk perception classes. In literature they are also called *semantic risk patterns*. The following patterns were examined particularly thoroughly (Renn, 2004a):

- risks posing an immediate threat, such as nuclear energy or large dams;
- risks dealt with as a stroke of fate, such as natural disasters;
- risks presenting a challenge to one's own strength, such as sports activities;
- risk as a gamble, such as lotteries, the stock exchange and insurance;
- risks as an early indication of insidious danger, such as food additives, ionizing radiation and viruses.

These patterns have functions similar to drawers in a filing cabinet. When faced with a new risk or when obtaining new information about a risk, most people try to file this information into one of the existing drawers.[2]

In addition to the cognitive processing of risk characteristics and risk situations, studies have shown that people tend to *stigmatize risk sources* that are associated with specific dreadful associations (Kasperson et al, 2001; Kunreuther and Heal, 2003). A salient example of stigma is the reaction to products that are deemed to be carcinogenic, although there is often limited, if any, scientific evidence to support this position. The mere suspicion that a substance could cause cancer is often sufficient for generating fear and for demanding strict regulatory action. Stigmatization leads to a cycle of public outrage and regulatory responses feeding into the process, which has been described as social amplification of risk (Kasperson et al, 1988, 2003). Stimulated by media reporting, the public's perception of the risk is often amplified in ways that are difficult to explain if one focuses on the standard elements of any technical risk assessment: probability and direct losses.

The problems associated with risk perception are complex because of the difficulty that individuals have in interpreting low probabilities when making their decisions (Kunreuther et al, 2001). In fact, there is evidence that people may not even want data on the likelihood of an event occurring. If people do not think probabilistically, how do they make their choices? Psychological research has revealed the following patterns of drawing inferences about probabilities and risks (Tversky and Kahneman, 1974; Ross, 1977; Kahneman and Tversky, 1979; Renn, 2004a):

- The easier and faster a risk is recognized, the more conscious individuals are thereof and the greater is the chance of its probability being overestimated. If, for example, an individual has known someone who died after being struck by lightning, that individual will perceive the risk of being struck by lightning as particularly significant (*availability bias*).
- The more a risk provokes associations with known events, the more likely its probability will be overestimated. This is why, for example, the use of the term 'incinerating' in waste disposal facilities readily evokes an association with harmful chemicals, especially dioxins and furans, even if there is no way that they could be released into the environment by the facilities concerned (*anchoring effect*).
- The more constant and similar the losses from risk sources, the more likely the impact of average losses will be underestimated. While road traffic accidents are not deemed acceptable, they are more or less passively accepted. If the average annual number of road casualties in a given country were to occur all at once, instead of being spread over the entire year, then a considerably greater level of rejection could be expected. Thus, people are not indifferent to the *distribution of risks over time*: they even prefer loss distribution over individual disasters (Kahneman and Tversky, 1979).
- The greater the uncertainty of loss expectation, the more likely the average loss assessment will be in the region of the median of all known loss expectations. In this way, loss expectations in objectively low risks are often overestimated, while objectively high risks are often underestimated (*assessment bias*).

Despite their importance for actually evaluating and managing a risk, overestimation or underestimation of loss expectations are not the most important aspects of risk perception. Instead, the context-dependent nature of risk assessment is the deciding factor. This context includes the qualitative risk-evaluation characteristics, the semantic images and the stigma effects. More recently, psychologists have also discovered that affect and emotions play an important role in people's risk perception (Loewenstein et al, 2001; Slovic et al, 2002). These factors are particularly relevant when individuals face a decision that involves a difficult trade-off between attributes, or where there is interpretative ambiguity as to what constitutes a 'right' answer. In these cases, people often appear to resolve problems by focusing on those cues that send the strongest affective signals (Hsee and Kunreuther, 2000).

The role of risk perception for risk governance

The most important policy question is how to treat risk perceptions in a policy arena that includes responses of different actors and the general public (Slovic et al, 1982; Fischhoff, 1985, 1995). There are two suggestions, from opposite ends of a spectrum. The first position states that the scientific concepts of risk are the only ones that can claim inter-subjective validity and applicability and, therefore, requires risk managers to obtain an assurance that (erroneous) risk perceptions are corrected via risk communication and education (Cross, 1998; Coglianese, 1999). The second position states that there is no overarching universally applicable quality criterion available in order to evaluate the appropriateness or validity of risk concepts. As a result, scientific concepts (often called *narratives* in this school of thought) should compete with concepts of stakeholders and public groups (Liberatore and Funtowicz, 2003; Jasanoff, 2004). If collective decisions on risk are necessary, the concept that is used to make these decisions should be negotiated among all relevant concept holders. None of these groups, including the science communities, is allowed to claim any privileged position in this negotiation.

I have strong reservations with respect to both positions and propose an approach by which the elements of what matters to the different groups when they conceptualize risk are to be regarded as equally legitimate factors for inclusion within risk governance (see also Gigerenzer and Selten, 2001; Pidgeon and Gregory, 2004). This implies, for example, that if people are willing to accept higher risks when they are in control of them, then this preference cannot be de-legitimized by professional economists who favour cost-effectiveness studies that treat all risks equally. In identifying aspects of concern and worry, all groups in society have the same right to raise them and to bring them to the negotiation table. However, the question of the degree to which these concerns are met or violated by risk-bearing activities or events should primarily be answered by those who have the knowledge, skills and/or the experience to measure or estimate the strength of relationships between cause (or dose) and effect. It seems wrong to give equal standing to those who intuitively estimate risks and those who assess risks on the basis of systematic observation, empirical data collection and rigorous modelling, just as it seems wrong to dismiss non-factual perceptions purely because they appear irrational to those with expert knowledge.

This position has major impacts on risk policy-making and communication. Policy-making needs to, *inter alia*, organize systematic feedback from society and, equally, include risk perceptions as an important input to deciding whether something should be done about a certain risk – and, in the affirmative, what that should be (Jaeger et al, 2001, pp282ff). This is the reason why we included 'concern assessment' in the appraisal stage. Risk communication is also affected in two ways: first, it is bound to elicit (and enable the exchange of) concerns and conceptual aspects of risk among and between all relevant actors; second, risk managers are well advised to ensure that the best available knowledge is widely distributed to those who raise these concerns.

Essay 4 *Review of Psychological, Social and Cultural Factors of Risk Perception*[3]

Introduction

Within the social sciences, people's judgements about events, situations or activities that could lead to negative consequences are usually labelled as risk perception. Principally, risks cannot be 'perceived' in the sense of being taken up by the human senses, such as images of real phenomena. However, this terminology has become the standard convention in social scientific communities (Slovic, 1992). Risk perception, in general, denotes the processing of physical signals and/or information about potentially harmful events or activities, and the formation of a judgement about seriousness, likelihood and acceptability of the respective event or activity (Slovic et al, 1980; Brehmer, 1987, Renn, 1990, 2004a; Rohrmann, 1999). Physical signals refer to direct observation by human senses; information refers to verbal and non-verbal exchange of messages about uncertain consequences of events or activities (communication with others).

Psychological and sociological research has revealed different meanings of risk depending upon the context in which the term is used. Whereas in the technical sciences the term risk denotes a functional relationship between probabilities and adverse effects, the everyday use of risk has different connotations. In most social contexts, 'risk' refers to the likelihood of an adverse effect resulting from an event or an activity, rather than an opportunity for desired outcomes. Hence, risk is defined in this essay as the *possibility that an undesirable state of reality (adverse effects) may occur as a result of natural events or human activities* (definition originally in Kates et al, 1985, p21). *Risk*s refer to a situation or event in which something of human value (including humans themselves) has been put at stake and where the outcome is uncertain (Jaeger et al, 2001, p17).

After defining the term risk, it is important to shed some more light on activities that are associated with risk analysis and risk handling from the social science perspective. How people think about the seriousness and acceptability of risks, and how they make their respective judgements, is influenced by the knowledge, values, feelings and judgements of others. The mental models and other psychological mechanisms which people use (e.g. cognitive heuristics and risk images) are internalized through social and cultural learning and are constantly moderated (reinforced, modified, amplified or attenuated) by media reports, peer influence and other communication processes. Technical and solely quantitative approaches for characterizing risks are obviously inadequate to reflect the complex pattern of individual risk perception. This has been stressed by many authors (Covello, 1983; O'Riordan, 1983; Fischhoff et al, 1984; Rayner, 1987; Slovic, 1987; Freudenburg, 1988; Heimer, 1988; Jungermann and Slovic, 1993; Rohrmann, 1995; Sjöberg, 2000b, 2006; Rohrmann and Renn, 2000; Wilkinson, 2001; Lupton and Tulloch, 2002; Renn, 2004a; Zinn and Taylor-Gooby, 2006a; Breakwell, 2007, pp18ff).

This essay attempts to review the current knowledge of risk perception and to explain the psychological, social and cultural factors that shape the experience of risk. The main objective of this essay is to integrate the results of psychological, sociological and cultural studies, and to present the major findings of the social sciences as they relate to risk perception and communication.

INSIGHTS INTO PSYCHOLOGICAL RISK PERCEPTION RESEARCH

In total, four classes of psychological variables are discussed in the literature on risk perception. These four classes are introduced in the next sections. The goal is to provide a quick overview of different 'schools of thought' and their contributions to understanding the psychological drivers for perceiving and evaluating risks.

Attention and selection filters

Most risks that modern society faces are not directly experienced by human senses, but are learned through communication. Rarely do we face disasters personally; however, the media provides us with ample information about hazardous events wherever they take place. The dangers of technologies or nature, the risks of food additives or chemicals in drinking water, the threat of nuclear disaster or a chemical explosion would probably never reach public attention unless society communicates about these adverse possibilities. Risk perception is not so much a product of experience or personal evidence, as it is a result of social communication (Luhmann, 1986b, 1997).

This observation has major consequences: today's society provides an abundance of information, much more than any individual can digest. It is assumed that the average person is exposed to 7000 bits of daily information, of which around 700 are perceived, 70 acknowledged, 7 stored in the short-term memory and possibly less than 1 remembered in the long term (Miller, 1956; Malhotra, 1982; Conard, 2005, p4; review in Covello, 1983). Most information to which the average person is exposed will be ignored. This is not a malicious act, but a sheer necessity in order to reduce the amount of information a person has to process in a given time. Human evolution has provided us with an almost automated, and often subconscious, tool of selecting the important information from the abundance of information supplies.

The attention and selection process is not random, although random elements may play a role. People have developed special strategies to select information that they feel is relevant to them. This is also true for risk information. The major criteria for selection are *ability* and *motivation* (Chaiken and Stangor, 1987). Ability refers to the physical possibility of the receiver to follow the message without distraction; motivation refers to the readiness and interest of the receiver to process messages. The conditions for both ability and motivation are listed in Table 4.1.

Three conditions have to be met to satisfy the criterion of *ability*: the information has to be accessible, the receiver must have the time to process the information, and other sources of distraction should be absent. Several factors influence the *motivation* of a receiver to actively process the information. The information content

Table 4.1 *Conditions and requirements for information selection*

Conditions	Elements of conditions
Ability	Physical access to information Time to process information Absence of sources of distraction
Motivation	Reference to personal interests, salient values or self-esteem Inducement of personal involvement with the issue, the content or the source

Source: Ortwin Renn

has to be relevant (referring to personal interests, salient values or self-esteem), and it should trigger personal involvement (with the issue, the content or the source). Both motivational factors are reinforced if the receiver has some prior knowledge of or interest in the subject or is in need of new arguments to back up his or her point of view.

If both criteria are met, the individual is ready to absorb the information. Having gained the receiver's attention does not determine the process, however, by which the information is acknowledged and evaluated. A complex procedure of information selection and processing takes place after the initial attention-drawing stimulus. This procedure can be described through several steps of information processing. After information has passed the initial selection filters, people draw inferences from the information, compare the content of the information with previously held beliefs or memories, evaluate the significance, truthfulness and personal relevance of the information, construct new beliefs (or more often reaffirm old beliefs), and form an opinion of (initial mental response) or an attitude towards (enduring mental response) the object or activity to which the information provided new insights. These steps are summarized in the Table 4.2.

In order to economize information processing, individuals are likely to evaluate whether it is necessary to study the content of the information in detail or to make a fast judgement according to salient cues in the message received. The first strategy refers to the central route of information processing, the second to the peripheral route (Petty and Cacioppo, 1986; Renn and Levine, 1991; Breakwell, 2007, pp132ff; see also Essay 7 on risk communication in this volume). The *central route* is taken when the receiver is so highly motivated by the message that s/he studies each argument carefully. The *peripheral route* is taken when the receiver is less inclined to deal with each argument, but forms an opinion or even an attitude on the basis of simple cues and heuristics.

In the central mode, the receiver performs two types of evaluations: first, he assesses the probability that each argument is true; and, second, he assigns weight to each argument according to the personal salience of the argument's content. The credibility of each argument can be tested by referring to personal experience, knowledge, plausibility, and the perceived motives of the communicator. The major incentives for changing an attitude in the central mode are the proximity to, and affinity with, one's own interests, values and world views. In the peripheral mode, receivers

Table 4.2 *Steps for information processing*

Steps	Description
Information passes through selection filters	Select and further process signals coming from the environment or from other social actors
Decode signals information	Decipher the meaning of the signals (investigate factual content, sources of information, value statements, overt and hidden intentions of sources and transmitters)
Draw one's own inferences	Come to conclusions about the intentions of the source and the transmitter in order to employ intuitive heuristics (common-sense reasoning) to make generalizations about the information received and to use symbolic cues for judging the seriousness of the information
Compare the decoded message with encoded messages stored in memory	Analyse the meaning of the message in the light of related messages from other sources or previous attitudes and beliefs
Evaluate messages	Rate the importance, persuasiveness and potential for personal involvement on the basis of the accuracy of the message, the potential effect on one's personal life, the perceived consistency with existing beliefs (to avoid cognitive dissonance), reference group judgements (to avoid social alienation) and personal value commitments
Form specific beliefs	Generate or change beliefs about the subject of the message or reaffirm previously held beliefs
Propensity to take corresponding actions	Generate intentions for future actions that are in keeping with newly formed beliefs

Source: adapted from Renn, 1992a

do not bother dealing with each argument separately, but look for easily accessible clues to make their judgement on the whole package. Examples of such cues are the length of a message, the number of arguments, the package (colour, paper, graphic appeal, etc.) and the presence of symbolic signals that trigger immediate emotional responses (compare with model of social amplification: Kasperson et al, 1988; Breakwell, 2007, pp224ff).

Cognitive heuristics

Once information has been received, common-sense mechanisms process the information and help the receiver to draw inferences. These processes are called intuitive heuristics. They are particularly important for risk perception since they relate to the mechanisms of processing probabilistic information. Early psychological studies focused on personal preferences for different compositions of probabilities and outcome (risk aversion, risk neutrality and risk proneness) and attempted to explain why individuals do not base their risk judgements on expected values (i.e. the product of probability and magnitude of an adverse effect) (Pollatsek and Tversky, 1970; Lopes, 1983; Renn, 1990). One of the interesting results of these investigations was the discovery of systematic patterns of probabilistic reasoning that are well suited for most everyday situations. People are risk-averse if the stakes of losses are high and are risk-prone if the stakes for gains are high (Kahneman and Tversky, 1979). Many people balance their risk-taking behaviour by pursuing an optimal risk strategy that does not maximize their benefits, but ensures a satisfactory pay-off and the avoidance of major disasters (Luce and Weber, 1986). Using rules of thumb rather than calculating expected values has been the main outcome of many empirical studies of how people perceive risks (Covello, 1983; Boholm, 1998).

One important rule of thumb is to overrate exposure and hazard, rather than the probability of harm (Renn et al, 1992). This intuitive heuristic is probably the most powerful factor for rejecting or downplaying information on risk. If people assume an exposure above zero or believe that a risk agent is present that can cause harm, such as cancer, they normally conclude that any disease from which a person exposed to this risk suffers has been caused by the risk agent (Kraus et al, 1992). Such assumptions imply that any exposure is regarded as negative, so that avoidance is the most prudent action.

A second example refers to the perception of risks and benefits. In most cases, one would assume that an activity that leads to high benefits may also be associated with high risks (and vice versa). Empirical studies on how people process information about risks and benefits show the opposite effect. Most respondents assume that high risks are linked to low benefits and vice versa (Alhakami and Slovic, 1994). One explanation for this negative correlation between risks and benefits may be that respondents calculate a net balance between risks and benefits and transfer this net result to both risks and benefits (De Jonge et al, 2007).

A third example for a rule of thumb that deviates from the experts' perspective on risk is the public understanding of uncertainty. The distinction that experts perform when conducting a risk assessment, between a probability distribution and the associated degrees of remaining uncertainties (expressed in confidence intervals or in other forms of uncertainty characterization), is not echoed in risk perception studies (Sparks and Shepherd, 1994; Frewer et al, 2002b). There has been a basic understanding among most people that the preferred dichotomy of judging a situation as either safe or unsafe needs to be replaced by a mental model that differentiates among different degrees of certainty. The open space between safe and unsafe, however, is perceived as a one-dimensional indication of knowledge gaps rather than an indication of (genuine) probability distributions. The more people associate uncertainties with a specific risk, the more they believe that society needs more science and research to reduce these uncertainties. Very often, they also require that the risk is not taken unless these knowledge gaps are bridged and a higher degree of confidence is accomplished through knowledge improvement (Sparks et al, 1994; Frewer et al, 2002b; De Jonge et al, 2007).

A fourth example for a widely used application of heuristic reasoning is to apply combinations of risks that are able to compensate for each other's losses (Aven, 2003, pp39ff). This specific deviation from maximizing expected utilities has been adopted as a normative guideline by portfolio theory used by investors in the stock market. According to this theory, investors should select a portfolio of stocks in which the risks of losing money on one share is correlated with the probability of gaining money for another share (mathematically through co-variance analysis).

These examples and many others show that deviations from the rule of maximizing one's utility are not so often a product of ignorance or irrationality, but an indication of one or several intervening context variables that often make perfect sense if seen in the light of the context and the individual decision-maker's values (Lee, 1981; Brehmer, 1987; Gigerenzer, 1991, 2000, 2007). However, there is ample evidence for clear violations of mathematical or logical rules in common-sense reasoning when it comes to processing probabilistic information. Many specific studies identified biases in people's ability to draw inferences from probabilistic information (Festinger, 1957; Simon, 1976, 1987; Ross, 1977; Kahneman and Tversky, 1979; reviews in Covello, 1983; Renn, 1990, Boholm, 1998; Jungermann et al, 2005; Breakwell, 2007, pp78ff). These biases are summarized in Table 4.3.

Although these biases constitute clear violations of logical rules, they might have been overrated in the literature (Fischhoff et al, 1981; Fleming et al, 1998; Rowe and

Table 4.3 *Intuitive biases of risk perception*

Biases	Description
Availability	Events that come immediately to people's minds are rated as more probable than events that are of less personal importance
Anchoring effect	Probabilities are estimated according to the plausibility of contextual links between cause and effect, but not according to knowledge about statistical frequencies or distributions (people will 'anchor' the information that is of personal significance to them)
Representation	Singular events experienced in person or associated with the properties of an event are regarded as more typical than information based on frequency of occurrence
Avoidance of cognitive dissonance	Information that challenges perceived probabilities that are already part of a belief system will either be ignored or downplayed

Source: Ortwin Renn

Wright, 2001). Many laboratory situations provide insufficient contextual information to provide enough cues for people upon which they can base their judgements (Lopes, 1983). Relying on predominantly numerical information and being unfamiliar with the subject, many subjects in these experiments resort to simplistic solutions when being asked to draw inferences for solving unfamiliar and often abstract problems. In many real-life situations, experience of, and familiarity with, the context provide additional information to calibrate individual judgements, particularly for non-trivial decisions (Heimer, 1988; Gigerenzer, 2000).

Recent experiments even show that these intuitive mechanisms of reasoning and decision-making are often superior to the rational route of maximizing one's utility (Gigerenzer, 1991, 2007). Classic decision theory claims that individuals who face several decision options are best advised to choose the one option that promises the highest expected value (Eisenführ and Weber, 2003, pp209ff; Goodwin and Wright, 2004). Individuals should therefore assess the expected benefits and costs (utilities) related to each option and multiply the expected utilities with the subjectively calculated probability of their occurrence (subjectively expected utility, or SEU, theory). Risk in this sense represents the net effect of negative or positive consequences associated with each option (magnitudes) and the assignment of probabilities to each outcome. If one expects an option to have multiple consequences (e.g. monetary costs, health risks, pleasure, improvement of social relationships, etc.), rational decision-makers will then assign relative weights to each of these dimensions and calculate the subjectively expected utility for each consequence. All of the dimensional utility gains or losses can then be added after being multiplied with their relative weight.

In reality, people most often do not use this rational mode of decision-making. Dietz and Stern (1995) noted that the relatively complex array of mathematics that the SEU model presumes of people is not consistent with what we know about human cognition. People simply are not very adept at multiplying probabilities by expected utilities of *n* different action alternatives, at least not without external aids. Human cognition, they point out, has developed along another track. What humans are good at is pattern recognition, classification, and the application of rules of thumb. Rather than systematically consider each action alternative, people are more likely to categorize similar action alternatives and make judgements about whole sets according to simple decision principles. These principles have been labelled as 'bounded rationality' (Simon, 1987; Jaeger et al, 2001, pp249f). Mechanisms of bounded rationality include the lexicographic methods by which individual decision-makers establish a hierarchy of the most valuable dimension (Tversky, 1972). Decision options that fail to meet the claims of the highest-ranking value (no matter how excellent their consequences are for other values) are eliminated. If the test of meeting the highest-ranking dimension suffices to determine a unique decision option, the claims of other options will not even be considered. If the highest-ranking value cannot determine a unique decision option, the next highest-ranking dimension is used to sort out the remaining decision options, and the claims of this second-ranking value are then given strong priority (in the sense explained) over the claims of all the lower-ranking values. Another alternative is the 'satisficing' method through which individuals determine minimum thresholds for all dimensions that they care about (Simon, 1976, pp83ff; Dawes, 1988, p51).

There is no doubt in the literature that these models of bounded rationality are, generally, reliable strategies that reduce complexity and make decisions quickly and efficiently. Yet, there is a new debate about the normative values of these 'suboptimal' strategies. While the classic decision theorists believe that nothing but the SEU model can produce optimal results (given the preferences of an individual), several psychologists and economists have provided empirical evidence for the superiority of these rules of thumb compared to the application of the SEU model (Gigerenzer, 2000; Gigerenzer and Selten, 2001; Miller, 2006). Deviations from the rule of maximizing one's straightforward utility appear to be less a product of ignorance or irrationality than an indication of a culturally developed coping mechanism that provides not only fast, but also appropriate, responses to a given threat. Nevertheless, risk managers should be aware of these biases because they are found in public perception and may be one of the underlying causes for the discrepancy between layperson judgement and professional assessments.

Psychometric factors (contextual characteristics)

The psychometric paradigm constitutes a further development of the bounded rationality idea, but expands the factors that influence risk perception beyond the classic components of expected harm and probabilities of their occurrence (review in Breakwell, 2007, pp26ff). It conceptualizes risks as a subjective estimate of individual fears or expectations about an action's or event's unwanted consequences. Such individual strategies to estimate and handle risks have been researched thoroughly in psychology and social psychology (Slovic et al, 1986; Slovic, 1987; McDaniels et al, 1997; Boholm, 1998; Sjöberg, 1999b; 2000b; Rohrmann and Renn, 2000; Townsend et al, 2004; Knight and Warland, 2005). People do not use completely irrational strategies to assess and evaluate information, but most of the time follow relatively consistent patterns of perception. These patterns can be traced back to certain evolutionary traits of hazard deterrence (Marks and Nesse, 1994; Renn, 2005). In dangerous situations, humans react with four basic strategies:

1 flight;
2 fight;
3 play dead; and, if appropriate,
4 experimentation (on the basis of trial and error).

This reaction pattern can be visualized by imagining how our ancestors reacted to a predator in the wilderness. In a situation of acute threat, such as coming up against a tiger, the victim would not have had time – it would not have made much sense to conduct a probability analysis as to whether the tiger is hungry or not. At this moment, a person who was threatened had only three possibilities: first, to flee and hope to be faster than the tiger; second, to believe in his strength and fight; or, third, to play dead, believing the tiger could be duped. In this case, the last option – namely, experimentation – is only open to the tiger.

In the course of cultural evolution, these basic patterns of perception were increasingly enriched with cultural patterns. Cultural patterns can be described by so-called qualitative evaluation characteristics and, in the school of psychometrics, are measured by using numerical scaling techniques. This approach to risk research was originally developed by the Oregon Group (see Fischhoff et al, 1978; Slovic et al, 1980, 1986; Slovic, 1992). A number of researchers followed their example, most of them in the US and Europe.[4] Paul Slovic, one of the principal contributors to the psychometric paradigm, has characterized the paradigm in the following way:

> *It elicits current preferences; it allows consideration of many aspects of risks and benefits besides dollars and body counts; and it permits data to be gathered for a large number of activities and technologies, allowing the use of statistical methods to disentangle multiple influences on the results.... Another distinguishing feature of our studies has been the use of a variety of psychometric scaling methods to produce quantitative measures of perceived risk, perceived benefit and other aspects of perceptions (e.g. estimated fatalities resulting from an activity).* (Slovic, 1992, pp118f)

The psychometric school of risk analysis expands the realm of subjective judgement about the nature and magnitude of risks and is based on four characteristics (Jaeger et al, 2001, pp102ff):

1. establish 'risk' as a subjective concept, not an objective entity;
2. include technical/physical and social/psychological aspects in assessing risks;
3. accept opinions of 'the public' (i.e. laypeople, not experts) as a matter of academic and practical interest;
4. analyse the cognitive structure of risk judgements, usually employing multivariate statistical procedures such as factor analysis, multidimensional scaling or multiple regression.

Psychometric methods provide an empirically driven explanation of why individuals do not base their risk judgements on subjectively expected utilities. The research revealed several contextual characteristics that individual decision-makers use when assessing and evaluating risks (Fischhoff et al, 1978; Slovic, 1987, Rohrmann and Renn, 2000; Renn et al, 2007, p78). The following contextual variables of risk have been found to affect people's judgements about risks (taken and expanded from Renn, 1990):

- *Expected number of fatalities or losses.* Although the perceived average number of fatalities correlates with the perceived seriousness of a risky technology or activity, the relationship is weak and generally explains less than 20 per cent of the declared variance. The major disagreement between technical risk analysis and risk perception is not about the number of affected persons, but about the importance of this information for evaluating the seriousness of risk.
- *Catastrophic potential.* Most people show distinctive preferences among choices with identical expected values (average risk). Low-probability/high-consequence risks are usually perceived as more threatening than more probable risks with low or medium consequences.

- *Risk-related characteristics.* Surveys and experiments have revealed that perception of risks is influenced by a series of perceived properties of the risk source (Slovic, 1987, 1992; Boholm, 1998; Marris et al, 1998; Renn, 2004a). Table 4.4 lists several of these characteristics in addition to those related to the risk situation. Among the most influential factors in this category are: perception of dread with regard to the possible consequences; familiarity with the risk, nature of the risk (human or natural); and others (Fischhoff et al, 1978; Drottz-Sjöberg, 1991; Slovic, 1992; McDaniels et al, 1997; Renn, 2004a, 2005). One example of a risk-related pattern is the perceived 'dread' of the consequences of a possible harmful event. If, for example, a person riding in a car thinks about possible accidents, she or he will always be under the impression that they would, with high probability, get away unscathed in a car accident ('fender-bender mentality'). However, if the same person is sitting in an airplane, she or he will be under the impression that if something happens, there is no getting away. This feeling of apprehension does not subside even when this person knows the odds and is convinced that, statistically, many more people die in car accidents than in airplane crashes. The feeling of helplessness triggers fear as it no longer permits the typical reaction patterns of flight, fight or playing dead as sensible strategies of hazard defence.

  Humans can deal with dangers better when they are well aware of them and when they prepare themselves to cope with threats. Seen from an evolutionary point of view, this also makes sense. After all, the known and familiar risk is much less fearsome than the unknown and less familiar risk. A good example is the perception of naturalness (Renn, 2005). Anything that is seen as natural is considered familiar and, thus, less dangerous. In contrast, anything that is perceived as artificial or chemically induced is considered foreign, unnatural and, thus, dangerous. As a side effect of modernization, much of society is under the impression that everything that is provided by nature is inherently benign, favourable, and healthy, whereas everything that comes from chemical processing (such as preservatives in food) is unnatural, highly risky, and unhealthy. This dualism does not, of course, withstand scientific examination. Beneath it, however, lies the longing of modern humankind for simple, unambiguous conditions, and for a clear polarity of good and bad, safe and dangerous. Naturalness is rated highly because 'nature' is not suspected of being an ideology. Those who do something for nature and intend to preserve the natural order are inherently altruistic. To what extent this dualism of nature and chemistry is already prevalent in everyday life can be seen by the change in meaning of the words 'synthetic' or 'artificial'. Things natural are 'in'; things synthetic or artificial are 'out'. It is not without reason that all large food companies advertise with 'natural' on their labels, regardless of how justified this may be.
- *Situation-related characteristics.* A second set of qualitative characteristics applies to the situation in which the risk manifests itself. Situation-related patterns of perception include aspects such as voluntariness and personal control (Covello, 1983; Slovic, 1987; Zepeda et al, 2003; Knight and Warland, 2005; Breakwell, 2007, p29). If a person is of the opinion that risk can be controlled, then she or he will perceive it as less serious. This mode of thinking frequently takes effect

where eating habits are concerned. People believe that they can easily do without sweets, alcohol, or other unhealthy food, if only they wanted to. However, mostly harmless chemical food additives are perceived as a threat to one's health. Other situational factors include the potential to blame a person or institution for the creation of a risky situation (Slovic et al, 1982, 1986). In addition, equity considerations play a major role in this context. The more that risks are seen as unfair, the more they are judged as severe and unacceptable (Kasperson and Kasperson, 1983; Short, 1984; MacLean, 1986; Kasperson, 2005a).

- *Beliefs associated with the cause of risk.* The perception of risk is often part of an attitude that a person holds about the cause of the risk (i.e. a technology, human activity or natural event). Attitudes encompass a series of beliefs about the nature, consequences, history and justifiability of a risk cause (Otway and Thomas, 1982; Rayner, 1992, Sjöberg, 2000b). Due to the tendency to avoid cognitive dissonance (i.e. emotional stress caused by conflicting beliefs) (Festinger, 1957), most people are inclined to perceive risks as more serious and threatening if other beliefs contain negative connotations (and vice versa). A person, who believes that industry policies are guided by greed and profit, is more likely to think that the risks of industrial pollution are only the 'tip of an iceberg'. On the other hand, a person who believes that industry provides consumers with goods and services that they need and value is likely to link pollutants with unpleasant, but essentially manageable, by-products of industrial production. Often, risk perception is a product of these underlying beliefs rather than their cause (Clarke, 1989).
- *Stigmatization*. In connection with unwanted facilities such as nuclear power plants or waste depositories, social scientists have found evidence for stigma effects associated with these facilities (Gregory et al, 1995; Flynn et al, 1998; Kasperson et al, 2001; Zwick, 2006, p95). Stigmatization refers to the process of eliciting negative emotions and strong feelings of risk aversion, independent of the cognitive content of the risk information (Peters, E. et al, 2004). As soon as the stigmatized risk is raised in a conversation, the negative connotations appear and colour all attempts at reaching a mental balance between risks and benefits. Stigmatization often occurs in a crisis situation when the perception of immediate threat, blame, and lack of time to react, coincide (Zwick, 2006).
- *Emotional responses.* More recent research on risk perceptions have revealed affective elements that do not only influence the emotional value of cognitive beliefs (as claimed by the popular Fishbein and Ajzen, 1975, model of attitudes), but are genuine drivers of risk perception (Peters, E. and Slovic, 1996; Finucane et al, 2000; Loewenstein et al, 2001; Slovic et al, 2002; Breakwell, 2007, pp109ff). Such emotions include fear, disgust and anger on the negative side and admiration, identification and immediacy on the positive side. More relevant, however, are affective variables that are able to colour beliefs in a specific direction. They shape the judgement about goodness or badness experienced as an emotion demarcating a positive or negative quality of a stimulus (Slovic et al, 2002, p412). Several scholars are also convinced that the reduction of cognitive dissonance (e.g. by downplaying the benefits if the risks are perceived as high) is also governed by emotional processes (Alhakami and Slovic, 1994). The relative importance of emotional factors for determining risk perception is, however, still

Table 4.4 *List of important qualitative risk characteristics*

Qualitative characteristics	Direction of influence
Personal control	Increases risk tolerance
Institutional control	Depends upon confidence in institutional performance
Voluntariness	Increases risk tolerance
Familiarity	Increases risk tolerance
Dread	Decreases risk tolerance
Inequitable distribution of risks and benefits	Depends upon individual utility; strong social incentive for rejecting risks
Artificiality of risk source	Amplifies attention to risk; often decreases risk tolerance
Blame	Increases quest for social and political responses

Source: adapted from Renn, 1990

contested. Sjöberg (2004) was unable to find significant correlations between affects and risk perception, while other studies show that affects interact with risk perception for some hazards only, but not for others (Bouyer et al, 2001).

- *Personal involvement.* Not surprisingly, people usually have more favourable perceptions of risks if they are practically or emotionally involved in the risk-causing activity or use risk-related technology. For example, individuals who use cellular phones perceive the risk of electromagnetic radiation as being much lower than those who do not use them (Siegrist et al, 2005b; Ruddat and Sautter, 2005). The same is true of the risk perception of sports, food habits, alcohol, smoking and travel (Hazard and Lee, 1999; Lundborg and Lindgren, 2004; Setbon et al, 2005; De Jonge et al, 2007)

Empirical studies show that these contextual variables are highly correlated with the perceived seriousness of risks and the judgement about acceptability (Slovic et al, 1982; Slovic, 1992, Marris et al, 1998, Zwick and Renn, 2002; Zwick, 2006). The high correlations have been measured using aggregate data, thus ignoring the differences between individuals. If correlations are calculated on the individual level (i.e. for each risk separately), research documents that judgements about risk perception or the acceptability of risk vary considerably between individuals, but also between different hazards (Renn, 1981; Gould et al, 1988; Barnett and Breakwell, 2001; Zwick and Renn, 2002). But even at the disaggregate level, the relationship between contextual variables and most risks included in the analysis is usually quite strong and is stronger than using any other alternative explanatory variables (Langford et al, 1999; Sjöberg, 2000b).

A good example illustrating the importance of these characteristics can be found in chemical risks (OECD, 2002). First, most chemicals are associated with negative risk characteristics, such as dread, lack of personal control, and artificiality. The perception of health risks induced by chemicals is usually linked to an absence of personal control, and the preponderance of dread thus amplifies the impression of seriousness. These characteristics make people even more concerned about the negative impacts than is warranted by the predicted health effects alone. Second, the beliefs associated with the risk source (e.g. industry) centre around greed, profit-seeking and alleged disrespect for public health. Third, the possibility of consumers being exposed to risks without their consent touches upon serious equity concerns if susceptibility to these risks varies considerably among individuals or rests on probabilistic balancing. Inequitable distribution of risks and benefits make the risk appear more severe and unacceptable. Finally, the artificial nature of chemicals and the sensational press coverage about accidents in the chemical industry may invoke negative emotions and could even lead to stigmatization. Products containing phthallates or polychlorinated biphenyls (PCBs) appear already to be associated with strong stigma effects (Renn, 2005).

The importance of these qualitative factors in risk assessment offers a plausible explanation for the fact that it is precisely those risk sources that technical risk assessment classifies as particularly low risk that are the source of greatest concern among the general public. Risk sources that are deemed controversial (such as nuclear energy, genetically modified food or nanoparticles) are very often burdened with negative attributes, while leisure activities are associated with positive associations (Jungermann and Slovic, 1993; Loewenstein et al, 2001).

Given the variety of contextual variables in risk perception, the question arises as to how these classes of variables interact, and how individuals combine and integrate information on these variables to form a holistic judgement about the risk in question. One option for conceptualizing and investigating this integration has been to reconstruct the mental model that respondents use in processing risk-related information (Bostrom et al, 1992; Atman et al, 1994; Morgan et al, 2001; review in Breakwell, 2007, pp95ff). Respondents are normally asked to provide an oral account of their thinking processes and to report about all of their associations and inferential reasoning. The various steps in coming to a conclusion are then mapped in some sequential or logical structure by the analyst(s). Empirical studies (e.g. on the risk perception of drugs in Jungermann et al, 1988) show that the method of mental maps underlines the importance of contextual factors in risk perception, but also points out specific models and structures of mental processing depending upon the risk and the cause of risk (Bostrom et al, 1992). Another option of grouping and classifying contextual variables is to construct typical patterns – so-called semantic images – which serve as orientations for individuals. This topic is explained and discussed in the following section.

Semantic images

Perceptions have a reality of their own: just like the characters in animated films who, suspended in mid-air, do not plunge to the ground until they realize their predicament, people construct their own reality and evaluate risk according to their subjective perceptions. This type of intuitive risk perception is based on how information about the source of a risk is communicated and on the psychological mechanisms for processing uncertainty, intuitive heuristics and the contextual characteristics discussed in the last section. This mental process results in perceived risk. Research on risk perception has identified a range of perception patterns that constitute discrete manifestations of key risk characteristic depending upon the context in which the risk is embedded. These are called *semantic risk images* (Renn, 1989, 2004a; Jaeger et al, 2001, pp105ff; Streffer et al, 2003; Renn et al, 2007, pp80ff). Although these semantic images have not been directly tested in empirical experiments or surveys, they have been deduced from statistical processing of data from studies of qualitative characteristics. In general, five distinct semantic images have been identified (Renn, 1990) (see Table 4.5). In addition to these five images, additional images of risk exist for habitual and lifestyle risks that are, however, less clear in their composition and structure.

The semantic images allow individuals to order risks and risk sources on the basis of a few salient characteristics. Reducing complexity by creating classes of similar phenomena is certainly a major strategy for coping with information overload and uncertainty. The five semantic images are powerful guides that help individuals to navigate through an abundance of often contradictory information and provide an efficient method of balancing the time for collecting and processing information with the personal need for orientation and attitude formation. This section describes the conditions for locating risks in each of the five image boxes and explains the consequences with regard to perception and evaluation.

Risk as a pending danger

In many areas of technology, particularly industrial technology, major accidents involving safety system failures can have catastrophic effects on humans and the environment. In technical safety philosophy, the main aim is to reduce the likelihood of such failure occurring, in order to ensure that the probability of impact is as small as conceivably possible. But the stochastic nature of such an event makes it impossible to foresee when it will actually occur. As a result, an event could, theoretically, occur at any time, although its likelihood is extremely low. A look at the perception of rare random events shows that probability plays hardly any role at all: it is the stochastic nature of the event that constitutes the perceived threat. Risk sources in this category include major facilities, such as nuclear power plants, liquid natural gas (LNG) storage facilities, chemical production sites and other man-made sources of potential danger that could have catastrophic effects on humans and the environment in the event of a serious accident.

The idea that a hazard can affect people at any time fosters feelings of threat and powerlessness. Instinctively, most people are better able to cope with risk mentally when they are prepared for and expect it. Just as the majority of people are more afraid at night than during the day (the risk of coming to harm during the day is considerably higher than at night; however, it is easier to be startled by potential danger at night), most feel more threatened by unexpected danger or by being unprepared than by danger that arises either on a regular basis or where there is enough time for risk control measures to be taken. Thus, the risk impact in this perception model depends upon three factors:

Table 4.5 *The five semantic images of risk perception*

1 Emerging danger (fatal threat)
- Artificial risk source
- Large catastrophic potential
- Inequitable risk–benefit distribution
- Perception of randomness as a threat

2 Stroke of Fate
- Natural risk source
- Belief in cycles (not perceived as a random event)
- Belief in personal control (can be mastered by oneself)
- Accessible through human senses

3 Personal thrill (desired risks)
- Personal control over degree of risk
- Personal skills necessary to master danger
- Voluntary activity
- Non-catastrophic consequences

4 Gamble
- Confined to monetary gains and losses
- Orientation towards variance of distribution rather than expected value
- Asymmetry between risks and gains
- Dominance of probabilistic thinking

5 Indicator of insidious danger (slow killer)
- (Artificial) ingredient in food, water or air
- Delayed effects; non-catastrophic
- Contingent upon information rather than experience
- Quest for deterministic risk management
- Strong incentive for blame

Source: adapted from Renn, 1990

1 random nature of the event;
2 expected maximum impact; and
3 time span for risk control measures.

Conversely, the comparative rarity of an event (i.e. the statistical expected value) is of little consequence. Rather, regularly occurring events signal more of a continued sequence of harmful events, for which one can prepare oneself through a process of trial and error.

While the perception of risk as an impending disaster often governs technical risk assessment, it rarely applies when assessing natural disasters. Earthquake, flood and tornado activity follow the same determinants as technological innovation (i.e. the occurrence of such events is rare, stochastic and allows little time for risk control measures to be taken). They are, however, assessed using a different risk model, as described below.

Risk as a stroke of fate

Natural disasters are usually seen as unavoidable events with catastrophic effects; but they are also perceived as quirks of nature or acts of God (and, in many cases, as the mythological wrath of God for collective sinful behaviour) and are thus beyond human control (Douglas, 1966; Watson, 1987; Wiedemann, 1993). In terminology used by Niklas Luhmann, they are dangers that humans are exposed to, but cannot control (Luhmann, 1990; 1993b). The possibilities for controlling natural disasters and lessening their impacts have not yet anchored themselves sufficiently in people's awareness of allowing the risks from natural disasters to be assessed in the same way as those from technological accidents.

Natural burdens and risks are seen as predetermined by fate, while technical risks are perceived as the consequences of decisions and actions. Such actions are assessed and legitimized according to different standards. Fate only finds justification in mythology or religion. If none other than God can be held accountable, no amount of human activity will improve the situation. The only alternatives are to flee from the risk situation or to deny its existence. The rarer the event, the more likely people are to deny it or suppress it; the more frequent the event, the more likely people will flee from the danger zone. It is thus understandable, although not altogether rational, that people will settle in earthquake and flood regions and will often return to those regions in the wake of a disaster. As opposed to the circumstances of technical risk, the random nature of the event is not the fear-triggering factor because people tend to believe that natural disasters occur at regular time intervals. In addition, the relative rarity of the event provides psychological reinforcement for risk denial.

With the increasing influence human actions can have on natural disasters, the *risk as a stroke of fate* model has recently turned into a mixture of risk perception elements that merge the perception of natural disaster with the perception of risks caused by human action. This is evident when, for example, a natural disaster occurs that is modified by human action. In this case, the question of accountability and blame arises, and cause is found in the failure to implement control or preventive measures (Douglas, 1990).

Risk as a personal thrill

When, despite the considerable risk, Reinhold Messner climbs the world's highest mountains without the aid of an oxygen respirator, when drivers drive much faster than the speed limit allows, when people throw themselves off a mountain or a cliff-top with nothing more than a pair of artificial wings to save them, and do so in the name of sport, the meaning of risk takes on a new dimension. As is often claimed, the pursuit of such leisure activities is not about accepting risk as a ticket to pleasure (feeling the wind in one's hair or enjoying a magnificent view); instead, the benefit lies in the risk itself. The attraction of such activities is the fact that they involve risk (Machlis and Rosa, 1990).

In all of these cases, people take risks in order to test their own strength and to experience triumph over natural forces or other risk factors. To pitch oneself against nature or one's competitors, and to overcome a self-contrived risk situation, are the major incentives in entering into the activity. It may well be that the challenges offered by our safety-conscious society are too few so that our – often instinct-based – desire for adventure and risk goes unsatisfied. Instead, artificial situations are created to provide a calculable and (through personal effort) surmountable risk that individuals expose themselves to voluntarily. Risk as a thrill involves a range of situation-specific attributes:

- voluntary involvement;
- personal control of, and ability to influence, the respective risk;
- limited period of exposure to the risk situation;
- the ability to prepare oneself for the risk activity and to practise appropriate skills;
- social recognition for overcoming the risk.

Risk as a thrill is such a dominant motivator that many societies have developed symbolic risk situations in the form of sports, games, speculation, investment and the rules of power acquisition as a channel for the 'kick' in overcoming danger, and to replace any possible negative outcome with symbolic penalties. Symbolic channelling of the 'high' in taking risks also includes symbolic anticipation of real danger by way of computer simulation and hypothetical risk assessment (Häfele et al, 1990). Conventional methods of testing or finding new uses for technological innovations by means of trial and error can no longer be morally justified in a society so fixated on protecting the individual. In place of error – which always causes harm – comes symbolic anticipation of danger: adventure holidays aim only at communicating the idea of risk; spare the thought that someone might get hurt. Technological systems must be designed so that no one comes to harm as a result of system failure (learning from actual mistakes is replaced by computer simulation of hypothetical disaster scenarios). Increased experience of purely symbolic risk naturally increases the demands placed on technological systems. The more the thrill of risk-taking is associated with symbolic consequences for oneself and potential competitors, the more one expects the consequences of technical sources of risk also to be symbolic. Real risk should simply not occur.

The shock of Chernobyl and other technological disasters lies primarily in the outrage that such accidents did not remain a purely hypothetical game of numbers, but instead had very real impacts upon the environment. The mix of hypothetical risk assessment and actual harm to health played a large part in causing the general confusion that abounded following Chernobyl (Peters, H. P. et al, 1987). What had long been deemed impossible both in perceived residual risk and in computerized risk simulation in the 'pretend world' of hypothetical risk assessment was suddenly reality, even though the health consequences for Western Europe could only be assessed on a hypothetical basis (Hohenemser and Renn, 1988).

Risk as a gamble

Risk as a thrill, in which one's own abilities to cope with risk are instrumental in engaging with the activity in the first place, is not the same as the risk involved in playing the lottery or games of chance. These involve losses or gains independent of the player's ability. While simply playing the game can in itself create a high and become the objective of the exercise, it is the anticipated or desired payout, the possibility of a big win, that produces that certain 'thrill' of gambling and not the actual process of playing (in contrast to games in which rewards and penalties have only symbolic value).

Psychologists have long conducted in-depth studies on risk behaviour in games of chance. First, the circumstances are easily simulated in the laboratory and, second, it is easy to identify deviations from statistical expected values (Dawes, 1988, pp92ff). However, it must be pointed out that the statistical expectations provide no standard upon which to base individual gambling behaviour. The stake must be kept to an absolute minimum while the main prize must be particularly attractive. Players tend to underestimate the probability of rare events and are thus more willing to play if their stake remains below their pain threshold (Kahneman and Tversky, 1979). The fact that there is always a winner incites the belief that you could be next. Gambling often involves hidden distribution ideologies (like dead cert betting systems, lucky numbers or fair shares). Some 47 per cent of Americans believe in the existence of lucky numbers, and that they increase certain players' chances of winning (Miller, 1985, Tables 8 to 13).

If the random element receives due recognition, then the perceived concept of stochastic payout distribution comes closest to the technical risk model. People are normally able to perform such probabilistic reasoning, but only in the context of gambling, lotteries, financial investment and insurance. Horse betting is an excellent example of the degree of sophistication in probabilistic reasoning that average people master in many countries. The common prejudice of many technical experts that laypeople are unable to handle risk information and to understand probabilities is certainly not true in this context. However, some of the biases of processing uncertainty apply to the perception of gambling risks, too. Laboratory experiments show that people orient their judgement about lotteries more towards the variance of losses and gains than towards the expected value (Pollatsek and Tversky, 1970). Prospect theory is the mathematical expression of individual preferences for risk aversion and gain proneness (Kahneman amd Tversky, 1979). Such deviations from the expected value model can be a very rational response, as explained earlier. If people perceive a risk as falling in this category, they normally apply a risk–benefit balancing model based on their subjective values and accept, or even seek, risks if this balance turns out to be positive. However, this concept is not used in the perception and assessment of technical risk. Quite the opposite: a study conducted in Sweden has shown that those questioned believe it highly immoral to apply a *game of chance mentality* to technical risk sources in cases where human health and life are at stake (Sjöberg and Winroth, 1985).

Risk as an indicator of insidious danger

In recent times, public debate has acquired yet another definition of risk. Increasing reports on environmental pollution and its long-term impacts on health, life and nature have forced scientific risk assessment to adopt a role as early warning indicators. In this risk perception model, scientific studies facilitate early detection of lurking danger and the discovery of causal relationships between activities or events and their latent effects. This definition of risk is used, for example, in cognitive handling of low doses of radiation, food additives, chemical crop protection products, and genetic manipulation of plants and animals. Perception of such risk is closely related to the need to find causes for apparently inexplicable consequences (e.g. seal deaths, childhood cancer or forest dieback). Unlike the scientific medical risk model, the probability of such an event is not seen as a significant deviation (i.e. it can no longer be explained by chance) from natural variation for the event in question, but rather as the degree of certainty with which a single event can be traced to an external cause (Kraus et al, 1992; Renn, 2004a).

The fact that cancer can be caused by ionizing radiation at least legitimizes the suspicion that all incidences of cancer that occur in the vicinity of a nuclear power plant can be explained by the fact that the plant emits radiation. Anyone who contracts cancer, or is forced to watch a family member or close friend suffer from the illness, will search for an explanation. In our secularized world, metaphysically based explanation patterns have lost their importance. At the same time, the best explanation supplied by current scientific knowledge, that cancer occurs at random, does little to satisfy the need for a 'meaningful' explanation. There is little consolation in knowing that one has contracted cancer by way of a stochastic distribution mechanism. If one has an actual reason – say, environmental pollution, smoking or bad eating habits – then the illness's occurrence at least makes some sense. And if, from a subjective standpoint, one's own actions (smoking or alcohol abuse) can be ruled out as the cause of the illness and blame can be placed on external causes, it may even fulfil a social purpose: that of heightening awareness in potential victims and stirring them to fight.

The often highly emotional debate on this type of risk must be viewed from this psychological standpoint. Our propensity to empathize helps us to identify with the victim. Risk assessment that shows a certain probability of lurking danger due to pollution triggers off identification with people affected by it. While risk analysts characterize the relative risk of events by using stochastic theories that provide average numbers over large populations (thus creating distance between themselves and the object of their study), the layperson sees these theories as proof of the part played by social actors in causing life-threatening diseases.

But, then again, the definition of probability is the crux of the discrepancy between intuitive and technical perceptions of risk. It is difficult to give someone a plausible explanation as to why, according to assessments conducted by the US Department of Energy, some 28,000 people in Europe will contract cancer in the next 50 years as a direct result of Chernobyl, but the individual risk of dying of cancer has only risen by 0.002 per cent (Hohenemser and Renn, 1988). For the average German, this means an increased probability from around 24 per cent today to 24.002 per cent. So who do these 28,000 cases involve, if each potential victim is only subject to a marginally increased risk of contracting cancer? The fact that this example (the product of low probability and a large population) also sheds light on the limitations of interpretative ability in scientific technical risk assessment goes without saying.

Where risks as an early indication are concerned, affected groups depend upon information provided by third parties because, as a rule, these risks cannot be perceived with the human senses. Moreover, these risks are highly complex (i.e. there are usually many years of latency between emission and effect). When we drink water containing pesticide residues, health symptoms may be visible only many years later, if at all.

If laypeople assess these risks, they sooner or later come across a key question: do I trust the institutions providing the necessary information or do I not? Trust is a key variable in the perception of risks in this category (Siegrist, 2000; Siegrist et al, 2000). If the answer is yes, people are willing to use a balancing approach between risks and benefits and to assign trade-offs between the two. If the answer is no, they demand zero risk. For example, if one depends upon information provided by third parties for the assessment of such risks, and these third parties are not considered trustworthy, then one does not accept any cost–benefit calculation. If the answer is yes, such a balancing act between perceived benefits and risks is performed. If the answer is maybe, often peripheral factors become decisive for deriving a final judgement (Renn and Levine, 1991). These include hints or cues related to conflicts of interest (is the communicator paid by industry or an NGO?); similarity of values (does the communicator share the same lifestyle or cultural background?); or affiliation to a highly esteemed reference group (does the communicator belong to a social group whom I deeply respect – for example, Nobel Prize winners?).

This perception pattern is, for example, a central problem of genetically modified organisms (GMOs) in agriculture and food. Many surveys indicate that those institutions which want to advance green genetic engineering meet with a lack of faith on the part of consumers (Frewer et al, 1995; Zwick and Renn, 1998; Hampel, 2004; Siegrist, 2000, 2007). Under these circumstances, consumers who are unable to assess the hazard of GMOs on their own, demand zero risk. This example also proves that it is not helpful to improve the acceptance rate of GMOs by providing risk–risk comparisons. The same people who demand zero risk in genetic engineering will ride a bicycle, drive a car or get on an airplane. They don't perceive this as inconsistent since these means of transportation are part of a different risk pattern, where the trade-off between benefit and risk are considered legitimate.

Some risk sources evoke more than one semantic image. Combinations of the slow agents and pending danger images are particularly interesting. For example, nuclear power is associated with large-scale accidents and slow deterioration of human health induced by low-dose radiation from normal operations. The same applies to many of the climate risks. Such combinations can act as risk amplifiers in public perceptions, leading to strong personal as well as social reactions (Kasperson et al, 1988, 2003).

Summary of psychological research on risk perception

Psychological research on risk perception brings us a step closer towards an analysis of how most people assess risk. The observed discrepancy between the results of technical risk assessment conducted by experts and intuitive assessment of the same risk by society is not, in the first instance, due to ignorance about the statistically derived expected values or an expression of erratic thought processes, but rather an indication of a multidimensional assessment process in which anticipated harm is only one among many factors (Slovic et al, 1982; Mazur, 1987a; IRGC, 2005; Breakwell, 2007, p3).

Studies conducted on an international scale also show that people everywhere, regardless of their social or cultural background, use virtually universal risk perception criteria in forming their opinions (Schwartz and Bilsky, 1990; Renn and Rohrmann, 2000; Hofstede, 2001; more critical about this claim are Koné and Mullet, 1994; Schmidt and Wei, 2006). However, the relative effectiveness of these criteria in forming opinions and in judgements about risk tolerance varies considerably between different social groups and cultures. While the above-mentioned qualitative characteristics are accepted (often subconsciously) as intuitive yardsticks for perceiving risks, their relative contribution to a person's actual opinion or motivation to take action depends upon more than just contextual characteristics (Siegrist et al, 2005a). In addition, individual lifestyles, threatening environmental factors, world views about nature (particularly tampering with nature), technology and society, and ingrained cultural values play a major role (Sjöberg, 2000a; Wilkinson, 2001; Scherer and Cho, 2003). In assessing risk, people who favour alternative lifestyles tend, more than others, to consider both 'reversibility of the consequences of risk' and 'congruence between risk bearers and benefactors', while those with strong material values assess risk more by way of personal control opportunities and trust in institutional risk control (Buss and Craik, 1983).

The conclusion to be drawn from this is that value expectations and cultural background are significant determinants of subjective risk that do not add to the semantic and qualitative factors already described, but, in effect, presuppose the existence of those factors in that they use them as heuristics to incorporate and process information on complex properties associated with the risk in question. Internalized value expectations and external circumstances can control the relative effectiveness of intuitive perception processes, but not their existence. This is not a matter of academic hair-splitting: it has direct relevance to communication and conflict management. If we assume that intuitive mechanisms of risk perception and assessment bear virtually universal characteristics that can more or less be reshaped by socio-cultural influences, then they can provide a fundamental basis for communication of which one can avail oneself, regardless of differences between the various standpoints. In addition to the pool of common symbols and rituals (shared meaning), whose importance to social integration is in constant decline in pluralistic societies, a new pool of common mechanisms of risk perception emerges that, along with common sense, signals the existence of supra-individual perception mechanisms.

Social and cultural drivers of risk perception

The psychological approaches primarily address individual risk perception patterns based on individual or group responses to qualitative factors or semantic images of risk. This provides valuable insights of how individuals process information and what contextual variables they associate with different types and situations of risk. However, the psychological research does not address the question of which social or cultural stimuli evoke certain patterns or why specific attributes are associated with different types of risk (Mazur, 1987a; Scherer and Cho, 2003). For some, nuclear power is perceived as a risk that society can control, when others believe that this risk is out of institutional control (Slovic et al, 2000). French respondents predominantly believed in the possibility of controlling and regulating nuclear power, while most Americans did not. As another example, to our surprise, being bitten by a dog turned out to be a serious risk that was associated with almost all negative attributes in Romania, but was seen as a voluntary, controllable and hardly dreadful risk in almost any other country (Sjöberg et al, 2000b). The reason for this is the abundance of stray dogs in Romania after the former dictator Ceausescu pulled down entire segments of the city of Bucharest without rescuing the many pets that lived in these buildings.

Historical, social and cultural influences are partially triggering the attribution of semantic images and qualitative characteristics to specific situations, activities or events with uncertain outcomes, and partially influence the opinion- and judgement-forming process in a direct way. These sociological and cultural factors are the subject of many studies related to cultural values, world views, institutional relationships and societal climate (Beck, 1986, 1992b; Douglas and Wildavsky, 1982; Heimer, 1988; Thompson et al, 1990; Luhmann, 1990, 1993b; Renn, 1992c; Marshall, 1999; Mythen, 2004; Zinn and Taylor-Gooby, 2006a). Sociologists have particularly stressed that the evaluative process of risk perception is determined by the norms, value systems and cultural idiosyncrasies of societies (see, for example, Beck, 1986, 1992b; Thompson et al, 1990; Sjöberg, 2006). Within this area, research has been more often qualitative than quantitative, including philosophical treatises on risk perception. The following sections will cover the most prominent social and cultural factors and the corresponding schools of thought (see also Essay 1).

Value commitments

Values provide orientation for judging and guiding behaviour. They are mental constructs that allow individuals or groups to assess a set of objects and/or state of affairs as good or bad (Frankena, 1967). These values are deeply embedded within a specific cultural context of beliefs, norms and moral convictions. When we use the term culture, we refer to the consistency or expectation of behavioural responses within a confined social system (Giddens, 1984). This consistency is grounded in a shared pool of values, roles and interpretations. This pool usually includes a set of inviolate principles (values that are not compromised regardless of potential benefits), role models and internalized codes of conduct; in large part, it defines the social and personal identity of each member of the culture. Most cultures reward members who conform to these shared values and punish members who do not (sanctions). Thus, acceptance of cultural values is linked to both cultural identity and individual self-esteem.

Positions on the risks of technologies or human activities are also affected by human values. Risks are deeply value-laden (Slovic, 2000a). Many people give priority to economic values, such as prosperity, and emphasize the positive side of technological changes. Others emphasize values such as environmental quality or healthy lifestyle, which suggests a more negative view of many technological changes. In the social sciences, values are placed in specific clusters (Fiorino, 1989b) (see Table 4.6).

Table 4.6 *Value clusters and their social and cultural conditions*

Cluster name	Examples	Function
Traditional values	Patriotism, regional or ethnic identity, social status and family stability	Group and cultural identity
Work ethics	Diligence, punctuality, efficiency, discipline and deferred gratification	Functionality and efficiency
Hedonistic values	Consumption, enjoyment, fun and immediate gratification	Incentive and motivation
Post-materialistic values	Harmony, social responsibility, environmental quality, decentralization and quality of life	Moral legitimization and cultural commitment

Source: Ortwin Renn

In contrast to many popular views, there is not a universal shift towards post-materialistic values throughout the Western world (Klages, 1984; Renn and Zwick, 1997, p51). It is true that these values have become more important and can be found on the value priority list of almost every individual; but the claim of a new post-materialistic personality is fiction (Zwick, 2006). Most people demonstrate a mix of all value clusters depending upon context and social relations. A vast majority of people are still interested in gaining additional personal income (even if they rate it low on the scale of personal aspirations). Even unfashionable virtues, such as discipline and efficiency, have their place in most people's value portfolio. However, many of the traditional and work-related values are absent from situations in which they used to dominate. This has been the case with many technologies: once perceived as manifestations of work ethics and hedonistic values (production and consumption), they are now increasingly related to post-materialistic concerns (Scheuch, 1990). This shift in value application is partially responsible for the perception of ambivalence, which is so typical for modern attitudes towards technology.

There is a clear tendency to align value clusters to specific situations. This is illustrated by the example of private transportation. Work ethics may be activated when using a car for professional reasons; hedonistic values when using it for leisure activities. Reading about the impact of private cars upon climate change my trigger post-materialistic values, and being confronted with car noise when taking a walk may invoke traditional values. The estimates of perceived risk differ when people are asked to picture themselves as part of these situations. In addition, people judge the probability of being hurt in an accident much lower if they assume to be the drivers rather than the passengers (Svenson, 1981).

How strong is the influence of values on risk perception? Empirical results differ in this question. There has been clear evidence that individuals with strong hedonistic and materialistic values are often more inclined to rate the risks of technology and economic activities as lower than those who place more emphasis on environmental quality, family harmony, and social justice (Edwards and von Winterfeldt, 1987;

Jungermann and Slovic, 1993; Boholm, 1998; see review in Renn and Zwick, 1997, pp53ff). As obvious as this relationship appears, it is nevertheless a weak association, and the amount of declared variance is always below 20 per cent (Zwick and Renn, 2002, pp53ff). However, there are clear indications that individuals who tend to be open to technical change, liberal in their views and aspire to a professional career are less worried about the risks of new technologies and other external activities than those who pursue an alternative lifestyle and harbour 'culture-pessimistic' attitudes (Zwick, 2006, pp93f). It is assumed that values play a more indirect role in risk perceptions. They act as selection and attention filters and add emotional colour to processing and weighing of conflicting information on risks.

Cultural approaches to risk perception

Similar to linking qualitative characteristics to semantic images, several sociologists and anthropologists have attempted to develop typical combinations of values, world views and conviction to form what they call 'cultural prototypes'.[5] These prototypes represent social and cultural constructions of what different subcultures within a society or different cultures define as posing a risk to them (Johnson and Covello, 1987). Four or five prototypes that separate different cultural groups in society from each other have been defined (Douglas and Wildavsky, 1982; Rayner, 1990, 1992; Schwarz and Thompson, 1990; Thompson et al, 1990; Wildavsky and Dake, 1990; Grenstad, 2000). These groups have formed specific positions on risk topics and have developed corresponding attitudes and coping strategies. They differ in their degree of *group* cohesiveness (the extent to which someone identifies with a social group) and the degree of *grid* (the extent to which someone accepts and respects a formal system of hierarchy and procedural rules).

These groups comprise entrepreneurs, egalitarians, bureaucrats, stratified individuals and (in some publications) hermits (Thompson, 1980), and can be localized within the group–grid space (see Figure 4.1). Organizations or social groups belonging to the *entrepreneurial* prototype perceive risk-taking as an opportunity to succeed in a competitive market and to pursue their personal goals. They are characterized by a low degree of hierarchy and a low degree of cohesion. They are less concerned about equity issues and would like the government to refrain from extensive regulation or risk management efforts. This group contrasts most with organizations or groups belonging to the *egalitarian* prototype, which emphasizes cooperation and equality, rather than competition and freedom. Egalitarians are also characterized by low hierarchy, but have developed a strong sense of group cohesiveness and solidarity. When facing risks, they tend to focus on the long-term effects of human activities and are more likely to abandon an activity (even if they perceive it as beneficial) than to take chances. They are particularly concerned about equity.

The third prototype, the *bureaucrats*, relies on rules and procedures in order to cope with uncertainty. Bureaucrats are both hierarchical and cohesive in their group relations. As long as risks are managed by a capable institution and coping strategies have been provided for every eventuality, there is no need to worry. Bureaucrats believe in the effectiveness of organizational skills and practices and regard a

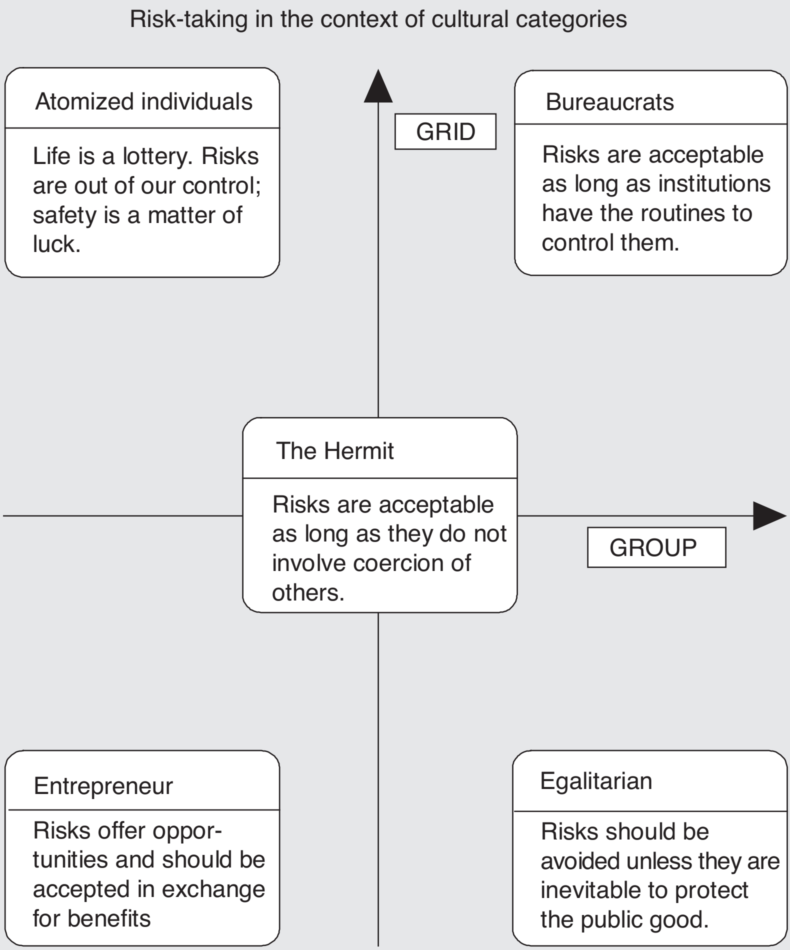

Figure 4.1 *Patterns of value clusters in the context of cultural theory of risk*

Source: adapted from Thompson et al, 1990 and Renn et al, 2007, p57

problem as solved when a procedure to deal with its institutional management is in place.

The fourth prototype, the group of *atomized* or *stratified individuals*, as a matter of principle believes in hierarchy, but it does not identify with the hierarchy to which it belongs. These people trust only themselves, are often confused about risk issues and are likely to take high risks for themselves, but oppose any risk that they feel is imposed upon them. At the same time, however, they see life as a lottery and are often unable to link harm to a concrete cause. In addition to the four prototypes, there may be a hybrid group called the *autonomous individuals* or *the hermit*, who can be grouped in the centre of the group-grid coordinates. Thompson (1980) describes autonomous individuals as self-centred hermits and short-term risk evaluators. They may be also be referred to as potential mediators in risk conflicts, since they build multiple alliances to the four other groups and believe in hierarchy only if they can relate the authority to superior performance or knowledge.

This theory has been criticized on several grounds (Nelkin, 1982; Johnson, 1987; Renn, 1992b; Boholm, 1996; Sjöberg, 1997; Breakwell, 2007, pp75f). First, most authors within the cultural theory emphasize that cultural prototypes do not characterize individuals but social aggregates (Rayner, 1987). Second, the relationship between cultural prototypes and interest is unclear and problematic. If cultural affiliation precedes interest, then what determines to which cultural prototype groups or organizations belong? Third, the selection of the five prototypes as the only relevant cultural patterns in modern society needs more evidence than the reference to tribal organizations (Douglas, 1985) or generic models of human interactions (Wildavsky and Dake, 1990). Furthermore, if prototypes are mixed in organizations, then the perspective (similar to many sociological concepts) is not falsifiable. Any observed behaviour is compatible with some mix of prototypes. Lastly, the cultural perspective has not provided sufficient empirical evidence of its validity. Although some studies reported significant and, at least, modest correlations between cultural prototypes and risk perception (Dake, 1991; Langford et al, 2000; Grendstad and Selle, 2000; Bouyer et al, 2001), the majority of empirical studies reported either non-significant interactions or rather low correlations between the two sets of variables (Brenot et al, 1998; Marris et al, 1998; Sjöberg, 2001; Zwick and Renn, 2002, Zwick, 2006).

The cultural theory of risk has its shortcomings and its merits. The reduction of cultural clusters to basically three important prototypes (entrepreneurial, egalitarian and bureaucratic) may be a valid and intuitively plausible hypothesis in analysing risk responses; but it should be treated as a hypothesis rather than an empirically proven explanation. There is sufficient anecdotal evidence that people with an entrepreneurial attitude react very differently to specific arguments compared to people with an egalitarian or bureaucratic attitude. For example, a reference to cost–benefit ratios makes perfect sense when presented to an audience of entrepreneurs, but would trigger outrage when referred to in a group of egalitarians. The emphasis on values and world views rather than interests and utilities (which in themselves are reflections of one's world view) is a major accomplishment of this theory.

Institutional trust and credibility

In addition to cultural and group-related factors in shaping risk responses, social science research has also investigated the role of social networks and reference group judgements. These orientations are important since most information about risk is not learned through personal experience and senses, but through 'second-hand' learning. Personal experience of risk has been increasingly replaced by external information about risks, and institutional risk management has substituted the quest for personal control. As a result, people rely more than ever on the credibility and sincerity of those from whom they receive information about risk (Beck, 1992b; Lupton and Tulloch, 2002; Löfstedt, 2003, 2005; Breakwell 2007, pp140ff; see also Essay 7 on risk communication). Thus, trust in institutional performance has been a major key for risk responses. This is particularly important for risks that belong to the category of 'insidious dangers'. Trust in risk management institutions may compensate for negative risk perception, whereas distrust may lead people to oppose risks even when they are perceived as small (Siegrist and Cvetkovich, 2000; Siegrist et al, 2000; Viklund, 2003). This function of trust as a mediator between negative risk perception and a positive judgement about acceptability was empirically proven by a study that compared attitudes towards nuclear power in France and the US (Slovic et al, 2000). This study showed that the French respondents had similar risk perceptions and shared the same concerns about safety as their American counterparts. However, the French sample demonstrated a high degree of trust and confidence in the technical elite of their country and in the effectiveness of regulatory bodies, of which US respondents were much more sceptical.

When people use the word trust, they often mean different things (Siegrist et al, 2000; Slovic, 2000a), such as credibility of a source, perceived competence, satisfaction with expected performance, or the degree of faith that they have in their good intentions. Most analysts of trust prefer a multidimensional concept, although many empirical studies rely on one indicator only (Blackburn, 1998). However, there is no consensus on the various components of trust, and the empirical results do not reveal a clear and unambiguous picture of what constitutes the assignment of trust in the eyes of the respondents.

In line with some of the literature (Barber, 1983; Lee, 1986), we have chosen seven components that we believe are constitutive components of trust (six taken from Renn and Levine, 1991; in addition, we selected 'empathy', suggested by Peters, R. G. et al, 1997) (see Table 4.7). Trust relies on all seven components; but a lack of compliance with one attribute can be compensated for by a surplus of goal attainment in another attribute.

Table 4.7 *Components of trust*

Components	Description
Perceived competence	Degree of technical expertise in meeting an institutional mandate
Objectivity	Lack of bias in information and performance as perceived by others
Fairness	Acknowledgement and adequate representation of all relevant points of view
Consistency	Predictability of arguments and behaviour based on past experience and previous communication efforts
Sincerity	Honesty and openness
Faith	Perception of goodwill in performance and communication
Empathy	Ability to understand the feelings and expectations of others and to be responsive to them

Source: adapted from Renn and Levine, 1991

Trust on a personal level refers to the expectation that a person will refrain from behavioural options that may harm the person who trusts. Trust necessarily entails risk-taking; but, in contrast to the scientific endeavour of predicting the probability of identified outcomes, trust implies that the selection of options is left to the entrusted person or institution. Due to the perceived competency and honesty of the entrusted entity, one does not need to bother with assessing the outcomes of actions and with controlling the decision-making process of that entity (Luhmann, 1973, 1980). This saves time and effort.

On a more aggregate level, trust denotes a generalized medium of social differentiation and division of labour (Parsons, 1960). The performance of specialized institutions in economy and government relies on a prior investment of trust by those who are served by this institution or finance its functioning. Total control would imply that the control agencies need the same expertise and the same time allocation as the performing institution. Such an arrangement neutralizes the desired effect of social differentiation and, ultimately, results in a society of intimate clans performing all necessary social, economic and political functions simultaneously. By short-cutting normal control mechanisms, trust can be a powerful agent for the efficient and economical performance of social tasks (Fukuyama, 1995). Durkheim's analysis of organic solidarity as a major structural variable of modern societies focused on trust as one of the predominant media that helped to shape the division of labour and to differentiate between societal functions (Durkheim, 1933; Luhmann, 1980).

The relative value of trust varies over time, as empirical surveys clearly indicate (Lipset and Schneider, 1983; Kramer, 1990). In some periods, people tend to invest a large amount of trust in institutions, and it takes many disappointments before they withdraw this investment. During other periods, people tend to be extremely cautious with the investment of trust, placing more emphasis on functional equivalents, such as more organized control or increased direct participation. Trust can partially be substituted by other generalized media, such as sharing power or control, but cannot totally be replaced.

It is obvious that modern societies face difficulties in providing sufficient trust for reaching consensus on its complex and differentiated activities. Most public institutions have lost trust and credibility over the last three decades, with a few exceptions (Lipset and Schneider, 1983; Löftstedt, 2005). Trust and credibility have decreased for institutional actors such as industry, the political system and many government agencies (Siegrist and Cvetkovich, 2000; Siegrist et al, 2000). In contrast, environmental groups and other watchdog NGOs have gained trust over the same period (Sparks et al, 1994; Zwick and Renn, 2002). Science still enjoys a high degree of credibility, although less than was recorded during the 1960s and 1970s. Most sociologists believe that the decline of confidence in public institutions is partially a function of better education and the increase of public aspirations with regard to their share of public resources and welfare (Katz et al, 1975; Hampel, 2004). In addition, the complexity of social issues and the pluralization of values and lifestyles may have contributed to a growing dissatisfaction with the actual performance of institutions (Wildavsky and Dake, 1990).

Lack of trust does not indicate, however, a declining relevance of trust for governing modern societies and managing technological risks. The contrary is true.

The reliance of technological society on trustful relationships between and among its subsystems has never been stronger than today. However, such a need for trust makes people more and more sensitive towards situations in which their investment of trust has been factually or allegedly misguided or exploited. The more trust is needed for implementing cooperative efforts or for coping with the external effects of social actions, the more cautious are people in assigning trust to those whom they are supposed to believe.

It would be beyond the scope of this essay to list all of the relevant empirical results that shed some light on the factors that influence trust in, and credibility of, institutions (see Essay 7 on risk communication for a more detailed analysis).

The results of these studies on credibility emphasize the close relationship between perceived performance of institutions and their trustworthiness (Covello, 1992). This is not very surprising. But what is the relationship between trust in risk management organizations and risk perceptions? There are many studies that provide evidence of a positive relationship between trust in institutions, such as business or risk management agencies, and low risk perception (Kunreuther et al, 1990; Bord and O'Connor, 1992; Jungermann et al, 1996; Siegrist and Cvetkovich, 2000, Siegrist et al, 2000; Viklund, 2003; Savadori et al, 2004; Knight and Warland, 2005; review in Cvetkovich and Löfstedt, 1999). However, several studies did not find any significant or strong relationships (Grobe et al, 1999; Sjöberg, 2001; Zwick, 2006). Other empirical investigations led to more differentiated results and insights: Spies et al (1998), for example, were able to demonstrate a relationship between trust and risk perception among members of the general public, but not among community leaders. Sjöberg (2001) assumes that trust is a placeholder for the experience of uncertainty or ignorance. If people feel that the issue is unclear and laden with uncertainties and ambiguities, they tend to express this in a negative judgement about trustworthiness or credibility of information sources, such as regulators or scientists. The final verdict on the influence of trust in risk management institutions and risk-related organizations is still open and more research is needed.

There is, however, little doubt in the literature that people's responses to risk depend, among other things, upon their confidence in risk-managing and risk-controlling institutions. Since the notion of risk implies that random events may trigger off accidents or losses, risk management institutions are always forced to legitimize their action or inaction when faced with an accident. On the one hand, they can cover up mismanagement by referring to the alleged randomness of the event (labelling it as unpredictable or an act of God); on the other hand, they may be blamed for events for which they could not possibly provide protective actions in advance (Luhmann, 1980, 1986b).

The stochastic nature of risk demands trustful relationships between risk managers and risk bearers, since single events neither prove nor disprove management failures; at the same time, they provoke suspicion and doubt. The slightest mistake by a risk management agency can be sufficient to destroy the delicate balance of trust (Löfstedt, 2005). The handling of risk by private corporations and governmental agencies has been crucial in explaining the mobilization rate of individuals for taking actions. The more that individuals believe risks not to be properly handled (in addition to being perceived as serious threats), the higher the likelihood that people will take action, such as mobilizing protest (Bord and O'Connor, 1992). It has been shown that in the nuclear case, the disillusionment of the US population with the nuclear option, as well as the number of people becoming political advocates of anti-nuclear policies, escalated with the increasing distrust of the nuclear regulatory agency (Kunreuther et al, 1990; Slovic et al, 2000). Public confidence in institutional performance seems to shape the propensity of people to judge risks as being manageable in the public interest or as being beyond human control.

The influence of the media

A vast amount of information about risks stems from intermediary sources. People develop attitudes and positions with respect to risky technologies and/or activities on the basis of second-hand information. This information is normally provided by the media. Many beliefs about risks and risk sources are, hence, shaped (or at least influenced) by the information and evaluations that the media transmit to their consumers. The media perform a dual role in the communication process: first, they collect information from primary sources and process this information by applying professional and institutional rules that govern the selection of received messages and their interpretation. Second, they send information to the final receiver. The recoding of messages involves conscious or unconscious changes of the original information material. Messages from several sources may be integrated within one new message, or comments may be added.

The transformation process of messages during transmission has been a popular topic of communication research. From a theoretical point of view, many different concepts about the nature of this transformation have been suggested in the literature (Peters, H. P., 1984, 1994, 1995, 2007; Peltu, 1985, pp129–130, 1988; Lee, 1986, p175; Shoemaker, 1987, p125; Sood et al, 1987, p30; Coleman, 1993; Dunwoody, 1994; Mazur, 1994; Singer and Endreny, 1994; Tyler and Cook, 1984; Kitzinger and Reily, 1997; Wahlberg and Sjöberg, 1998; Brookes, 1999; Heinrichs and Peters, 2006; overview in Bryant and Zillman, 1994). The basic differences between these approaches may be confined to two major questions. First, are the media creating new messages or are they reflecting existing messages; second, how biased are journalists in their coverage vis-à-vis their own social convictions and external pressures? Both questions have not yet found a final answer (Mazur, 1984; Peltu, 1985, pp140–141; Lichtenberg and MacLean, 1991; Dunwoody and Peters, 1992; Dunwoody, 1994; Freudenberg et al, 1996; Stocking, 1999; Breakwell, 2007, pp156ff).

With regard to the first question, the literature suggests a strong media influence on public opinion during the early years of communication research. Through extensive testing, however, this hypothesis was later substituted by the hypothesis that the media set the agenda, but do not change the attitudes or the values of the audience in terms of the issues on the agenda (McCombs and Shaw, 1972; Peltu, 1985, p140; Lichtenberg and MacLean, 1991; Peters, H. P., 1995; Wahlberg and Sjöberg, 1998; Sjöberg and Wahlberg, 2002). Only in the long term do the media have a lasting effect on the attitudes and value structures of their consumers (Frewer et al, 1997).

In terms of the second question, evidence has been gathered to support almost all possible viewpoints (for a review, see Wahlberg and Sjöberg, 1998). Political and commercial pressures have been seen to influence media coverage, while courageous news reports have been in conflict with vested interests. Cultural biases have also occurred within the journalistic community, and a variety of different political and social attitudes continue to exist among journalists. Some journalists perceive their job as a mere translation of events into verbal or visual expressions, while others believe that they should play a more active role in shaping and explaining issues (for example see the controversy about media influence postulated by Kepplinger in the review by Köcher, 1986; Lichtenberg and MacLean, 1991; Peters, H. P., 1995a).

In short, the extreme view that the media are mere reflectors of reality or that they are docile instruments of social pressure groups may, occasionally, be true; but this is not the rule. In reality, the situation is more complex: media coverage is neither dependent upon external pressures nor is it an autonomous subsystem within society (Lowery and DeFleur, 1983; Dunwoody, 1999). Often, the media reinforce the dominant interpretation of the main stakeholders without giving credence to any extreme position, while mentioning that these extreme positions exist (Wahlberg and Sjöberg, 1998). Media coverage reflects internalized individual values, organizational rules and external expectations. It depends upon the issue itself, the institutional context and the political salience of the issue (Breakwell, 2007, pp159, 221). A universal theory of how this transformation takes place is, therefore, not likely to evolve. Some of the common characteristics of media coverage, however, deserve some attention:

- The media construct reality just as readers construct their understanding of media reports (Dunwoody, 1992). These constructions are a result of mental and professional frames that journalists use in selecting and recoding information. Construction does not imply that coverage is independent of real events. But there is ample evidence that the media amplify some elements and downplay others when processing information (Sood et al, 1987; Wilkins and Patterson, 1987). For example, the number of fatalities is a rather weak indicator of the amount of coverage that risk issues will receive, while the degree of social conflict arising from a risk debate correlates strongly with media coverage (Adams 1986; compare also some counter-evidence in Freudenburg et al, 1996).
- The media direct their attention towards events, not continuous developments. A technology's accident-free performance over many years is not newsworthy unless it is framed as an event (such as a public celebration). Likewise, incremental climate changes only become hot news if they are linked to a conference, an exceptionally hot summer or wide-reaching political statements (Peltu, 1988; Peters, H. P., 1995). In line with these observations, the newsworthiness of a story will decline unless fed with new information (Breakwell, 2007, p158).
- The media have no internal mechanism to resolve conflicts among experts. Journalists have neither the time nor the qualifications to find out who is right in a scientific debate. The most frequently used method to handle competing scientific evidence in the media is to give each side room to state or justify claims (Peltu, 1989; Dunwoody and Peters, 1992). Most journalists have lists of people who will

provide counter-statements to any account that they encounter when working on a story. Neither quality of evidence nor proportionality (with respect to the number of dissidents or professional qualification) determines the amount of coverage that each side will receive. The amount is either equally distributed among camps or biased towards the preferences of the journalist or, more frequently, towards some medium level of what seems to represent mainstream stakeholder views (Dunwoody and Peters, 1992). Media in a pluralistic society tend to reinforce diversity, dissent and relativity of values (Rubin, 1987, p53; Breakwell, 2007, p161).

Is there any evidence about specific media treatment of risk-related information? The media collect information from direct eyewitnesses of hazard events (anecdotal evidence), as well as systematic information from risk management institutions (Renn, 1991; Kitzinger and Reily, 1997; Breakwell, 2007, pp156ff). Displaying anecdotal experience (such as losing property or being injured) contrasts with the statistical evidence provided by risk experts. This contrast reinforces the constructive nature of media coverage and its reception (the same event through two very different lenses), and often contributes to the erosion of trust in experts (see above). In addition, the nature and magnitude of the original hazard are only of minor interest to most journalists. They prefer to focus on the way in which institutions handle risks and communicate about their activities. As Singer and Endreny (1987, p13) have pointed out, the media emphasize hazards that are relatively serious and relatively rare; it is the combination that gives them their punch. For example, the Chernobyl accident, with 31 casualties, received 129 minutes of CBS news coverage, while the 1976 Tandshan earthquake, leaving 800,000 people dead, received less than 9 minutes on the average TV evening news (Sood et al, 1987, p37).

The relationship between media coverage and changes in risk perception has been documented in many studies. Frewer et al (2002a) were able to show that risk perceptions of genetically modified organisms were almost proportional to the intensity of media coverage. Other studies indicate that information from the media has a stronger impact on abstract non-personal risk perceptions than on personal risks (Coleman, 1993; Kahlor et al, 2006). This supports our thesis that communicative signals become more relevant and influential the more that access to physical evidence or direct personal experiences is lacking. The feeling of being dependent upon external information is also a trigger for using more caution in assigning trust and credibility.

The literature contains endless lists of factors that are assumed to determine the attractiveness of risk-related messages for transmitters (for an overview, see Wahlberg and Sjöberg, 1998; Breakwell, 2007, pp156ff). Such factors include technologically induced hazards (versus natural hazards); importance of infotainment, the significance of interactions between media, the role of pressure groups, the degree of uncertainty and controversy (all in Breakwell, 2007, pp156–161), the possibility of blaming someone for the outcome (Sandman et al, 1987, p105; Sandman, 2005); cultural distance from the place of occurrence (Adams, 1986); human interest components; drama and conflict; exclusiveness of coverage (Peltu, 1985, pp137–138); proximity to politically hot issues; prestige of information source; and degree of conflict among stakeholders (Peters, H. P., 2007).

Interaction among transmitters; plural input from different sources; the coexistence of personal, professional and institutional selection and amplification criteria; and interaction among different target audiences all create enough complexity and uncertainty that the final effect of the communication process can hardly be measured at all, let alone effectively controlled. Reception studies of media coverage are therefore rare and often very restricted in experimental design. It is clear, however, that people tend to form opinions and attitudes through a selection process in which parts of news stories are taken out and rearranged in accordance with personal preferences, existing attitudes and values (Dunwoody, 1992; Dunwoody and Peters, 1992). Media consumers create puzzles constructed by many elements (cognitive and evaluative) from a variety of media reports. It is not so much the intention of the message that consumers take for granted, but their pre-existing viewpoints that make them select and interpret the messages. At the same time, the media strive to obtain counter-arguments for every expert opinion and to publish them in tandem, regardless of how representative they may be of the relevant scientific community. Thus, there is a forced emphasis on plurality and on disagreements among experts.

The social arena of risk

Beyond the impact of cultural values, trust and communication by others on the formation of risk perceptions, the risk debate itself influences how people assess and evaluate risks. Risk debates take place in a political context in which risk reduction may only be one objective among others. Using the metaphor of an arena, social conflicts can be described as a struggle between various actors on the arena stage, controlled by a rule enforcement agency (usually a governmental institution) and observed by professional 'theatre critics' (the media) who interpret the actions on the stage and transmit their reports to a larger audience (Kitschelt 1980, 1986; O'Riordan, 1983; Renn, 1992c; Jaeger et al, 2001, pp175ff).

To be successful in a social arena, it is necessary to mobilize social resources. These resources can be used to gain the attention and support of the general public, to influence the arena's rules and to 'score' in the arena in competition with the other actors. Which are the social resources that social groups need in order to be influential in society? The early functionalist school of sociology referred to social resources as 'all persons or organizations, which can be of help to an individual or a social work agency in solving problems' (Fairchild, 1976, p291). As a means of mobilizing resources, different functional segments of society use the generalized media (i.e. instruments to mobilize support) (Parsons and Shils, 1951; Parsons and Smelser, 1956). The medium for the economic sector is money; for the political sector, power; for the social sector, prestige; and for the cultural sector, value commitment (Parsons, 1963). More recent literature suggests that these media are actually the resources that groups want to mobilize, whereas the term 'media' should be confined to the currency (exchange value) within each resource type (Luhmann, 1982b; Münch, 1982). Based on this understanding of resources, five factors appear to be of major relevance in describing risk arenas: money, power, social influence, value commitment, and evidence. Money provides incentives (or compensation) for gaining support; power is the legally attributed right to impose a decision on others; social influence produces a social commitment to find support through solidarity; value commitment induces support through persuasion and trust; and evidence can be used to convince people about the likely consequences of their own actions. Resources are not the ends, but the means for actors to accomplish their goals.

Figure 4.2 illustrates the arena metaphor. The centre stage of the arena is occupied by the principal actors (i.e. those groups in society who seek to influence policies). Groups often focus on several issues at once and are involved in different arenas; others focus only on one issue in a single arena. Each arena is characterized by a set of rules: formal rules that are coded and monitored by a rule enforcement agency, and informal rules that are learned and developed in the process of interactions among actors. Among the formal rules are laws, acts and mandated procedures; among the informal rules are regulatory styles, the political climate of group interactions, and role expectations. In most cases, the rules are external constraints for each actor. Formal rule changes require institutional actions; informal changes occur as a result of trial and error and may change according to whether or not rule bending is penalized. Several actors may join forces to change the rules even if they disagree on the substance of the issue.

The rule enforcement agency ensures that actors abide by the formal rules, and it often coordinates the process of interaction and negotiation. In many arenas, the rule enforcement agency is also the ultimate decision-maker. In this case, all actors try to make their claims known to the decision-makers and to convince them through arguments or public pressure to adopt their viewpoint. In an adversarial policy style, which is typical for the US (Löfstedt, 2004), rule enforcement agencies regard themselves more as brokers or mediators than as sovereign administrators who are consulted by various social actors, which tends to be the European policy model (Vogel, 1986).

Issue amplifiers are the professional 'theatre critics' who observe the actions on stage, communicate with the principal actors, interpret their findings and report them to the audience. Through this communication process they influence the allocation of resources and the effectiveness of each resource to mobilize public support within the arena. The audience consists of other social groups, who may be enticed to enter the arena, and of individuals who process the information and may feel motivated to show their support or displeasure with one or several actors or the arena as a whole. Part of the political process is to mobilize social support by other social actors and to influence public opinion.

Actors will enter risk arenas if they expect that this will provide them with an opportunity to gain more resources (Kitschelt, 1980; Dietz et al, 1989; Renn, 1992c). Beyond their reservoir of resources that they already have, they can earn more resources by exchanging one resource for another (e.g. winning public trust by sharing power through participation or exchanging evidence for prestige) and by communicating to other actors and the media. The objective of communication is to receive public support and to mobilize other groups for one's own cause. The more resources a group can mobilize in an arena, the more likely it is that it dominates the conflict-resolution process and gets its point of view incorporated within the final decision.

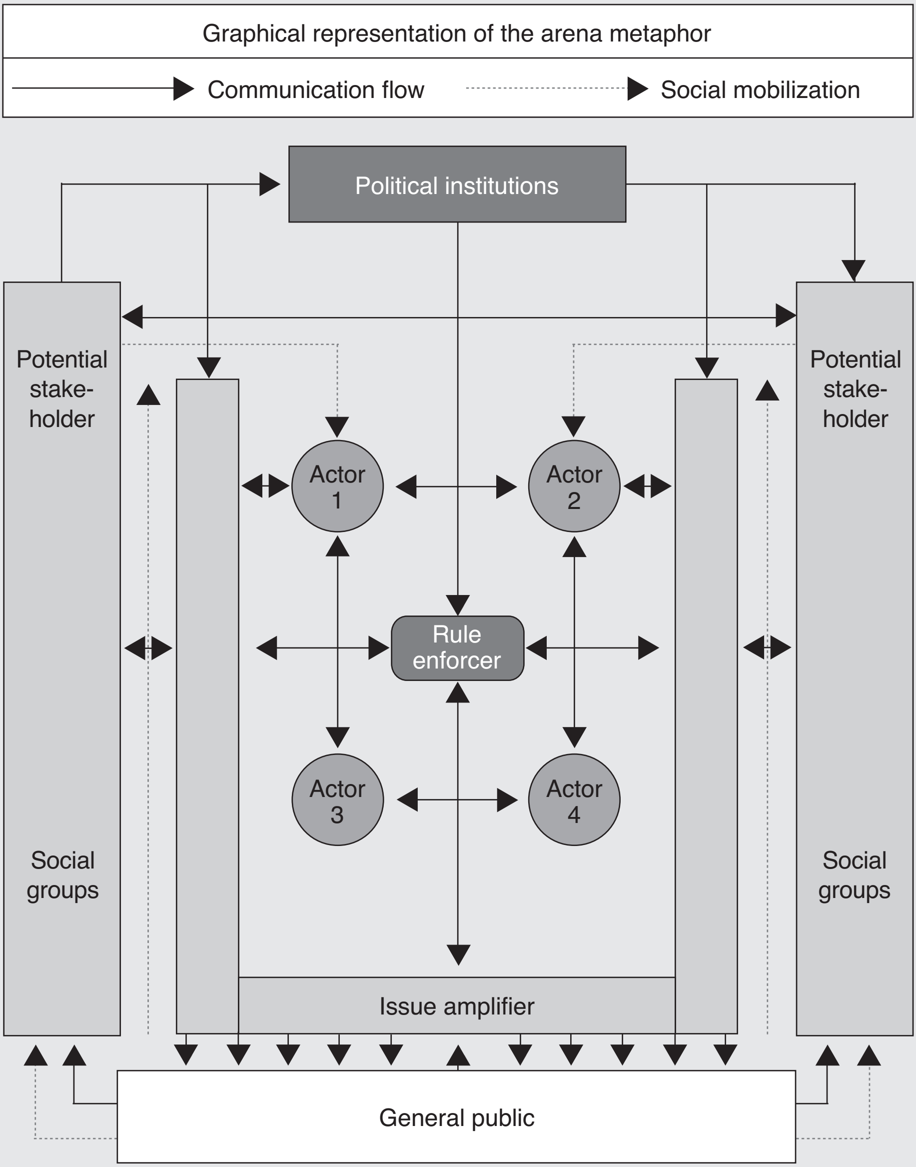

Figure 4.2 *Graphical representation of the arena metaphor*

Source: adapted from Renn, 1992c

The outcome of the arena process is undetermined. On the one hand, various actors may play out different strategies that interact with each other and produce synergistic effects (*game theoretical indeterminacy*). Strategic manoeuvring can even result in an undesired outcome that does not reflect the stated goal of any actors and may, indeed, be suboptimal for all participants. On the other hand, interactions in the arena change the arena rules (*structural indeterminacy*). Novel forms of political action may evolve when actors use trial and error to test tolerance levels of the other actors for accepting limited rule violations. Both characteristics of arenas limit the use of arena theory for predictions, but do not compromise its value for explaining conflicts and enlightening policy analysis.

Risk arenas operate under similar structural rules and constraints, like any other arena. Risk debates focus on two issues: what is an acceptable level of risk, and how are risks and benefits distributed in society? All social groups who feel that their interests or values are affected by a specific risk source may be compelled to enter the arena. Success in the risk arena relies on the social actors' ability to mobilize resources. Beyond these commonalities that risk arenas share with others, some characteristics are worth mentioning:

- *The evidence trap.* Finding a viable compromise in conflicts requires agreement on evidence. If each group provides conflicting evidence about impacts, it is difficult to reach a consensus. The more limited the manoeuvrability of groups when making factual claims without being 'falsified', the more likely they will reach similar conclusions in terms of evidence. This need for evidence-based arguments increases the value of systematic knowledge for reaching a compromise or consensus. In risk issues, this normalizing effect of evidence through reality checks is less powerful than in other arenas because the stochastic nature of the potential consequences (uncertainty) does not allow any inference with regard to a single facility or event. Consequently, there are competing and rationally defensible strategies for coping with risk, such as using the expected value as an orientation for risk acceptability or taking the minimax (minimizing the maximum possible loss) approach.
- *The symbolic nature of risk issues for distributional conflicts.* Risk arenas attract social groups who demand legitimization of existing distributional practices. The risk, as such, may not be the trigger for entering the stage but, rather, its symbolic meaning for decision-making processes in society and for existing power structures. Such groups use the risk arena to mobilize social resources in order to affect policies in other arenas.
- *Social desirability.* The tendency to use a risk arena for other purposes is also reinforced by the saliency of the risk issue for the audience. Affluent societies show strong concerns for health, safety and the environment. Mobilization strategies that build on common concerns can be very effective in generating value commitments and social influence. Risk issues are excellent candidates for piggybacking one's own claims with the respective 'hot' risk issue.
- *Structural weakness of risk management agencies.* Risk management agencies face the dilemma of dealing with ambiguities and often do not succeed in exchanging power for other desired resources. In particular, they have difficulty in exchanging institutionally provided evidence for trust since evidence is so contested. As a result, they are unable to mobilize social resources beyond their power reservoir. Because of the weak position of the rule-enforcement agencies, risk arenas tend to experience more rule innovations than other arenas where strong enforcement agencies are present.

The plurality of evidence, the weak role of rule enforcement agencies, the tendency of the risk debate to attract symbolic connotations, and the public responses of moralization and polarization have all contributed to the importance of the risk issue in contemporary societies. German sociologist Ulrich Beck (1986, 1992b) has even characterized modern industrial societies as 'risk societies'.

In which way do risk arenas and their structural conditions influence risk perceptions? First, the arena concept explains why some risk issues receive national or even international attention (such as BSE in Europe), while other risks of even higher magnitude are downplayed or neglected. Through media influence and permanent visibility in the political arena, people gain the impression that this issue must be serious and that it deserves their immediate attention (Mazur, 1981, 1984). The process may start with a risk that includes several of the negative attributes discussed in the previous section on 'Psychometric factors (contextual characteristics)', such as dread, unfamiliarity, artificiality, or lack of personal control. Powerful groups might pick up this issue because they can see the mobilization potential when making the problem public. By initiating such a debate they expect to improve their political standing and accomplish their goals. The media will report about this mobilization initiative and provoke reactions by other groups. This exchange of arguments will fuel even more debate and conflict and, in consequence, media coverage. Individuals become more aware of the issue and perceive the risk as being more serious than they originally felt. In extreme cases, this can even lead to (temporary) stigmatization, as Zwick (2006) has demonstrated for the case of BSE and Renn and Covello (1989) for the case of syringes from drug addicts left on New Jersey beaches. However, as Downs (1972, 1998, pp100ff) observed, the attention span of the public is short. Unless new arguments are brought into the arena or new events pop up that keep the issue alive, the debate will slowly die. Often this goes along with a more relaxed attitude towards the risk cause, which in turn lowers the degree of perceived seriousness of risks. This attention cycle was observed in the case of Chernobyl and, more recently, with avian flu.

Second, the arena metaphor points to the importance of framing for understanding risk perception (Breakwell, 2007, pp92f). Whether BSE is seen as a familiar veterinary disease that cows contracted from sheep, with fairly little impact upon human health, or as a symbol of unnatural industrial agriculture that 'forced' vegetarian animals, such as cows, to consume meat with the sole purpose of increasing the profits of the agro-industrial complex, makes all the difference in the world when it comes to risk perception (Wynne and Dressel, 2001). Another example may be climate change: if an increase of carbon dioxide concentration is seen as a symbol of our destructive power over nature and the environment, a more negative risk perception is likely to occur compared to an interpretation where the concentration is perceived as the price for prosperity and well-being. In addition to the psychological attributes that affect risk perception, it is important to investigate the socially constructed and culturally reinforced frames that often shape the emotional, and influence the cognitive, responses to risk. This symbolic weight of specific risks constitutes another factor in explaining the discrepancy between expert judgements on risks and people's perceptions; even more importantly, it provides a good analytical perspective for studying inter-individual and inter-cultural differences in the risk perception of identical risk objects or activities (Koné and Mullet, 1994; Renn and Rohrmann, 2000).

Reflexive modernization approach to risk perception

Reflexive modernization refers to the consequences of modernity: individualization, pluralization of knowledge claims and moral standards, and globalization of world trade, production and consumption, communication and cultural world views (Giddens, 1990, 1991; Beck, 1992b, 2000b; see also Essay 1 on approaches to risk). The approach rests on the assumption that the meta-rationality of modernity (i.e. instrumental rationality, efficiency, justice through economic growth, and steady improvement of individual living conditions through scientific and technical progress) has lost its legitimizing power (Giddens, 1994; Lash, 2000; Jaeger et al, 2001, pp209ff; Mythen, 2004; Knight and Warland, 2005; Zinn and Taylor-Gooby, 2006a, pp39ff; Renn et al, 2007, pp51ff).

Both Beck and Giddens claim that the integrative power of science to resolve societal conflicts has decreased over time and that the plurality of knowledge claims has led to growing irritation on the side of the public. As a result of this confusion about the merits and risks of modernization, widespread scepticism has evolved over the role and function of science and technology in producing social benefit and in the belief in progress (i.e. the notion that secular understandings of the world lead to a safer and more rewarding existence for humans; Knight and Warland, 2005). Science and technology are viewed as double edged – 'creating new parameters of risk and danger, as well as offering beneficent possibilities for human kind' (Giddens, 1991, p28). Beck and Giddens disagree, however, about the potential role that risk professionals could play in this situation. Whereas Beck claims that risk assessors in science and government fuel this irritation, since they systematically underestimate the real threats and rely on a methodology aimed at legitimizing ubiquitous exposure of society to incalculable risks, Giddens believes that a more reflexive approach to performing risk analyses (i.e. interdisciplinary, inclusive and integrative) constitutes the only viable solution to overcoming the current stage of confusion and irritation. They do agree, however, on the general observation that professional risk analyses are increasingly questioned by powerful groups in society and that risk issues have become battlegrounds for substantial conflicts about resource allocation, social justice and future economic development (Beck et al, 1998; Beck, 2000a).

Beck's analysis of risk refers to five major characteristics of risk in modern societies compared to risk-taking in traditional societies (Beck, 1990, 1992b):

1 *Transboundary effects*. Modern risks transgress sectoral, social, national and cultural boundaries. They may originate in one country or one sector, but will then proliferate into other areas and other sectors (e.g. BSE).
2 *Globalizing impacts*. Risks tend to affect everybody (e.g. climate change).
3 *Increase of penetrating power*. Risks tend to penetrate and transform social and cultural systems in a significant manner and to change social behaviour (e.g. genetically modified organisms in agriculture).
4 *Incalculable nature*. Due to the lack of boundaries and the complex global consequences of taking risks, the instruments and tools for calculating risks are inadequate and inaccurate so that even insurance companies are unable to calculate premiums that are proportional to the respective risks (e.g. nuclear power plants).

5 *Lack of accountability*. Potential victims of risks are being unduly burdened without their consent and without any institution or person being accountable for future damage (e.g. car exhaust).

The preoccupation of modern society with risks has made public institutions become more reflective (or 'reflexive') of their role and function in society: actors need to be reassured of the validity of their objectives and strategies through continuous communication with the outside world. The result is that any attempt to monitor, reduce or eliminate risks through industrial processes will only serve to hasten unplanned and unforeseen latent consequences (Knight and Warland, 2005). The development and implementation of pesticides, for example, has resulted in the contamination of groundwater and the accumulation of residues in food. The industrialization of food production has also increased the use of additives, posing new and unfamiliar health risks to consumers and the environment. In essence, most economic activities to improve prosperity or personal income have been accompanied by negative side effects that have either not been recognized or have been systematically suppressed by powerful social actors. As a result, people have lost faith in the promises of modernity and expect that the price to pay for prosperity will haunt them later on when risks become apparent.

A major aspect of risk in the theory of 'reflexive' modernization is the issue of equity and environmental justice (Beck, 1994). Despite Beck's claim that traditional inequities are irrelevant for modern risks since they seem to threaten everyone (even those who caused the risks; see the example of Chernobyl), the dominant social conflicts about risk touch upon the issue of legitimizing experienced inequities. How can originators and the regulators of risks legitimize and justify the fact that they place burdens onto societies, social groups or future generations without their prior consent? Similar to the arena metaphor, the reflexive modernization approach focuses on the symbolic level of legitimizing risks. The actual risk estimates take a back seat in the public debate and become strategic instruments for pointing to inconsistencies or highlighting uncertainties. Public outrage is mainly driven by the feeling of being unfairly treated, deceived by powerful interest groups or (ab)used as guinea pigs in a global capitalist system.

What does the theory of reflexive modernization add to our understanding of risk perception? Most notably, individuals respond to the trends of individualization, pluralization and globalization by searching for genuine orientation (Jaeger et al, 2001; Knight and Warland, 2005). Most individuals reject a world view in which knowledge and moral judgements are considered arbitrary (Lash, 2000). Confused by the plurality of lifestyles and value systems, they look for mental anchors that can provide them with a feeling of security and stability (Marshall, 1999; Mythen, 2005). These anchors may include religious beliefs (even to the extreme of fundamentalism), faith in an enlightened rational and humanistic governance system, reliance on reference group judgements, or a revitalization of traditional values. In the context of reflexive modernization, they need to gain ontological security and stability of their life-world (Beck, 1992b, based on Giddens, 1984). These primary needs are constantly threatened by risk producers who impose risks on all members of society (without their consent) and, hence, threaten to destroy the basis of their own livelihood. Beck does not offer a solution to this problem other than the suggestion of placing more trust in sub-political civil society actors and refusing to license any technical facility that cannot insure its maximum losses (Beck, 1997, 1999).

Social amplification of risk

The last approach covered in this review refers to a suggestion by Roger Kasperson and colleagues (1988) to develop an integrative framework for explaining risk perceptions, as well as social responses to risks. The concept of social amplification of risk is based on the thesis that the social and economic impacts of an adverse event are determined by a combination of the direct physical consequences of the event and the interaction of psychological, social, institutional and cultural processes (Kasperson et al, 1988, 2003; Renn, 1991; Breakwell, 2007, pp224ff). The authors were motivated to develop this framework due to the lack of integrative theories of risk and the inadequacy of the two main approaches at the time – psychometrics and cultural theory – to capture the complex risk experience of individuals and social entities. The framework of social amplification should include these alternative approaches and provide a consistent analytic structure for investigating psychological, social and cultural factors of risk perception and risk responses. Amplification in this framework includes both intensifying and attenuating signals about risk. Thus, alleged overreactions of target audiences receive the same attention as alleged 'downplaying'.

Social interactions can heighten or attenuate perceptions of risk. By shaping perceptions of risk, they also influence risk behaviour. Behavioural patterns, in turn, generate secondary consequences that extend far beyond direct harm to humans or the environment. Liability, insurance costs, loss of trust in institutions or alienation from community affairs are a few such examples. Secondary effects such as these are important because they can trigger demands for additional institutional responses and protective actions. They can also – in the case of risk attenuation – impede the installation of protective actions.

Figure 4.3 illustrates the process of amplification. The amplification process starts with either a physical event (such as an accident) or the recognition of an adverse effect (such as the discovery of the ozone hole). In both cases, individuals or groups will select specific characteristics of these events or aspects of the studies and interpret them according to their perceptions and mental schemes. These interpretations are formed into a message and communicated to other individuals and groups (Renn, 1991). Individuals or groups collect and respond to information about risks and act as 'amplification stations' through behavioural responses or communication. Amplification stations can be individuals, groups or institutions. Amplification differs among individuals in their roles as private citizens and employees or members of social groups and public institutions.

The behavioural and communicative responses are likely to evoke secondary effects that extend beyond the people directly affected by the original hazard event. Secondary impacts are, in turn, perceived by social groups and individuals so that another stage of amplification may occur to produce third-order impacts. The impacts may spread or 'ripple' to other parties, distant locations or other risk arenas. Each order of impact will not only disseminate social and political impacts, but may also trigger (in risk amplification) or hinder (in risk attenuation) positive changes for risk reduction.

The social amplification of risk framework is particularly interested in signals as the basic unit of social communication. Signals in social interactions define a relationship between the information source, potential transmitters and receivers. In social communication, those signals must convey a meaning – otherwise, they are regarded as noise. A cluster of meaningful signals pertaining to the same topic is called a message. Signals and messages may be created by individual actors or they may emerge from a group process (such as when a newspaper editorial board writes an editorial). In either case, it is the content and ordering of the message that is of analytical interest. By comparing these properties of messages about a risk event in society, one can learn how actors selectively interpret (through social interaction) facts and anticipated consequences. This provides a basis for testing hypotheses (albeit only retroactively, since there is not enough evidence to suggest generalization beyond the immediate case study) about how the privileging of information can influence the social construction of risk (Pidgeon, 1997).

In the framework, risk is conceptualized partly as a social construct and partly as an objective property of a hazard or event (Short, 1989, p405). This avoids the problems of conceptualizing risk in terms of total relativism or technological determinism. The experience of risk is not only an experience of physical harm, but also the result of a process by which individuals or groups learn to acquire or create interpretations of hazards. These interpretations provide rules for selecting, ordering and explaining signals from the physical world. Both processes may have physical consequences. Hazards may directly impact upon health. Communication about risks may result in changes in technologies, methods of land cultivation, or the composition of water, soil and air.

The social amplification concept is useful for selecting, ordering and classifying social phenomena and for suggesting causal relations that can be investigated empirically. It provides a heuristic tool for the analysis of risk experience. One can also think of it as a dynamic framework that allows for systematic interpretation of empirical data while attempting to integrate differing perspectives on risk. Several empirical applications have been reported, and the results have been used to refine the framework (Kasperson et al, 1989, 2003; Machlis and Rosa, 1990; Renn et al, 1992; Burns et al, 1993; Firpo de Souza Porto and Machado de Freitas, 1996; Frewer et al, 2002a; Rosa, 2003; Breakwell and Barnett, 2003; Masuda and Garvin, 2006). One review described it as a 'framework that, like a net, is useful for catching the accumulated empirical findings, and that, like a beacon, can point the way to disciplined inquiry' (Machlis and Rosa, 1990, p164).

Drawing upon this concept of social amplification of risk, Renn et al (1992) conducted an empirical investigation about the functional relationships among five sets of variables that enter into the amplification process. The first class of variables included the physical consequences of 128 hazardous events (events that exposed humans or the environment to physical harm); the second class referred to the amount of press coverage about these 128 events; the third class entailed the individual layperson perceptions with respect to these events; the fourth class described

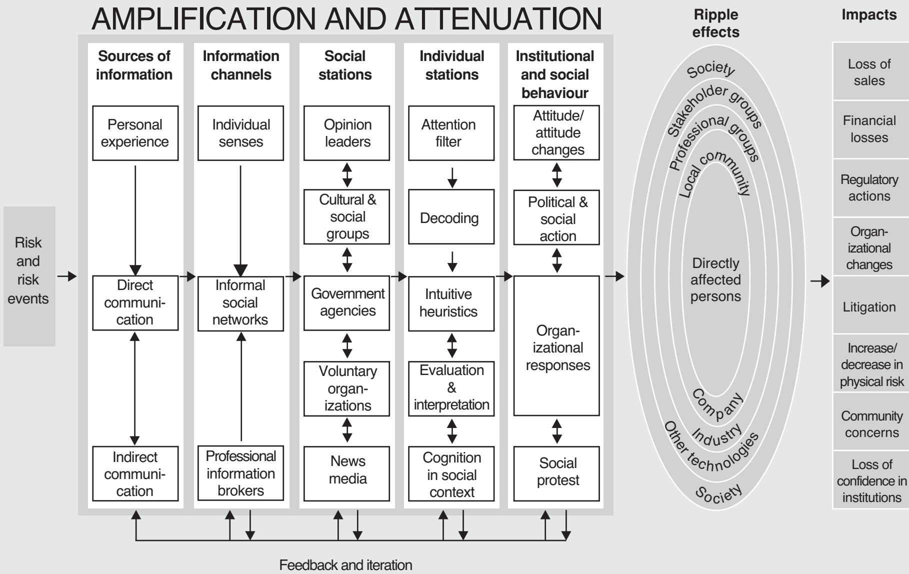

Figure 4.3 *Amplification and attenuation*

Source: taken from Kasperson et al, 2003, p30

the public responses (individual behavioural intentions and group mobilization potential) to these hazards; and the fifth class contained the socio-economic and political impacts of these events as measured by documents and a group Delphi (see explanation of a group Delphi in Essay 10) with experts. The study investigated the structure of causal relationships among these variables classes.

The most interesting result of this study is the weak link between casualties and most of the other variables. The best physical risk predictor is exposure rather than any other indicator of harm. Exposure contributes to dread and is also highly correlated with media coverage. Its direct influence on intended action is small, indicating that exposure operates through risk perception variables to influence personal actions. The link between exposure and societal impacts is not significant, however, despite the initially high correlation between the two variables (0.48). Exposure appears to shape societal experiences with risk through the media and through perceptions and intended individual actions. The data reflect the major assumption of the social amplification model (i.e. that physical events are observed and interpreted by groups and individuals, amplified through individual and social processors, and then expressed in terms of societal consequences).

The intuitive attractiveness of the metaphor 'amplification' demonstrates the merits, but also the limitations, of using a metaphor common to the description of electronic signal theory. Although each of the social amplification effects can be expressed in terms of familiar control actions, such as volume, filtering, equalizing, mixing, muting and stereo (Renn, 1991), they only make sense if the denotations of each term are adjusted to the social context. In particular, transmitters in social communication have hardly any resemblance with electronic amplifiers. Instead, social transmitters are active actors in the communication process, with their own independent agendas, rules and goals.

The function of transmitters and the interrelatedness of message and messenger have been the two major arguments against the metaphor of amplification and the use of information theory for analysing risk communication. In his review of the original paper introducing the concept of social amplification in the journal *Risk Analysis*, Steve Rayner (1988) criticized the social amplification metaphor as a mechanistic understanding of social communication that cannot be characterized as a system in which messages and messenger are separate entities. The changes wrought in the signal bearers constantly transform the instrument (i.e. society).

The proponents of the social amplification concept have responded to this criticism by stating explicitly that using signals as the basic unit of analysis does not imply that stations of signal processing are passive and mechanical transformation stations (Renn, 1991, Kasperson, 1992). On the contrary, all actors participating in the communication process transform each message in accordance with their previous understanding of the issue, their application of values, world views, and personal or organizational norms, as well as their own strategic intentions and goals.

The social amplification metaphor has evolved as an umbrella framework that provides ample space for social and cultural theories (Kasperson, 1992; Kasperson et al, 2003). It is not based on a nomological theoretical concept, but rather on the simple insight that social experiences of risk are only partially determined by the experience of harm or even expected harm. The distinction between individual and social amplification stations corresponds with the two traditions in risk perception: the individual processing of information and the social responses to risk based on experience of (dis)trust, the political arena conditions and cultural affiliations. It provides a more holistic picture of the risk perception process and takes into account psychological, sociological and cultural aspects.

Summary of social and cultural influences on risk perception

The social and cultural factors that influence risk perception expand the horizon of interactions between the mental processing of risk and uncertainty, cognitive heuristics, contextual variables and semantic images, on the one hand, and values, communication effects, trust in organizations, cultural prototypes, political arenas and the overall climate of plural and individualized societies, on the other. In addition to these classes of independent variables, one can find numerous other suggestions for potential relationships between risk perception and their determinants. Within the realm of psychological research, one should mention personality and character (Sjöberg, 2000b); and within the realm of sociological and cultural studies, the influence of demographic variables or socio-political status (Schütz and Wiedemann, 1998; Lima et al, 2005; Zwick, 2006). These classes of variables are, however, not explanatory in the sense of revealing causes for specific behavioural or attitudinal patterns, but could act, at best, as intervening variables. The insight that women are more risk-averse and express, on average, more concerns about risks does not reveal the underlying cause. Is this relationship due to biological differences, gender education and enculturation, familiarity with risks, or socio-cultural self-images? Socio-demographic studies provide important cues about phenomena that need further explication and explanation, but they are rarely an explanation in themselves.

An integrative model of risk perception

Based on the review of psychological, social and cultural factors that shape individual and social risk perceptions, we have attempted to develop a structured framework that provides an integrative and systematic perspective on risk perception. Figure 4.4 illustrates this perspective by pointing towards four distinct context levels (originally developed by Renn and Rohrmann, 2000; inspired by the generic model in Breakwell 1994):

1 heuristics of information processing;
2 cognitive–affective factors;
3 socio-political institutions; and
4 cultural background.

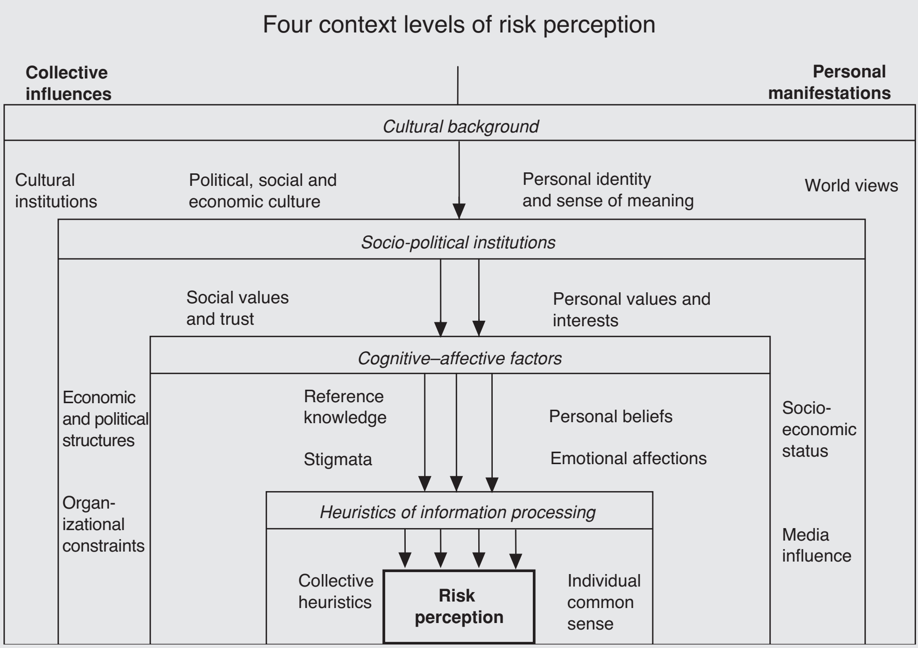

Figure 4.4 *Four context levels of risk perception*

Source: adapted from Renn and Rohrmann, 2000

Each level is further divided into two subsections, representing individual and collective manifestations of risk perceptions. Each level is embedded in the next higher level to highlight the mutual contingencies and interdependencies among and between individual, social and cultural variables.

Level 1: Heuristics of information processing

The first level includes the collective and individual heuristics that individuals apply during the process of forming judgements about risks. These heuristics are independent of the risk in question and the personal beliefs, and of emotions or other conscious perception patterns of the individual. Heuristics represent common-sense reasoning strategies that have evolved over the course of biological and cultural evolution. They may differ between cultures; but most evidence in this field of psychological research shows a surprising degree of universality in applying these heuristics across different cultures. Improved knowledge and expertise in logical reasoning and inferential statistics, as well as a principal awareness of these heuristics, can help individuals to correct their intuitive judgements (if deemed necessary) or to apply these heuristics only to situations where they seem appropriate. Recent research results suggest that these heuristics are more appropriate for problem solving in many everyday situations than previously assumed (Gigerenzer and Selten, 2001). Regardless of the normative value that these heuristics may offer, they represent primary mechanisms of selecting, memorizing and processing signals from the outside world and pre-shape the judgements about the seriousness of the risk in question (for an overview, see Chapter 3 in this volume, and Rohrmann and Renn, 2000).

Level 2: Cognitive and affective factors

The second level refers to the cognitive and affective factors that influence the perception of specific properties of the risk in question (there is also an indirect influence through the assignment of special weights to the universal heuristics described above). Cognition about a risk source – what people believe to be true about a risk – governs the attribution of qualitative characteristics (psychometric variables) to specific risks (e.g. dread or personal control options) and determines the effectiveness of these qualitative risk characteristics on the perceived seriousness of risk and the judgement about acceptability. It is interesting to note that different cognitive processes can lead to the same attribution result. In an empirical study, Rosa et al (2000) were able to show that for the Japanese sample the arousal of catastrophic images was associated with the degree of individual knowledge of and familiarity with the respective risk in question, whereas US respondents linked collective scientific experience and knowledge to catastrophic potential. The two samples were, however, identical in assigning the degree of catastrophic potential to a set of technologies, even if they had different mental models about what constitutes catastrophic potential. The fact that individuals, within their own culture or by their own agency, are able to choose between different cognitive routes justifies the distinction between the two primary levels: cognitive factors and heuristics.

While cognitive factors have been explored extensively, emotions have been widely neglected in risk perception research. More recently, however, psychologists have discovered that affect and emotions play an important role in people's decision processes (Loewenstein et al, 2001; Slovic et al, 2002). People's feelings about what is good or bad in terms of the causes and consequences of risks colour their beliefs about the risk and also influence their process of balancing potential benefits and risks. Affective factors are particularly relevant when individuals face a decision that involves a difficult trade-off between attributes, or where there is interpretative ambiguity as to what constitutes a 'right' answer. In these cases, people often appear to resolve problems by focusing on those cues that send the strongest affective signals (Hsee and Kunreuther, 2000; Peters, E. et al, 2004). On the collective level, stigmata referring to risk sources or activities play a similar role in stimulating emotional responses (Slovic et al, 2002). Empirical studies regarding technological hazards show that emotional and cognitive factors are mutually related (Zwick and Renn, 1998). It is not yet clear whether cognitive beliefs trigger off the respective emotional responses, or whether emotional impulses act as heuristic strategies to select or develop arguments supporting one's emotional stance.

Level 3: Social and political institutions

The third level refers to the social and political institutions that individuals and groups associate with either the cause of risk or the risk itself. Most studies on this level focus on trust in institutions, personal and social value commitments, organizational constraints, social and political structures, and socio-economic status. One important factor in evaluating risk is the perception of fairness and justice in allocating benefits and risks to different individuals and social groups (Linnerooth-Bayer and Fitzgerald, 1996). Theoretical approaches, such as reflexive modernization or the social arena metaphor, provide plausible explanation of why the debate on equity and justice has become so relevant for risk perception (Knight and Warland, 2005). Other studies have placed political and social organizations, and their strategies to communicate with other organizations and society at large at the focus of their attention (Clarke, 1989; Shubik, 1991).

The media, social reference groups and organizations also shape individual and societal risk experience. Many studies reviewed in this essay investigated the role of the media (see also the review in Wahlberg and Sjöberg, 1998). Press coverage appears to contribute substantially to a person's perception of risk, particularly if the person lacks personal experience of the risk and is unable to verify claims of risks or benefits from his own experience. In contrast to popular belief, however, there is no evidence that the media create opinions about risks or even determine risk perceptions. Studies on media reception rather suggest that people select elements from media reports and use their own frame of reference to create understanding and meaning (see examples in Lichtenberg and MacLean, 1988). Most people reconfirm existing attitudes when reading or viewing media reports (Peters, H. P., 1991).

Level 4: Cultural background

The last level refers to cultural factors that govern or co-determine many of the lower levels of influence. The most specific explanation for cultural differences about risk perceptions comes from the so-called 'cultural theory of risk'. This theory claims that there are four or, in some studies, five prototypes of responses to risk (Thompson, 1980; Douglas and Wildavsky, 1982; Thompson et al, 1990). These prototypes refer to entrepreneurs, egalitarians, hierarchists, atomized individuals and, as a separate category, hermits. Opinions on the validity of the cultural theory of risk differ widely. Slovic et al (2000) regard this approach as useful in explaining some of the differences in risk perception; Sjöberg (2001) and Sjöberg et al (2000b) found the variance explained by cultural prototypes to be so low that they rejected the whole concept. Rohrmann (2000) also expressed a sceptical view, mainly because of methodological considerations about the empirical validity of the claims. All authors agree, however, that specific culture-based preferences and biases are, indeed, important factors in risk perception. The disagreement is about the relevance of the postulated four or five prototypes within the realm of cultural factors.

In addition to the theory of cultural prototypes, the review included two sociological concepts that provide plausible explanations for the link between macro-sociological developments and risk perceptions. The theory of reflexive modernization claims that individualization, pluralization and globalization have contributed to the decline of legitimacy with respect to risk professionals and managers (Marshall, 1999; Mythen, 2005). Due to this loss of confidence in private and public institutions, people have become sceptical about the promises of modernity and evaluate the acceptability of risks according to the perceived interest and hidden agenda of those who want society to take these risks (Beck, 1992b). The second approach was linked to the concept of social arenas in which powerful groups struggle for resources in order to pursue their interest and objectives. Here, symbolic connotations constructed by these interest groups act as powerful shaping instruments for eliciting new beliefs or emotions about the risk or the source of risk (Renn, 1992c; Jaeger et al, 2001).

All four levels of influence are relevant in order to gain a better and more accurate understanding of risk perception. In spite of many open questions and ambiguities in risk perception research, one conclusion is beyond any doubt: abstracting the risk concept to a rigid formula, and reducing it to the two components, 'probability and consequences', does not match people's intuitive thinking of what is important when making judgements about the acceptability of risks (Mazur, 1987a; Pidgeon, 1997; Wilkinson, 2001). Paul Slovic (1992, p150) stated this point quite clearly:

> *More generally, psychometric research demonstrates that, whereas experts define risk in a narrow, technical way, the public has a richer, more complex view that incorporates value-laden considerations such as equity, catastrophic potential and controllability. The issue is not whether these are legitimate, rational considerations, but how to integrate them into risk analyses and policy decisions.*

To understand risk perception, one needs to study the psychological, social and cultural components and, in particular, their mutual interactions. The framework of social amplification may assist researchers and risk managers to forge such an integrative perspective on risk perception. Yet a theory of risk perception that offers an integrative, as well as empirically valid, approach to understanding and explaining risk perception is still missing.

CONCLUSIONS

This list of individual and social factors that shapes risk perception demonstrates that the intuitive understanding of risk is a multidimensional concept and cannot be reduced to the product of probabilities and consequences alone (Allen, 1987). Although risk perceptions differ considerably among social and cultural groups, the multidimensionality of risk and the integration of beliefs related to risk, the cause of risk and its circumstances within a consistent belief system appear to be common characteristics of public risk perception in almost any country in which such studies have been performed (Renn and Rohrmann, 2000). This is not to say that professional risk assessments do not matter for people's perception; but they are only one element among many others that shape the formation of attitudes towards risks and judgements about their acceptability (Boholm, 1998; IRGC, 2005; Breakwell, 2007, p3).

Risk perception studies have revealed the various elements that shape the individual and social experience of risk. First, individual and social risk experience appears to be influenced by intuitive heuristics, by the perceived characteristics of the risk and the risk situation, by affective associations and beliefs about the risk source and about the actors involved in the risk-taking activity. It is also worth mentioning that the degree of perceived seriousness of risk is more strongly related to exposure than to actual casualties, upon which most risk assessment is based (Renn et al, 1992). An exposure of few people resulting in several casualties is likely to be less influential with regard to risk perception and public response than an exposure of many people resulting in minor injuries or only few casualties.

Second, individual perception is widely governed by semantic images. These images constitute tools for reducing complexity by providing easily identifiable cues for ordering new risks into one of five images: emerging danger, insidious danger, stroke of fate, gamble and personal thrill. These images are internalized through cultural and social learning. They cluster around qualitative variables that specify the context and the situation in which the risk manifests itself within each image. These variables allow for a certain degree of abstraction with respect to perceiving and evaluating risks across different risk sources; yet they still provide sufficient contextual specification for making the distinctions between negligible, serious and unacceptable risks. Rather than evaluating risk with a single formula, most people use a set of multiple attributes, many of which make normative sense.

Third, among these multiple attributes, dread, personal control, familiarity and blame were shown to be good predictors for risk perception in most countries. This has been confirmed by empirical investigations in, for example, the US, Germany, France, Canada, Austria, Australia and Japan (Rohrmann and Renn, 2000). Many studies show that psychometric variables explain a greater proportion of the variance in risk perception than alternative approaches (Marris et al, 1998; Slovic et al, 2000;

Sjöberg, 1999b, 2000b). The degrees to which these qualitative characteristics are assigned to specific risk sources depend, however, upon cultural context, and also upon social amplification effects, partially triggered by extensive media coverage.

Fourth, the processing of risk by the media, social groups and organizations follows its own patterns and shapes the societal experience with risk. Social and cultural influences play a crucial role in determining the overall propensity to link specific characteristics to risk (such as the belief in institutional control) and the attribution of symbolic features to the risk or the risk source independent of its technical properties (e.g. genetic engineering as symbol of human hubris).

Fifth, in a social environment in which personal experience is largely constructed by second-hand information, trust is an essential prerequisite for communication and social coordination. Although the empirical proof that trust is a major driver for risk perception is still contested (Sjöberg, 2001), there is no doubt that, either directly or indirectly, people are influenced in their judgements about acceptability of risks depending upon the degree of trust in the risk initiator (most often industry) and the risk regulator (Siegrist and Cvetkovich, 2000). In risk arenas, trust can easily be destroyed by unpredictable or non-avoidable disasters; at the same time, it can easily be exploited by risk managers if they explain disasters as random events or acts of God, thus covering up managerial incompetence or erroneous judgements (Löfstedt, 2005). Since both processes occur simultaneously, trust is constantly at stake in institutional responses to risk. In addition, the ambiguity in assigning causality or blame to various actors (including nature or God) makes risk an ideal issue for forming debates in a political arena. Struggling for social resources, actors in risk arenas can mobilize public support by blaming other actors for taking (rejecting) risks. The probabilistic nature of risk prevents any of the actors in the arena from producing compelling evidence that their claims are correct. There is always a degree of ambiguity in any risk policy. This ambiguity has two consequences: resources other than evidence become major chips in the game for more social influence in risk debates, and trust becomes the major variable that helps individuals to assign credibility to one or the other side in the debate.

What benefits can scientists and policy-makers gain from the study of risk perception? What guidance can be derived from studies on intuitive risk perception for risk and technology policy-making? Even if there are no recipes to be obtained from analytical studies about risk perception, studies on risk perception can provide some insights that might help policy-makers to improve their performance (see also Essay 2 in this volume; Slovic et al, 1982; Slovic, 2000b):

- Risk perception studies demonstrate what matters to people. In a democratic society, the concerns of people should be the guiding principle for collective action. Context and supporting circumstances of risk events or activities constitute significant concerns. These perception patterns are not just subjective preferences cobbled together: they stem from cultural evolution, are tried and trusted concepts in everyday life and, in many cases, control our actions in much the same way as a universal reaction to the perception of danger. Their universal nature across all cultures allows collective focus on risk and provides a basis for communication (Rohrmann and Renn, 2000). From a rational standpoint, it would appear useful to systematically identify the various dimensions of intuitive risk perception (concerns assessment) and to measure the extent to which these dimensions are met or violated, by the best available scientific methods. Many psychometric variables that matter to people are open to scientific study and scrutiny. In principle, the extent to which different technical options distribute risk across various social groups, the degree to which institutional control options exist, and the level of risk that can be accepted by way of voluntary agreement can all be measured using appropriate research tools. Risk perception studies help to diagnose these concerns. Scientific investigations can determine whether these dimensions are met or violated, and to what degree. This is based on the view that the dimensions (concerns) of intuitive risk perception are legitimate elements of rational policy; but assessment of the various risk sources must follow rational scientific procedures on every dimension.

- Designing policies about risks requires trade-offs (i.e. relative weights of the various target dimensions). Such trade-offs depend upon both context and the choice of dimension. Perception research offers important pointers concerning the selection of dimensions for focus. For example, the aspect of fairness that rates highly among people as an evaluation tool for the acceptability of risks plays a significant role in such trade-offs and in weighting the various dimensions. In their roles as risk assessors, experts have no authority to select these dimensions or to specify their relative importance. This is where formal methods such as risk–risk comparisons and other evaluation tools reach their limits. The multidimensionality of the intuitive risk model prevents risk policy from focusing one-sidedly on the minimization of expected impacts. A breach of the minimization requirement, however, implies acceptance of greater damage than is absolutely necessary (although this can be justified in individual cases depending upon the risk situation).
- Risk perception studies are crucial for designing and evaluating risk communication programmes. Without knowing the concerns of the targeted audience, communication will not succeed. In addition, risk perception studies help communicators to identify points of conflict or disbelief. They can diagnose lack of trust or credibility and suggest more effective ways of restoring trust when it has been lost. The insights from risk perception research will not guarantee the success of risk communication; but they can certainly assist risk communications in designing more effective and efficient communication programmes.

Further research into the processes and consequences of risk perception is certainly necessary in order to improve our understanding of risk perception and to help individuals and social groups become more aware of their own way of perceiving and evaluating risks. This self-awareness and self-reflection may be a contribution to mastering the confusion and irritations that, according to the theory of reflexive modernization, have been triggered by increased value and knowledge pluralism, and by loss of institutional trust. The more we know about the mechanisms of how we process information and form judgements, the more we can engage in a mutual discourse about the most prudent, effective and fair manner in which to handle the risks and opportunities that modern technology, economic developments and lifestyle activities offer. For this to happen, we need to understand each other's viewpoint, reflect upon the potential consequences of different options for action, and zoom in on the one course of action that seems most desirable or acceptable for all of the people who must live with the consequences.

5

Risk Evaluation[1]

Characterizing and evaluating risks

The most controversial aspect of handling risks refers to the process of delineating and justifying a judgement about the tolerability or acceptability of a given risk (HSE, 2001). The term '*tolerable*' refers to an activity that is seen as worth pursuing (for the benefit that it carries); yet it requires additional efforts for risk reduction within reasonable limits. The term '*acceptable*' refers to an activity where the remaining risks are so low that additional efforts for risk reduction are not seen as necessary. For purely natural hazards, the two terms appear at first glance to be meaningless since humans have no choice in tolerating or accepting these risks. Human activities, however, do influence the impact of natural hazards through changes in vulnerability and exposure options (such as building codes or zoning laws). By examining the resulting risks as a function of vulnerabilities, a judgement on tolerability and acceptability with respect to the selection of protective measures becomes meaningful again.

The distinction between tolerability and acceptability can thus be applied to a large array of risk sources. Tolerability and acceptability can be located in a risk diagram, with probabilities on the y-axis and extent of consequences on the x-axis (see Figure 5.1). This is known as the 'traffic light model', representing acceptable risk in green, tolerable risk in amber and intolerable risk in red (throughout this book we convert the model to black and white using light grey to represent acceptable risk, dark grey for tolerable risk and black for intolerable risk).[2] In this model, the black zone signifies intolerable risk, the grey one indicates tolerable risk in need of further management actions (in accordance with the 'as low as reasonably practicable' – ALARP – principle), and the white zone shows acceptable or even negligible risk.

To draw the line between 'intolerable' and 'tolerable' as well as 'tolerable' and 'acceptable' is one of the most difficult tasks of risk governance. The UK Health and Safety Executive has developed a procedure for chemical risks based on risk–risk comparisons (Löfstedt, 1997a). Some Swiss cantons, such as Basle County, experimented with roundtables as a means of reaching consensus on

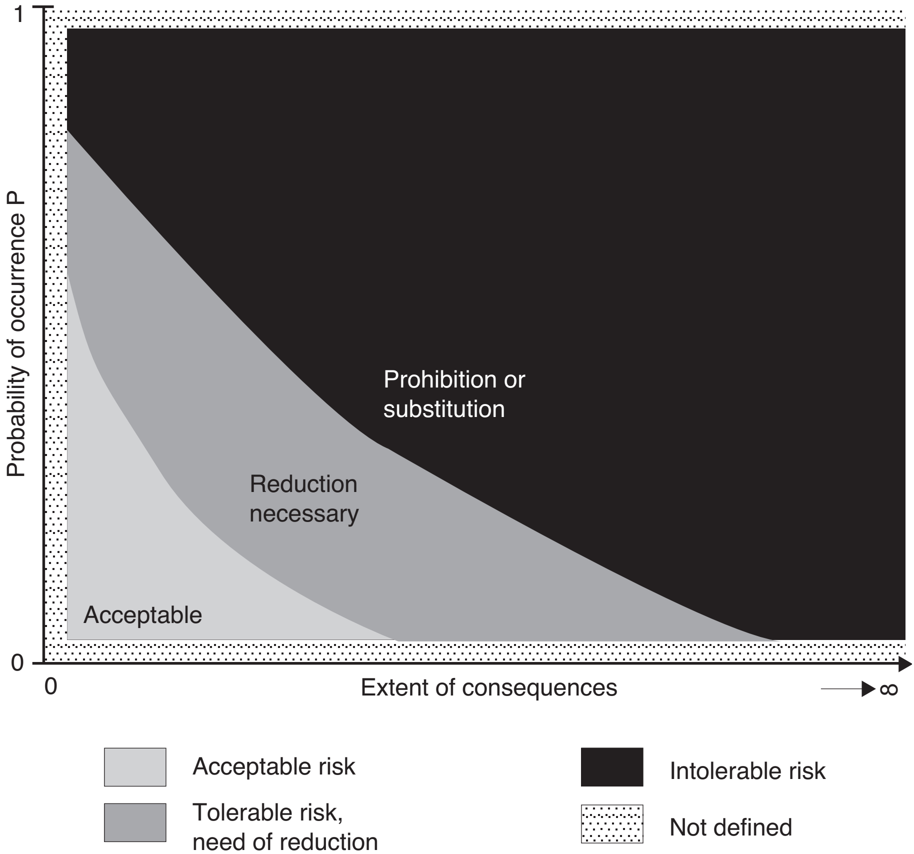

Figure 5.1 *Acceptable, tolerable and intolerable risks*

Source: adapted from WBGU, 2000, p6 and IRGC, 2005, p37

drawing the two lines, where participants in the roundtable represented industry, administrators, county officials, environmentalists and neighbourhood groups (RISKO, 2000). Irrespective of the selected means of supporting this task, the judgement on acceptability or tolerability is contingent upon making use of a variety of different knowledge sources. One needs to include the risk estimates derived from the risk assessment stage and additional assessment data from the concern assessment within the appraisal stage.

The traffic light model represents an oversimplification, but reflects the actual need for a judgement at the end of the appraisal and evaluation process. This final closure on the risk allows for only three alternatives at a particular point in time: either to take no management action (although this could allow for doing additional research or collecting the input necessary to reappraise the risk at a later time), to ban the risk, or to initiate risk mitigation or management actions. There is no other alternative at this point. The model emphasizes that this important judgement be made as transparent as possible to all interested individuals and parties, and that the organizations responsible for this judgement have the skills, the assets, the background knowledge and the sensitivity to arrive at an informed, balanced and fair judgement.

Existing taxonomies of risk differ considerably in where they position the decision-making with regard to what is acceptable and what is tolerable within the overall risk process. Some assign it to the risk assessment part, others to the risk management part, and yet others place it at the level of policy and option assessment, reaching far beyond the narrow risk acceptance criteria. For the generic approach to risk handling that our risk governance framework pursues, the question of appropriate placement should be handled in a flexible manner.

Why? As with the framing part, judgements on acceptability rely on two major inputs: *values* and *evidence*. What society is supposed to tolerate or accept can never be derived from looking at the evidence alone. Likewise, evidence is essential if we are to know whether a value has been violated or not (or to what degree). With respect to values and evidence we can distinguish three cases (March, 1978):

1 ambiguity of evidence but not of values (interpretative ambiguity);
2 ambiguity of values but not of evidence (normative ambiguity);
3 ambiguities of values and evidence.

Case 1: Interpretative ambiguity

In those cases where there is unanimous agreement about the underlying values and even the threshold of what is regarded as tolerable or acceptable, evidence in the form of risk estimates may be sufficient to locate the risk within the traffic light diagram. A judgement can then best be made by those who have most expertise in risk and concern assessments, in which case it makes sense to place this task within the domain of appraisal. The judgement will thus be based on best scientific modelling of epistemic and aleatory uncertainties. Characterization also includes an analysis of the concerns associated with different outcomes and the likely secondary implications. It will be helpful for risk managers to receive best expert advice on potentially effective risk reduction measures and other management options that may lead to satisfactory results. It is, however, not the task of the risk appraisal team to make a selection of options, let alone decide on which option should be implemented.

Leaving the resolution of interpretative ambiguity to the risk and concern assessors places a major challenge on the science-based assessment process. It may be extremely difficult for experts to agree on interpreting ambiguous results. It is not uncommon for the public to hear expert 1 say that there is ‘nothing to worry about regarding a particular risk’, while at the same time learning from expert 2 that

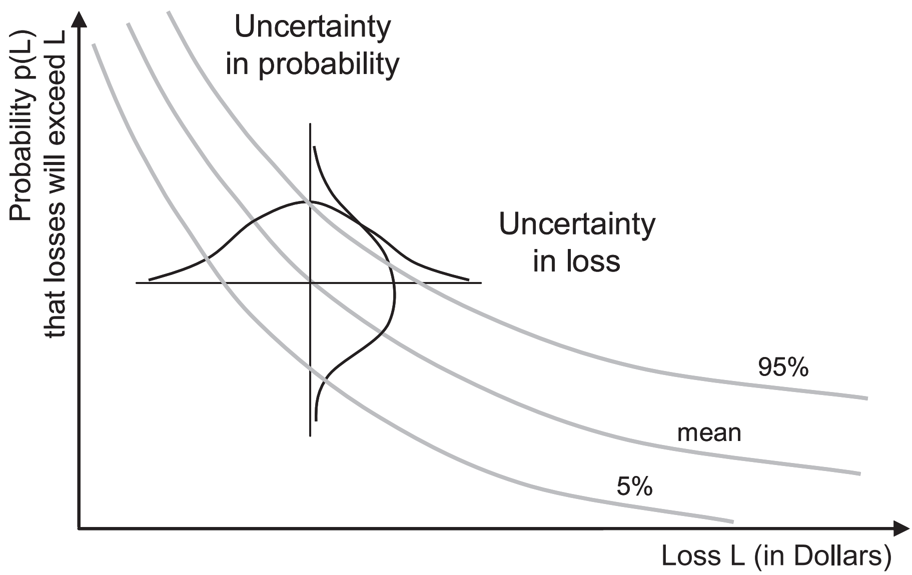

Figure 5.2 *Example of loss exceedance probability curves*

Source: adapted from IRGC, 2005, p38

'this risk should be on your radar screen'. One way of capturing these discrepancies in risk interpretations is to construct an *exceedance probability (EP) curve* (Grossi and Kunreuther, 2005). An EP curve specifies the probabilities that a certain level of losses will be exceeded. The losses can be measured in terms of dollars of damage, fatalities, illness or some other unit of analysis.

To illustrate with a specific example, suppose one was interested in constructing an EP curve for dollar losses to homes in Seattle as a result of an earthquake. Using probabilistic risk assessment, one combines the set of events that could produce a given dollar loss and then determines the resulting probabilities of exceeding losses of different magnitudes. Based on these estimates, one can construct the mean EP curve depicted in Figure 5.2. By its nature, the EP curve inherently incorporates uncertainty associated with the probability of an event occurring and the magnitude of dollar losses. This uncertainty is reflected in the 5 per cent and 95 per cent confidence interval curves in Figure 5.2.

The EP curve also serves as an important tool for evaluating risk management options, thus assisting managers to optimize risk reduction. It puts pressure on experts to state the assumptions upon which they are basing their estimates of the likelihood of certain events occurring and the resulting consequences. In fact, EP curves, such as those depicted in Figure 5.2, supplemented by a discussion of the nature of these assumptions, should enable the assessors to characterize interpretative ambiguities and to provide a framework for risk managers to test the efficiency of risk reduction options.

Case 2: Normative ambiguity

If the underlying values of what could be interpreted as tolerable, or acceptable, are disputed, while the evidence of what is at stake is clearly given and non-controversial, the judgement needs to be based on a discourse about values and their implications. Such a discourse falls clearly in the domain of risk management. A good example may be the normative implications of risks related to smoking. Science is very familiar with these risks, and there is little uncertainty and interpretative ambiguity about dose–effect relationships. Yet, there is considerable debate about whether smoking is tolerable or not. Being a voluntary activity, some countries leave it to the decision of each consumer, while others initiate major activities to reduce and even ban smoking. Another example is wearing helmets on bicycles. The statistical data on this subject are rather straightforward; there are no major uncertainties or interpretative ambiguities. Yet, many countries do not want to impinge upon the freedom of each cyclist to personally decide whether or not to wear a helmet, while other countries pursue a more paternalistic policy.

Case 3: Interpretative and normative ambiguity

A third case arises where both the evidence and the values are disputed. This would imply that assessors should engage in an activity to find some common ground for characterizing and qualifying the evidence, and risk managers need to establish agreement about the appropriate values and their application. A good example for this third case may be the interpretative and normative implications of global climate change. An international expert group, such as the Intergovernmental Panel on Climate Change (IPCC), has gone to considerable trouble to articulate a common characterization of climatic risks and their uncertainties. Given the remaining uncertainties and the complexities of the causal relationships between greenhouse gases and climate change, it is then a question of values whether governments place their priorities on prevention or on mitigation (Keeney and McDaniels, 2001).

Since this third case includes both of the other two, the process of judging the tolerability and acceptability of a risk can be structured into two distinct components: risk characterization and risk evaluation. The first step, risk characterization, determines the evidence-based component for making the necessary judgement on the tolerability and/or acceptability of a risk; the second step, risk evaluation, determines the value-based component for making this judgement.

Risk characterization includes tasks such as point estimates of risks; descriptions of remaining uncertainties (as undertaken, for instance, in climate change models or risk studies on endocrine disruptors); potential outcome scenarios, including social and economic implications; suggestions for safety factors to include inter-target variation; assurance of compatibility with legal prescriptions; risk–risk comparisons; risk–risk trade-offs; identification of discrepancies between risk assessment and risk perceptions, as well as of potential equity violations; and suggestions for reasonable standards to meet legal requirements (Stern and Fineberg, 1996). The evidence collected and summarized here goes beyond the classic natural science reservoir of knowledge and includes economic and social science expertise.

The second step, risk evaluation, broadens the picture to include pre-risk aspects such as choice of technology, social need for the specific risk agent (substitution possible?), risk–benefit balances, political priorities, potential for conflict resolution and social mobilization potential. The main objective here is to arrive at a judgement on tolerability and acceptability based on balancing pros and cons, testing potential impacts on quality of life, discussing different development options for the economy and society, and weighing the competing arguments and evidence claims in a balanced manner. In particular, evaluation is directed towards three different kinds of deliberations:

1 deliberation on the results of risk characterization in consideration of wider social and economic factors (e.g. benefits, societal needs, quality-of-life factors, sustainability, distribution of risks and benefits, social mobilization and conflict potential), legal requirements and policy imperatives;
2 weighing of pros and cons and trading-off of different (sometimes competing or even conflicting) preferences, interests and values;
3 taking into account the individual and social benefits associated with the risk-bearing technology or activity.

On an individual level, it is plausible that decisions should be made on the basis of a balanced comparison of potential costs and benefits, risks and opportunities. Market economies assume that each individual is the best judge for striking the correct balance. Whether someone purchases 20 pairs of shoes or 7 pyjamas remains his or her choice. Balancing individual risks and benefits is more problematic, however, when decision-makers are faced with weighing collective or private benefits that impose risks on others or on the environment thus creating inequitable situations (Jaeger et al, 2001, pp112ff). The question then becomes: what risk can a society impose on those who do not share the benefits in full or in part (MacLean, 1986; Rayner and Cantor, 1987)? This question is, in principle, independent of the benefits that the one individual enjoys by obtaining the desired good. Yet, all societies are willing to impose some risks on its members if some broader groups in society will benefit. This relationship, however, is sometimes far from being symmetrical (Shrader-Frechette, 1984), so the distribution of benefits and risks must be scrutinized very carefully. Regulatory action may be necessary to prevent major inequities.

On the collective level, risk evaluation should also consider positive external effects – for example, on the labour market, the competitiveness of an economy and the effects on social justice. Our framework anticipates the need for deliberation during this phase of evaluation. This is the point at which risk acceptability and tolerability are addressed, and the likely benefits to society – whether in whole or in part – must be included in the balancing procedure. The delicate nature of balancing benefits and risks is also the reason why, in the process of risk evaluation, risk managers, risk assessors and representatives of major stakeholder groups need to convene for making the often painful but necessary trade-offs between conflicting objectives and values.

Table 5.1 *Tolerability/acceptability judgement*

Assessment components	Definition	Indicators
1 **Risk characterization**	Collecting and summarizing all relevant evidence necessary for making an informed choice on tolerability or acceptability of the risk in question and suggesting potential options for dealing with the risk from a scientific perspective	**Risk profile:** • Risk estimates • Confidence intervals • Uncertainty measures • Hazard characteristics • Range of 'legitimate' interpretations • Risk perceptions • Social and economic implications **Judging the severity of risk:** • Compatibility with legal requirements • Risk–risk trade-offs • Effects on equity • Public acceptance **Conclusions and risk reduction options. Suggestions for:** • Tolerable risk levels • Acceptable risk levels • Options for handling risks
2 **Risk evaluation**	Applying societal values and norms to the judgement on tolerability and acceptability and, consequently, determining the need for risk reduction measures	• Choice of technology • Potential for substitution • Risk–benefit comparison • Political priorities • Compensation potential • Conflict management • Potential for social mobilization

Source: adapted from IRGC, 2005, p41

The separation of evidence and values underlying the distinction between characterization and evaluation is, of course, functional and not necessarily organizational. Since risk characterization and evaluation are closely linked and depend upon each other, it may even be wise to perform these two steps simultaneously in a joint effort by both assessors and risk managers. As some analysts have pointed out (Löfstedt and Vogel, 2001; Vogel, 2003), the US regulatory system tends to favour an organizational combination of characterization and evaluation, while European risk managers tend to maintain the organizational separation.

The distinction between the three challenges of risk assessment (complexity, uncertainty and ambiguity) can also assist assessors and managers in assigning, or dividing, the judgement task. If a given risk is characterized by high complexity, low remaining uncertainties and hardly any ambiguities (except for interpretative differences over an established scientific risk assessment result), it is wise to let the assessment team dominate the process of making tolerability/acceptability judgements. If, in contrast, the risk is characterized by major unresolved uncertainties and if the results lead to highly diverse interpretations of what they mean for society, it is advisable to let risk managers take the lead.

Table 5.1 summarizes these two steps, which, in conclusion, are closely interrelated and may be merged if the circumstances require it. The list of indicators represents only a small selection of potential dimensions and is displayed here for illustrative purposes.

Essay 5 *Prometheus Unbound: A Proposal for Classifying and Evaluating Risks*[3]

Introduction

The myth of Prometheus, the benefactor of the human race and creator of science and crafts, has not lost its visual power despite the fact that the story was recorded more than 2700 years ago. Its spiritual quality and its complex web of archaic images and references to a world of competing gods may leave modern audiences estranged and bewildered; but the underlying texture of courage and caution, of betrayal and suffering, of wisdom and foolishness corresponds to the universal experiences of humankind beyond the boundaries of historical context (Perls, 1973, p238; Nennen, 1989, pp56ff). Furthermore, the juxtaposition of ingenuity and hubris, of foresight and complacency, of scientific progress and cultural disenchantment reminds society of the inevitable ambiguity of human progression. Humans are still struggling for the reconciliation of mind and soul, truth and wisdom, technological change and cultural cohesion. The German philosopher Hans-Georg Gadamer characterized the Prometheus myths as the cradle of human development (Gadamer, 1993, p151). He writes: 'To tell the history of Prometheus is to tell the history of occidental societies.'

The first account of Prometheus, the creator of technology and fire-carrier, can be traced back to the two main works of Hesiod: *Theogony* (genealogy of the gods) and *Works and Days* (a farmer's almanac). His father was Lapatos, a descendant of the Titans, and his mother Okeanid Klymene. From his father he received strength, ingenuity and ambition; from his mother, the gift of foresight. Prometheus was able to foresee and, hence, to modulate the future (Lenk, 1991, p170). In addition, Hesiod characterized him as a friend of the human race. The gifts that he received from his ancestors were transferred to the humans over time. However, Prometheus also had dark elements in his character. He was selfish and deceptive. Hesiod speaks of him as the 'trickster-god' (Wutrich, 1995, p10).

The first trick that he played on the gods brought him considerable trouble. During a religious ceremony, Prometheus sacrificed the inferior parts of a sacrificial animal to the gods and deceived them by disguising the worthless bones and interior parts with a thin layer of grease. He kept the meat himself. An angry Zeus punished him immediately and bound him to a rock where an eagle came during the day to eat his liver and other inner organs. During the night the body recovered and the organs revitalized. This punishment went on day and night until Heracles freed the suffering Prometheus. Once in freedom, he took revenge and stole the fire from the gods and brought it to the human race, thus enabling the humans to use the fire for clearing land and producing metal instruments. Now it was Zeus's turn again to retaliate. He created the first woman called Pandora, who was also a master of deception. From the outside beautiful and charming, from the inside wicked and mean – so the characterization of Hesiod. He writes (quoted from Gadamer, 1993, p152):

Born was the mean gender,
the roots of all females
who for the sake of evil to succeed
live in conjunction with men.

Prometheus was clever enough to refuse the gift of Zeus knowing that he was to be deceived. But his brother Epimetheus (literally translated: a man who thinks after the fact) was eager to accept the gift despite the warnings of his brother. Epimetheus is described as a fun-loving, dull-witted and simple-minded personality. Once in the house of Epimetheus, Pandora opens her infamous box, and all evils that can cause human sufferings and pain escape and haunt all humans thereafter. Only hope is left in the box.

What is the reason that this ancient story written 2700 years ago still attracts our attention? Why are we still captivated by a story that defies our logic and does not reflect our present cultural or religious beliefs? Modern scholars associate the story of Prometheus with a conscious account of the Neolithic revolution (i.e. the transition from a society of gatherers and hunters to a society of farmers; Wutrich, 1995, p140). In the days of Hesiod, this was particularly important as small peasant subsistence farming was more and more replaced by larger farming units based on clan family ownership. *Works and Days* was specifically addressed to farmers. With the mastering of fire, agriculture could flourish, as well as the crafting of instruments. The time of the Prometheus bound, when food was provided only to the extent that it was replenished by nature, was replaced by a time of incredible opportunities through the transformation of nature. This new time, however, was full of risks and dangers – in particular, when complacency (Epimetheus) or hubris (Prometheus) dominated over anticipatory planning and caution. The changes of the times in which Hesiod lived were fundamental and radical. They can be compared only to the industrial revolution starting in the 18th century, and probably the post-industrial revolution that we may face today (Mohr, 1996, p46). The Prometheus myth reflects the collective human experience in major transitional periods. This is why it speaks to us even today.

It is interesting to note that during the Industrial Revolution, many artists and authors chose the myth of Prometheus to illustrate their experience with the new era (Wutrich, 1995, p67). It started with Philip Marlow's adaptation of *Dr Faustus*. The play is modelled in accordance with the main themes of the Prometheus legend; the same character was later used by Johann Wolfgang von Goethe (original 1808; 2003). In 1820, Percy Shelly wrote his famous play *Prometheus Unbound*. The title refers to the Aeschylos play *Prometheus Bound* and reflects the second revolutionary change in human history (i.e. liberation from the chains of feudalism). Even the revolutionary Karl Marx wrote in his dissertation: 'Prometheus is the most noble saint and martyr in the philosophical almanac' (quoted from Dietz et al, 1989, p13). Modern societies are now facing a new revolution: the transition from an economy of material production to an economy of information exchange and genetic engineering.

Is there anything to learn from the experiences of human societies in their efforts to cope with crucial transition times? Is there a lesson to learn from the Prometheus legend? Although myths are visions of fundamental truth, it is not possible to extract from them simple lessons for the management of human affairs. Myths imply ambiguity, fuzziness and a holistic perspective (Perls, 1973, p240). They are, however, reminders of the genuine forces that are inevitably present in the making of new technological eras. They can guide us through the clouds of uncertainty and ambiguity associated with new scientific advances and technological breakthroughs. Far from providing recipes for managing technologies and risks, they can help us to orient ourselves in the tension between courage and caution, and to create powerful images that provide sources for understanding and handling risks in modern societies (Mittelstraß, 1998).

Inspired by the myth of Prometheus, the German Advisory Council on Global Change (WBGU) has taken images from Greek mythology to characterize global risks to humankind and to design appropriate tools for dealing with these risks (WBGU, 2000). This essay is based on this approach and develops a concept for characterizing and evaluating risks.

RISK EVALUATION AND A 'NEW' RISK CLASSIFICATION

Analytical approach

The central categories of risk assessment are the *extent of damage* and the *probability of occurrence*. *Damage* is generally understood as negative evaluated consequences of human activities (e.g. accidents from driving, cancer from smoking or fractured legs from skiing) or events (e.g. volcanic eruptions, earthquakes and explosions). If indicators are available for determining the probability of occurrence as well as the extent of damage, the degree of reliability associated with the assessment of each component is called *certainty of assessment*. If the *certainty of assessment* is low, one needs to characterize the nature of the uncertainty in terms of statistical confidence intervals, remaining uncertainties (identifiable, but not calculable) and plain ignorance.

For a comprehensive risk evaluation and an adequate risk management, it is justified and necessary that both scientific risk assessments and risk perceptions are incorporated and considered (Fiorino, 1989b). When deciding about acceptability or tolerability of risks, one needs a comprehensive set of criteria and attributes in order to come up with a balanced and reasonable judgement. Which criteria are suitable for such an evaluation, and how can we justify our selection? What kind of criteria can science offer to the evaluation, and what criteria can be derived from the revealed concerns of the people who might be, or will be, affected by the consequences of the risk?

While, within the field of risk assessment, the criteria of damage, probability and remaining uncertainties seem to be the crucial yardsticks for evaluating risks, it is much more difficult to find a common set of criteria reflecting additional public concerns. Empirical research has shown that people tend to evaluate risks based on a large set of evaluative criteria, of which only a few may claim universal validity (Renn and Rohrmann, 2000). The following contextual variables of risk have been found to affect the perceived severity of risks to varying degrees (Drottz-Sjöberg, 1991; Rohrmann and Renn, 2000; Boholm, 1998; Renn, 2004a; Breakwell, 2007, pp29ff; see the review of risk perception in Essay 4):

- expected number of perceived fatalities or losses;
- catastrophic potential;
- qualitative risk characteristic, such as voluntariness, personal control, familiarity, dread, and others;
- emotional associations with the risk (stigma);
- trust in regulatory agencies and risk-handling institutions; and
- social and cultural beliefs associated with the cause of risk or the risk-handling actors.

If the need for including public concerns within risk evaluation is accepted, one should use the results of the existing perception studies as the major heuristic rule for selecting the relevant criteria. Since the list of relevant criteria is long and not identical for different groups, selection poses a serious problem. The German Advisory Council on Global Change has addressed this problem in its 1999 annual report (WBGU, 2000). The council organized several expert surveys on risk criteria (including experts from the social sciences) and performed a meta-analysis of the major insights from risk perception studies. The council also consulted the literature on similar approaches in countries such as the UK, Denmark, The Netherlands and Switzerland (country reviews in: von Piechowski, 1994; Beroggi et al, 1997; Hattis and Minkowitz, 1997; Hauptmanns, 1997; Löfstedt, 1997a; Petringa, 1997; Poumadère and Mays, 1997).

Nine criteria were finally chosen to represent most of the experts' and public concerns as the result of a long exercise of deliberation and investigations. The experts, for example, were asked to characterize risks on those dimensions they would use for substantiating a judgement on tolerability. These dimensions were compared in common discussion sessions and those that appeared the most influential for characterizing different risks were distilled (see Table 5.2).

The last category of 'mobilization' was the only criterion aimed at describing public response (or outrage) that found approval by all experts. After the WBGU proposal had been reviewed and discussed by many additional experts and risk managers, it was decided to unfold the compact 'mobilization index' and divide it into four major elements (Klinke and Renn, 2002; IRGC, 2005):

1 inequity and injustice associated with the distribution of risks and benefits over time, space and social status (thus covering the criterion of equity);
2 psychological stress and discomfort associated with the risk or the risk source (as measured by psychometric scales);
3 potential for social conflict and mobilization (degree of political or public pressure on risk regulatory agencies);
4 spillover effects that are likely to be expected when highly symbolic losses have repercussions for other fields, such as financial markets or loss of credibility in management institutions (OECD, 2003a).

Table 5.2 *Criteria for evaluating risks*

Criteria	Description
Extent of damage	Adverse effects in natural units, such as fatalities, injuries, production losses, etc.
Probability of occurrence	Estimate for the relative frequency of a discrete or continuous loss function
Incertitude	Overall indicator for different uncertainty components
Ubiquity	Defines the geographic dispersion of potential damages (intra-generational justice)
Persistency	Defines the temporal extension of potential damage (intergenerational justice)
Reversibility	Describes the possibility of restoring the situation to the state before the damage occurred (possible restoration – e.g. reforestation and cleaning of water)
Delay effect	Characterizes a long time of latency between the initial event and the actual impact of damage; the time of latency could be of physical, chemical or biological nature
Violation of equity	Describes the discrepancy between those who enjoy the benefits and those who bear the risks
Potential of mobilization	Is understood as a violation of individual, social or cultural interests and values, generating social conflicts and psychological reactions by individuals or groups who feel affected by the risk consequences

Source: adapted from WBGU, 2000, p56

Social criteria measure the additional effect with regard to psychological or social responses beyond the expected effect from acknowledging the performance of each risk on other physical criteria. A similar division has been proposed by the UK government (Environment Agency, 1998; Galson, 2000; Pollard et al, 2000; HSE, 2001). This proposal includes two main criteria with three sub-criteria each:

- *anxiety,* divided into dread, unfamiliarity and notoriety;
- *discontent,* divided into unfairness, imposition and distrust.

I believe that the inclusion of social criteria into the formal risk evaluation process is still in its infancy and needs more refinement. Several agencies are now preparing such an extended evaluation process.

A 'new' risk classification

Theoretically, a huge number of risk classes can be deduced from the nine criteria. Such a substantial number of classes would not be useful for the purpose of developing a comprehensive risk classification. In reality, some criteria are tightly coupled and other combinations are theoretically possible; but there are no, or only a few, empirical examples. Considering the task of setting risk regulation priorities, risks with several extreme qualities require special attention (WBGU, 2000; Klinke and Renn, 2002). The Council chose a classification where similar risk candidates are classified into risk classes in which they reach or exceed one or more of the possible extreme qualities with regard to any one of the criteria (see Figure 5.3).[4] Some of the criteria could be pooled because they are closely interrelated (e.g. equity and mobility, as well as persistence, ubiquity, and irreversibility). This classification leads to six genuine risk classes that were given names from Greek mythology. The various mythological figures demonstrate the complex issues associated with the new self-awareness of creating manageable risks, rather than just being exposed to fate.

Damage events with a probability of almost one were excluded from this classification. A high potential of damage with a probability of nearly one are clearly located in the intolerable area and are, therefore, unacceptable. Such risks are rare with regard to technological hazards, but frequent in terms of natural hazards. By the same token, probability heading towards zero is harmless as long as the associated potential of damage is irrelevant. It is a characteristic of technological risk that the extent of damage is negatively correlated with the level of probability. The higher the damage, the lower is the probability. Also excluded were activities that reflect everyday mundane risks, such as car accidents, household accidents, common flu and others. These risks are highly significant because so many people are exposed to them. Yet, they did not justify a risk pattern or class of their own.[5]

Risk class 'sword of Damocles'

According to Greek mythology, Damocles was invited to a banquet by his king. At the table, he had to sit under a sharp sword hanging on a wafer-thin thread. Chance and risk are tightly linked for Damocles, and the sword of Damocles is a symbol of impending danger. The myth does not tell about a snapping of the thread with its fatal consequences. The threat, rather, comes from the possibility that a fatal event could, at any time, happen to Damocles, even if the probability is low. Accordingly, this risk class relates to risk sources that have a very high potential for damage and, at the same time, very low probability of occurrence. Many technological risks, such as nuclear energy, large-scale chemical facilities and dams, belong to this category.

Risk class 'Cyclops'

The ancient Greeks knew of enormous giants who were punished, despite their strength, by only having a single eye. They were called Cyclops. With only one eye, only one side of reality and no dimensional perspective can be perceived. Applied to risks one can ascertain either the probability of occurrence or the extent of damage. One of the sides will remain uncertain. In the risk class Cyclops, the probability of occurrence is largely uncertain, whereas the maximum damage can be estimated. Some natural events, such as floods, earthquakes and volcanic eruptions (but also the appearance of AIDS and nuclear early warning systems) belong to this category.

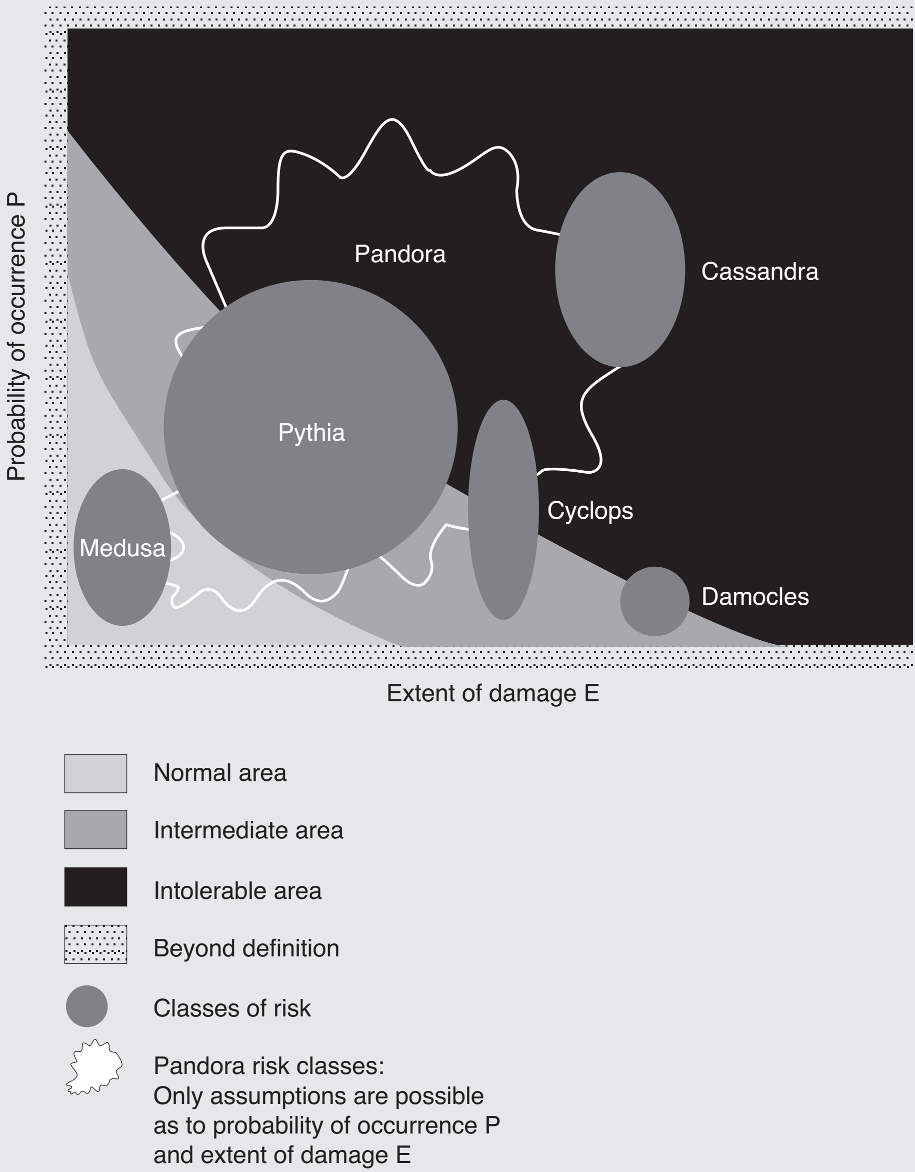

Figure 5.3 *Risk classes*

Source: adapted from WBGU, 2000, p63

Risk class 'Pythia'

The Greeks of antiquity consulted their oracles in cases of uncertainty. The best known is the oracle of Delphi with the blind prophetess Pythia. Pythia's prophecies were always ambiguous. It certainly became clear that a great danger might be impending;

but the probability of occurrence, the extent of damage, the allocation and the way in which the damage manifested itself remained uncertain. Human interventions in ecosystems, technical innovations in biotechnology and the greenhouse effect belong to this risk class, where the extent of changes is still not predictable.

Risk class 'Pandora's box'

The old Greeks explained many evils and perils through the myth of Pandora's box – a box that was sent to the beautiful Pandora by Zeus, the king of the gods. As long as the evils and perils stayed in the box, no damage whatsoever was to be feared. However, when the box was opened, all evils and perils were released, which then irreversibly, persistently and ubiquitously struck the Earth. This risk class is characterized by both uncertainty in the criteria of probability of occurrence and the extent of damage (only presumptions) and high persistency. Here, persistent organic pollutants and endocrine disruptors are modern examples.

Risk class 'Cassandra'

Cassandra was a prophetess of the Troys who certainly predicted the victory of the Greeks correctly; but her compatriots did not take her seriously. The risk class Cassandra describes a paradox: probability of occurrence and extent of damage are known; but there is no imminent concern because damage will only occur in the future. Of course, Cassandra-type risks are only interesting if the potential of damage and the probability of occurrence are relatively high. This is why this class is located in the intolerable 'red' area. A high degree of the delay effect is typical for this risk class (i.e. a long period between the initial event and the impact of the damage). An example of this effect is anthropogenic climate change.

Risk class 'Medusa'

Ancient mythology tells that Medusa was one of three snake-haired sisters of the Gorgon, whose appearance turns the beholder to stone. Similar to the Gorgon, who spread fear and horror as an imaginary mythical figure, some new phenomena have an effect on modern people. Innovations are occasionally rejected, although they are hardly assessed scientifically as threat. Such phenomena have a high potential of mobilization in public. Medusa was the only sister who was mortal – if we transfer the picture to risk policy; Medusa can be confronted with effective debate, further research and public communication. According to the best knowledge of risk experts, risks of this class are located in the 'normal' area. Because of specific characteristics, these risk sources frighten people and lead to strong denial. Often, a large number of people are affected by these risks; but harmful results cannot be proven statistically. A typical example comprises electromagnetic fields.

Summarizing the risk classes

Table 5.3 lists all six risk classes in tabular form, describes their main characteristics and provides examples for each type. The classification is the first step in evaluating

Table 5.3 *Overview of the risk classes, their criteria and typical representatives*

Risk class	Probability	Extent of damage	Other criteria	Typical examples[6]
Damocles	Low	High		Nuclear energy, dams, large-scale chemical facilities
Cyclops	Indecisive	High		Nuclear early warning systems, earthquakes, volcanic eruptions, new infectious diseases
Pythia	Large uncertainty intervals	Potentially high		Greenhouse gas effect on extreme weather events, BSE, some GMOs, some applications of nanotechnology
Pandora	Unknown	Potentially high	High persistence	POPs, endocrine disruptors
Cassandra	High	High	Long delay	Anthropogenic climate change, destabilization of terrestrial ecosystems, threat to biodiversity
Medusa	Low	Low	High mobilization	Electromagnetic fields

Source: adapted from WBGU, 2000, p62

the tolerability or acceptability of the risks by locating each risk within the traffic light model and is later used for designing appropriate management strategies. These will be explained in the following sections.

Each risk class is indicative of a different pattern of complexity, uncertainty and ambiguity (these terms are explained in Chapter 3). Table 5.3 provides a simple overview of the six classes in relation to the three risk characteristics. The two classes

Table 5.4 *Overview of different degrees of incertitude with regard to the main criteria and the risk classes*

Characteristics	Explanation	Risk classes
Complexity	Multifaceted web of causal relationships where many intervening factors interact to affect the outcome of an event or an activity	• Sword of Damocles • Cyclops
Uncertainty	Lack of reliability or confidence in the postulated cause–effect relationships	• Pythia • Pandora's box
Ambiguity	Conflicting views about the interpretation of a risk and its tolerability	• Cassandra • Medusa

Source: Ortwin Renn

of Damocles and Cyclops are both highly complex in nature; but the uncertainties are partially resolved by scientific studies (for Cyclops, however, only one component has been resolved). The two classes of Pythia and Pandora face major uncertainties about either the causal relationships or the extent of this relationship (Pythia). They also tend to be highly complex. The two remaining classes of Cassandra and Medusa give rise to conflicts in society about their significance and tolerability. Whereas in the case of Medusa many members of the public are more worried and alarmed than the experts, the reverse is true for Cassandra. Here, the experts warn society about potential pending dangers; but, due to considerable time lapse between the cause and the final effect, no one seems to be particularly worried about it.

Assisting risk evaluation

Decision tree for characterizing and evaluating risks

The essential aim of the risk classification is to locate risks in one of the three spaces of the traffic light diagram (see Figure 5.3) in order to assess its tolerability or acceptability. In addition, this classification helps to derive effective and feasible strategies, regulations and measures for risk reduction. The characterization provides a knowledge base so that risk managers can better select specific political strategies and measures that correspond to each risk class (WBGU, 2000, p7). To do this effectively, we propose a decision tree in which five central questions have to be answered (see Figure 5.4).

First question: Is there any knowledge about the probabilities (p) and the extent of damage (d)?

If knowledge is not available on any of the criteria mentioned above, such unknown risks cannot be properly evaluated. Nonetheless, they might have major importance because they are usually associated with desirable benefits, for example through innovations. Therefore, the aim must be to create institutional mechanisms that provide almost automatic responses once the scope of potential impacts becomes visible or detectable. The most important task here is to ensure that more knowledge about the unknown risk potential is generated. This requires three basic evaluation strategies: the first one is to do a 'quick and dirty' screening of the risk by means of analogy and comparison with similar situations; the second one is to provide sufficient public or private money for investigating the potential for harm through further research; the third one is to make those who take the risks, or impose the risks on others, liable for any damage that may occur (e.g. through insurance). Insurance premiums then act as incentives for the risk originators to generate more knowledge about the potential impacts in due time. If knowledge is already available somewhere in society, institutional arrangements need to be in place in order to ensure that it is disseminated to the affected parties and to political decision-makers (Zimmermann and Pahl, 1999). If there is reason to assume that the risk-bearing activity or technology could seriously harm people, it should not be tolerated. Conversely, if there is no major hazard associated with the risk activity or technology, routine monitoring may suffice.

Second question: Does the risk in question exceed pre-specified thresholds of one or more of the criteria for risk characterization?

Each risk can be classified with more or less reliability on each of the nine criteria. The classification itself has no impact upon regulation unless intervention levels are defined. These thresholds for action cannot be determined in abstract. It may be one of the main objectives of the screening and framing task to define thresholds for action based on the nine criteria. Each risk candidate can then be tested against the predefined threshold. If a risk falls below any one of the predefined thresholds, the risk potential can be judged as 'normal' so that the existing structures of routine management and regulation are sufficient to cope with them. Such 'normal' risks are characterized by fairly low complexity, uncertainty and ambiguity. One can locate these risks in the normal 'green' area (see Figure 5.3).

If the risk potential exceeds any one of the thresholds on the evaluation criteria, it causes more problems because the risks touch areas that go beyond ordinary dimensions. In this case, an assignment to one of the six risk classes is inevitable. For this purpose, the next question should be answered.

Third question: Do we face high degrees of uncertainty with both extent of damage and probability of occurrence?

High uncertainty ratings on the two central risk characteristics lead to a classification of Pythia or Pandora's box. The Pythia risk class presumes that the scientific appraisal provides sufficient proof for a causal relationship between agent and effect, but that neither the extent of damage nor the probabilities can be quantitatively specified. Risks within the class of Pandora are those where only credible assumptions about such a causal connection exist, but no substantial evidence (Costanza and Cornwell, 1992). Normally such a risk would not fall into the intermediate or acceptable area. But if the risks are classified as being ubiquitous, persistent and irreversible, a more cautious approach is warranted. In such a case, the risks cannot be significantly reduced or even avoided if the worst case occurred and the suspicion about negative impacts became true. If the damage potential is known and can be identified, the next question will be relevant.

Fourth question: Is the damage potential likely to be dramatic or even catastrophic?

If the experts assess the catastrophic potential as being high, but the probabilities are either rated as low or as unknown, one of the two risk classes of Cyclops and of Sword of Damocles fits the description. The Cyclops risk class is characterized by a great extent of damage, whereas the probability of occurrence remains uncertain. The Damocles risk class is also characterized by a high disaster potential, but the probability that this potential manifests itself as concrete damage is low, sometimes even minimal. If both the disaster potential and the probability of occurrence are high, one would normally reject such risks. Most likely, existing legal statutes would already prohibit their implementation. But if there is a considerable lapse of time between the triggering event and the damage impact, it leads to the situation that such risks are often ignored and no one is willing to acknowledge the threat. Such risks are characterized by the risk class Cassandra.

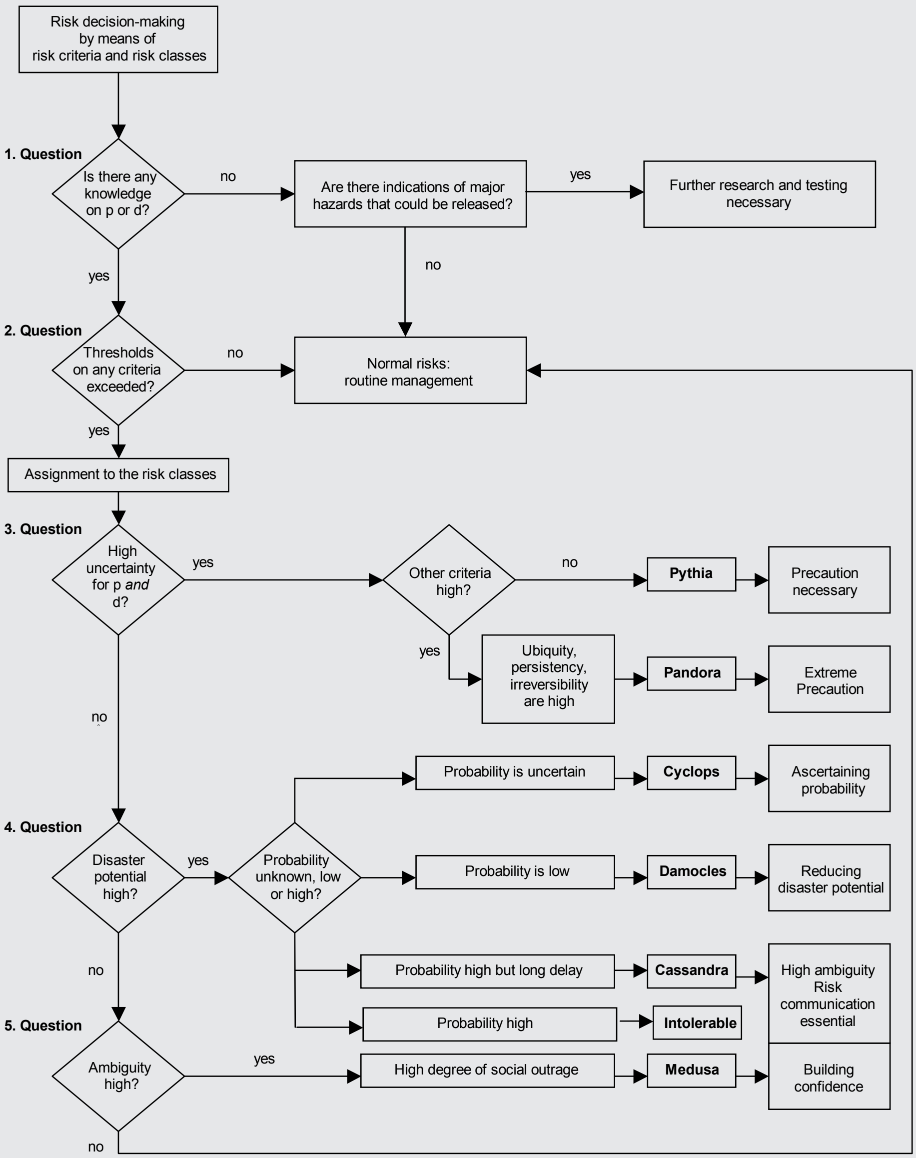

Figure 5.4 *Decision tree for evaluating and classifying risks*

Source: adapted from WBGU, 2000, p7 and Klinke and Renn, 2002

Fifth question: Is there high ambiguity associated with the risk under consideration?

A high degree of ambiguity can be caused by two reasons: experts rate the risks as higher than most stakeholders and the public, or vice versa. Of course, there are many intermediate stages of conflicting risk evaluations between and among stakeholders and within the public. Yet, for making our argument, we can deal with the two extremes here. In the first case, experts warn society; but nobody seems to listen (which is most often due to long delay effects between the cause of risk and its effect). In the second case, experts believe the risks to be acceptable, but relevant actors in society think otherwise. The two cases are symbolized by the two risk classes Cassandra and Medusa. In particular, if the risk potential triggers high anxiety among individuals, violates equity values and/or produces a high potential of social mobilization in public, a discrepancy between expert and public risk evaluation can be expected. The concerns about these risks relate to the subjective perception of the affected people that can lead to distress, anxiety and sometimes even psychosomatic malfunctions (Renn, 1997b). People may also feel unequally treated (i.e. they perceive a discrepancy between those who are able to take advantage of the benefits and those who bear the risks). These risk phenomena are subsumed under the risk class Medusa since they generate a high mobilization in public. Once a risk is classified as producing a high mobilization potential, it is necessary to look into the three components of the social mobilization criterion separately, in order to design the appropriate management and communication strategy.

Risk dynamic

The ultimate goal of all measures taken for risk reduction is to move risks from the transitional area to the normal area. It cannot be the concern of risk policy to reduce risks down to zero, but rather to transform risks in such a way that they finally reach the light grey area of the traffic light diagram (see Figure 5.3). This would entail that common methods of risk–benefit assessment can be applied by market participants and by state regulators.

The move from an unacceptable or intolerable risk into the area of acceptability will normally follow a process that passes through several stages. Figure 5.5 illustrates this movement from class to class. In general, we may distinguish between two types of measures that could initiate such a move: those aimed at improving knowledge (through research and via liability), and those induced by regulatory measures impinging upon critical class-specific properties (such as reducing complexity, uncertainty, ambiguity or other hazard characteristics, such as irreversibility, ubiquity or persistency). As Figure 5.5 indicates, improved knowledge generally leads to a movement from one class of risk to another (for instance, from Pandora to Pythia; from Pythia to Cyclops; and from there to Damocles or Medusa). Measures acting upon a specific critical quantity can similarly trigger a cascade movement or can bring about a direct movement to the normal area. In the following paragraphs, this movement from one class of risk to another is explained for a fictitious example.

Imagine a substance that is used globally, is highly persistent and for which there are reasonable grounds to assume that it causes irreversible effects. This risk belongs to the Pandora class. It is located in the upper third of the transitional area, whereby the uncertainty bars (confidence intervals) extend into the unacceptable range. A risk of this type suggests two primary strategies: expanding knowledge and limiting the risk potential. Let us first examine the outcome of expanding knowledge. Let us assume the knowledge pertaining to the risk can be further quantified, in the process of which the assumption of irreversible consequences or of high persistency may be substantiated. If this is the case, a substitution of the substance, or even a ban, is urgently called for. The risk is thereby unequivocally moved into the prohibited area. There may be one exception: if a large period of time elapses between the triggering event – human or environmental exposure – and its consequence, so that there is little political prospect of taking direct influence through a ban or restriction. We then have a typical Cassandra-type risk. To handle this, a major communication effort to strengthen long-term responsibility needs to be undertaken, and principal actors need to be mobilized in order that the necessary strategy of substitution, or at least of containment, is implemented effectively.

Let us further assume in our illustrative example that the spatial distribution of this substance can, indeed, be limited to a degree that ubiquitous dispersal is prevented. In this case, the risk is moved to the Pythia class, as the probability of occurrence and the severity of effects are now better known, but are still both subject to major uncertainties. The next step in this case is thus to determine the damage potential more clearly. Let us then assume that there are reasons to infer that substantial damage is possible, yet the probabilities are not yet known. This would place the risk in the Cyclops class. Cyclops forms a pivotal node in Figure 5.5 as risks can undergo transmutation from there to a variety of other classes. If, for instance, we can succeed in determining the probability of occurrence and this is relatively low, then the risk can be categorized as belonging to the Damocles class, characterized by high severity and low probability. If, however, probability is found to be high and there is no time lag, the risk would be located in the prohibited area. If not, the risk again would move towards the Cassandra category. If technological or other measures can be applied to reduce the damage potential, nothing now stands in the way of moving the risk to the normal area. If the disaster potential remains very high despite major reduction efforts, the risk lands in the Damocles class. From here, too, it can be moved to the normal area through a two-pronged strategy of improving knowledge and reducing disaster potential. If all reduction tools fail, then a fundamental decision is due as to whether the benefit associated with this risk is considered to be so substantial that the high potential for damage is tolerated, its probability of occurrence being low. If the outcome of this decision is negative, the risk moves into the prohibited area.

For all types of risk, the desired commutation to the normal area can be via the Medusa class. Thus, in our fictitious example, the public may have little confidence in the purported reduction of damage potential. By way of illustration, we only need to recall the uproar caused in Germany by the 'Castor' nuclear waste transports (WBGU, 2000, p18). Although the health risk from radiation has been assessed as low in terms of both probability and severity, the loss in terms of credibility and reliability was large enough to generate a major political and psychological mobilization effect. Acting on a long history of suffering in public risk debates and their political ramifications, many risk regulators may prefer to opt for a ban, even though both probability and damage potential indicate a normal risk. In such a case, measures aimed at communicating risks to the public, building confidence in risk management institutions and further improving knowledge are the necessary steps to convince the public of the 'normality' of the risk and, at the same time, to commit technology

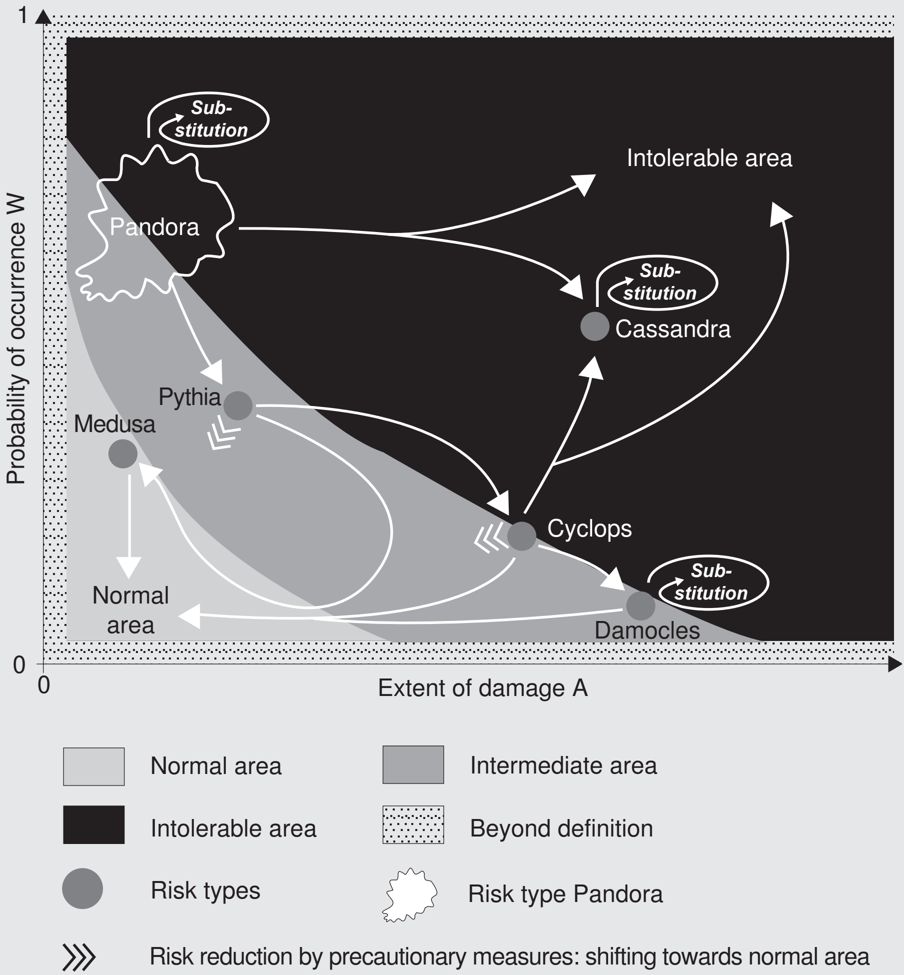

Figure 5.5 *Risk dynamic*

Source: adapted from WBGU, 2000, p19

operators to handle the risk as required by law. In addition, a need always remains to critically review whether the measures instituted really have led to the intended risk reduction. After passing through all of these stations, the normal area can finally be reached.

The cascade movement presupposes intensively tackling the risks to be assessed, and continuously monitoring and evaluating the risk reduction measures to be taken. This requires time, institutional provisions and resources. Nonetheless, given the extent of technological, medical and natural threats, investments in moving risks from the upper to lower positions will normally pay off. The analytical framework of risk classes put forward here, as well as the associated dynamic conception of measures offer a logically consistent and politically practicable concept. At the same time, the categorization in risk classes and the implementation of class-specific measures, can help society to deal with risks more effectively and in a targeted way, and can instruct risk managers in industry and policy on how to handle risks rationally.

Conclusions

The main objective of this essay has been to develop the adequate tools for characterizing and evaluating risks. The WBGU developed a special system for classifying risks based on a multitude of risk evaluation criteria and delineated from this categorization a distinction of six risk classes. This approach started with a reconsideration of risk evaluation because it demands an integration of knowledge and values. The suggestion by the German Advisory Council on Global Change includes a larger set of criteria for evaluating risks than those used before. In addition, the proposal of the council tries to incorporate the major concerns of people as they have been identified in risk perception studies (Slovic, 1987). Responsive risk evaluation needs to take these aspects into account. Based on these assumptions, this essay provides a classification scheme that can assist risk evaluators and managers to focus on the main problem of the risk under investigation and to go through a set of questions that help to allocate risk and to make a prudent judgement on risk tolerability or acceptability. The final judgement about tolerability, of course, cannot be prescribed by any method. Whether a risk is tolerable depends upon the values, the relative weight of each value and the nature, extent and probability of the risk consequences as assessed and evaluated by those entitled to make these decisions. As will be explained later in Chapter 8 (and Essay 9), for highly uncertain and ambiguous risks, stakeholder and public participation is essential for coping with this difficult but unavoidable task of balancing the pros and cons of each technology, substance or activity that produces both risks and benefits.

The promises of Prometheus need to be balanced against the potential evils that the opening of Pandora's box may entail. This balance is not easy to find as opportunities and risks emerge in a cloud of uncertainty. The dual nature of risk, as a potential for technological progress and as a social threat, demands a dual strategy for risk evaluation. Public values and social concerns may act as the driving agents for identifying those topics for which risk assessments are judged necessary or desirable. As much as risk assessment needs to broaden its scope of research targets, as well as improve its handling of uncertainty, social concerns must inform policy-makers about public concerns, develop better methods of mutual communication, and provide models for the type of discourse needed to bring the technical analyses in line with the social and cultural needs of the respective societies. There is no shortage of new problems and challenges in risk research. The remaining gift of Pandora was hope. So we are left with the hope that we will have the professional skills, the demanded creativity and ingenuity, and the energy and ethics necessary to meet the challenges of the risk societies at the beginning of the 21st century.

6

Risk Management[1]

Generating and evaluating risk management options

Risk management starts with a review of all relevant information, particularly from combined risk appraisal, consisting of both a risk assessment and concern assessment where the latter is based on risk perception studies, economic impact assessments and the scientific characterization of social responses to the risk source. This information, together with the judgements made in the phase of risk characterization and evaluation, form the input material upon which risk management options are assessed, evaluated and selected. At the outset, risk management is presented with three potential outcomes:

1 *Intolerable situation:* either the risk source (such as a technology or a chemical) needs to be abandoned or replaced, or in cases where that is not possible (e.g. natural hazards), vulnerabilities need to be reduced and exposure restricted.
2 *Tolerable situation:* the risks need to be reduced or handled in some other way within the limits of reasonable resource investments (ALARP, including best practice). This can be done by private actors (such as corporate risk managers) or public actors (such as regulatory agencies) or both (public–private partnerships).
3 *Acceptable situation:* the risks are so small – perhaps even regarded as negligible – that any risk reduction effort is unnecessary. However, risk-sharing via insurance and/or further risk reduction on a voluntary basis present options for action that can be worthwhile pursuing even in the case of an acceptable risk.

With regard to these outcomes, risk managers may either face a situation of unanimity (i.e. all relevant actors agree with how a given risk situation should be qualified) or a situation of conflict in which major actors challenge the classification undertaken by others. The degree of controversy is one of the drivers for selecting the appropriate instruments for risk prevention or risk reduction.

For a systematic analysis of the risk management process, it is advisable to focus on tolerable risks and those where tolerability is disputed; the other cases are fairly easy to deal with. In the case of intolerable risks – and often in the case of tolerable but highly disputed risks – risk managers should opt for prevention strategies as a means of replacing the hazardous activity with another activity leading to identical and similar benefits. One should first make sure, however, that the replacement does not introduce more risks or more uncertainties than the agent it replaces (Wiener, 1998). In the case of acceptable risks, it should be left to private actors to initiate additional risk reduction or to seek insurance for covering potential but acceptable losses (although this does not eliminate the need for all concerned to have sufficient information and resources to do so). If risks are classified as tolerable, or if there is dispute as to whether they are tolerable or acceptable, risk management needs to design and implement actions that make these risks acceptable over time. Should this not be feasible, then risk management, aided by communication, needs at least to credibly convey the message that major effort is undertaken to bring these risks closer to being acceptable. This task can be described in terms of classic decision theory (Hammond et al, 1999; Morgan, 1990; Keeney, 1992; Aven and Vinnem, 2007, pp49ff):

- *Identification and generation of risk management options.* Generic risk management options include risk avoidance, risk reduction, risk transfer and – also an option to take into account – self-retention. While avoiding a risk means either selecting a path that does not touch on the risk (e.g. by abandoning the development of a specific technology) or taking action in order to fully eliminate a certain risk, risk transfer deals with ways of passing the risk on to a third party. Self-retention as a management option essentially means taking an informed decision to do nothing about the risk and to take full responsibility both for the decision and any consequences occurring thereafter. Risk management by means of risk reduction can be accomplished by many different means:
  - *technical standards and limits* that prescribe the permissible threshold of concentrations, emissions, take-up or other measures of exposure;
  - *performance standards* for technological and chemical processes, such as minimum temperatures in waste incinerators;
  - *technical prescriptions* referring to the blockage of exposure (e.g. via protective clothing) or the improvement of resilience (e.g. via immunization or earthquake-tolerant constructions);
  - *governmental economic incentives*, including taxation, duties, subsidies and certification schemes;
  - *third-party incentives* (i.e. private monetary or in-kind incentives);
  - *compensation schemes* (monetary or in kind);
  - *insurance and liability*;
  - *cooperative and informative options*, ranging from voluntary agreements to labelling and education programmes.

All of these options can be used individually or in combination in order to accomplish even more effective risk reduction. Options for risk reduction can be initiated by private and public actors or both together.

- *Assessment of risk management options with respect to predefined criteria.* Each of the options will have desired and unintended consequences which relate to the risks that they are supposed to reduce. In most instances, an assessment should be conducted according to the following criteria:
  - *Effectiveness:* does the option achieve the desired effect?
  - *Efficiency:* does the option achieve the desired effect with the least resource consumption?
  - *Minimization of external side effects:* does the option infringe upon other valuable goods, benefits or services, such as competitiveness, public health, environmental quality, social cohesion, etc.? Does it impair the efficiency and acceptance of the governance system itself?
  - *Sustainability:* does the option contribute to the overall goal of sustainability? Does it assist in sustaining vital ecological functions, economic prosperity and social cohesion?
  - *Fairness:* does the option burden the subjects of regulation in a fair and equitable manner?
  - *Political and legal implementation:* is the option compatible with legal requirements and political programmes?
  - *Ethical acceptability:* is the option morally acceptable?
  - *Public acceptance:* will the option be accepted by those individuals who are affected by it? Are there cultural preferences or symbolic connotations that have a strong influence on how the risks are perceived?

  Measuring management options against these criteria may create conflicting messages and results. Many measures that prove to be effective may turn out to be inefficient or unfair to those who will be burdened. Other measures may be sustainable, but not accepted by the public or important stakeholders. These problems are aggravated when dealing with global risks. What appears to be efficient in one country may not work at all in another country. Risk managers are, therefore, well advised to make use of the many excellent guidance documents on how to handle risk trade-offs and how to employ decision–analytic tools for dealing with conflicting evidence and values (Viscusi, 1994; Wiener, 1998; van der Sluijs et al, 2003; Goodwin and Wright, 2004).
- *Evaluation of risk management options.* Similar to risk evaluation, this step integrates the evidence on how the options perform in terms of predefined evaluation criteria, with a value judgement about the relative weight that each criterion should be assigned. Ideally, the evidence should come from experts and the relative weights from politically legitimate decision-makers. In practical risk management, the evaluation of options is conducted in close cooperation between experts and decision-makers. As pointed out later, this is the step where direct stakeholder involvement and public participation are particularly

important, and it is therefore best ensured by making use of a variety of methods (Rowe and Frewer, 2000; OECD, 2002).

- *Selection of risk management options.* Once the different options are evaluated, a decision has to be made as to which options are selected and which rejected. This decision is obvious if one or more options turn out to be dominant (relatively better on all criteria). Otherwise, trade-offs have to be made that require legitimization (Graham and Wiener, 1995). A legitimate decision can be made on the basis of formal balancing tools (such as cost–benefit or multi-criteria decision analysis), by the respective decision-makers (given that their decisions are informed by a holistic view of the problem) or in conjunction with participatory procedures.
- *Implementation of risk management options.* It is the task of risk management to oversee and control the implementation process. In many instances, implementation is delegated (e.g. when governments take decisions but leave their implementation to other public or private bodies or to the general public). However, the risk management team has, at any rate, the implicit mandate to supervise the implementation process or at least to monitor its outcome.
- *Monitoring of option performance.* The last step refers to the systematic observation of the effects of the options once they are implemented. The monitoring system should be designed to assess intended, as well as unintended, consequences. Often, a formal policy assessment study is issued in order to explore the consequences of a given set of risk management measures on different elements of what people value. In addition to generating feedback on the effectiveness of the options, the monitoring phase should also provide new information on early warning signals for both new risks and old risks viewed from a fresh perspective. It is advisable to have the institutions performing the risk and concern assessments participate in the monitoring and supervision so that their analytic skills and experience can evaluate the performance of the selected management options.

These steps follow a logical sequence but can be arranged in different orders depending upon both situation and circumstance. It might be helpful to visualize the steps not as a linear progression, but as a circle forming an iterative process in which reassessment phases are intertwined with emerging options, arising crises or new demands placed on risk managers. Occasionally the assessment of different options requires new options to be created in order to achieve desired results. In other cases, the monitoring of existing rules affects the decision to add new criteria to the portfolio. Rarely do issues for risk appraisal and management follow the sequence used for the process described in this chapter. Option generation, information processing and options selection should, indeed, be seen as a dynamic process with many iterative loops.

Table 6.1 summarizes the steps of risk management in accordance with the basic model used by decision theory. The list of indicators represents the

Table 6.1 *Generic components of risk management*

Management components	Definition	Indicators
1 Option generation	• Identification of potential risk-handling options, particularly risk reduction (i.e. prevention, adaptation and mitigation, as well as risk avoidance, transfer and retention)	• Standards • Performance rules • Restrictions on exposure or vulnerability • Economic incentives • Compensation • Insurance and liability • Voluntary agreements • Labels • Information/education
2 Option assessment	• Investigations of the impacts of each option (economic, technical, social, political and cultural)	• Effectiveness • Efficiency • Minimization of side effects • Sustainability • Fairness • Legal and political implementation • Ethical acceptability • Public acceptance
3 Option evaluation and selection	• Evaluation of options (multi-criteria analysis)	• Assignment of trade-offs • Incorporation of stakeholders and the public
4 Option implementation	• Realization of the most preferred option	• Accountability • Consistency • Effectiveness
5 Monitoring and feedback	• Observation of the effects of implementation (link to early warning) • *Ex-post* evaluation	• Intended impacts • Unintentional impacts • Policy impacts

Source: adapted from IRGC, 2005, p44

most frequently employed heuristic rules for selecting input and for measuring performance.

RISK MANAGEMENT STRATEGIES BASED ON RISK CHARACTERISTICS

Making use of the distinction between complexity, uncertainty and ambiguity, it is possible to design generic strategies of risk management to be applied to risk classes, thus simplifying the risk management process outlined above. One can distinguish four such classes:

1 *Linear (routine) risk problems.* This class of risk problems requires hardly any deviation from traditional decision-making. Data are provided by statistical analysis, goals are determined by law or statutory requirements, and the role of risk management is to ensure that all risk reduction measures are implemented and enforced. Traditional risk–risk comparisons (or risk–risk trade-offs), risk–benefit analysis and cost-effectiveness studies are the instruments of choice for finding the most appropriate risk reduction measures. Additionally, risk managers can rely upon best practice and, in cases of low impact, upon trial and error. It should be noted, however, that simple risks should not be equated with small or negligible risks. The major issues here are that the potential negative consequences are obvious, the values that are applied are non-controversial and that the remaining uncertainties are low. Examples are car accidents, known food and health risks, regularly recurring natural disasters or safety devices for high buildings.

2 *Complex risk problems.* For this risk class, major input for risk management is provided by the scientific characterization of the risk. Complex risk problems are often associated with major scientific dissent about complex dose–effect relationships or the alleged effectiveness of measures to decrease vulnerability (complexity refers to both the risk agent and its causal connections, and the risk-absorbing system and its vulnerabilities). The objective for resolving complexity is to receive a complete and balanced set of risk and concern assessment results that fall within the legitimate range of plural truth claims.

In a situation where there are no complete data, the major challenge is to define the factual base for making risk management or risk regulatory decisions. The main emphasis is on improving the reliability and validity of the results that are produced in the risk appraisal phase. Risk and concern assessors, as well as managers, need to make sure that all relevant knowledge claims are selected, processed and evaluated. They may not get a single answer, but they might be able to get a better overview of the issues of scientific controversy. If these efforts lead to an acknowledgement of wide margins of uncertainty, the management tools of the uncertainty strategy should be applied. If input variables to decision-making can be properly defined and affirmed, risk characterization and evaluation can be done on the basis of risk–benefit balancing and normative standard-setting (*risk-informed regulation*). Traditional methods such as risk–risk comparison, cost-effectiveness and cost–benefit analysis are also well suited to facilitate the overall judgement for placing the risk in the traffic-light model (acceptable, tolerable or intolerable). These instruments, if properly used, provide effective, efficient and fair solutions with regard to finding the best trade-off between opportunities and risks. The choice of instruments includes all of the classic options outlined in the previous paragraph.

It is, however, prudent to distinguish between *management strategies for handling the risk agent* (such as a chemical or a technology) and *those needed for the risk absorbing system* (such as a building, an organism or an ecosystem).

Addressing complex structures of risk agents requires methods for improving causal modelling and data-quality control. With respect to risk-absorbing systems, the emphasis is on the improvement of *robustness*[2] in responding to whatever the target is exposed to. Measures to improve robustness include inserting conservatisms or safety factors as an assurance against individual variation (normally a factor of 10 to 100 for occupational risk exposure and of 100 to 1000 for public risk exposure); introducing redundant and diverse safety devices to improve structures against multiple stress situations; reducing the susceptibility of the target organism (e.g. iodine tablets for radiation protection); establishing building codes and zoning laws to protect against natural hazards; and improving the organizational capability to initiate, enforce, monitor and revise management actions (high-reliability learning organizations).

3 *Risk problems due to high unresolved uncertainty.* If a high degree of uncertainty remains, risk management needs to incorporate hazard criteria (which are comparatively easy to determine), including aspects such as reversibility, persistence and ubiquity, and select management options empowering society to deal even with worst-case scenarios (such as containment of hazardous activities, close monitoring of risk-bearing activities, and securing reversibility of decisions in case risks turn out to be higher than expected). It seems prudent to take a *precautionary approach* when managing risks characterized by multiple and high uncertainties. Since unresolved uncertainty implies that the (true) dimensions of the risks are not (yet) known, one should pursue a cautious strategy that enables learning by restricted errors. The main management philosophy for this risk class is to allow small steps in implementation (containment approach) that enable risk managers to stop or even reverse the process as new knowledge is produced or the negative side effects become visible. The primary thrust of precaution is to avoid irreversibility (Klinke and Renn, 2002).[3]

With regard to risk-absorbing systems, the main objective is to make these systems resilient so that they can withstand or even tolerate surprises. In contrast to robustness, where potential threats are known in advance and the absorbing system needs to be prepared to face these threats, *resilience* is a protective strategy against unknown or highly uncertain hazards. Instruments for resilience include the strengthening of the immune system; diversification of the means for approaching identical or similar ends; reduction of overall catastrophic potential or vulnerability, even in the absence of a concrete threat; design of systems with flexible response options; and the improvement of conditions for emergency management and system adaptation. Robustness and resilience are closely linked, but they are not identical and require partially different types of actions and instruments.

4 *Risk problems due to interpretative and normative ambiguity.* If risk information is interpreted differently by different stakeholders in society (i.e. there are different viewpoints about the relevance, meaning and implications of factual explanations and predictions for deciding about the tolerability of a risk, as

well as management actions), and if the values and priorities of what should be protected or reduced are subject to intense controversy, risk management needs to address the causes for these conflicting views (von Winterfeldt and Edwards, 1984).

Genetically modified organisms for agricultural purposes may serve as an example to illustrate the intricacies related to ambiguity. Surveys on the subject demonstrate that people associate high concerns with the application of gene technology for social and moral reasons (Hampel and Renn, 2000). Whether the benefits to the economy balance the costs to society in terms of increased health risks was not mentioned as a major concern of the polled public. Instead, people disagreed about the social need for genetically modified food in Western economies, where abundance of conventional food is prevalent. They were worried about the loss of personal capacity to act when selecting and preparing food, about the long-term impacts of industrialized agriculture and the moral implications of tampering with nature (Sjöberg, 2000a). These concerns cannot be addressed by either scientific risk assessments or by determining the right balance between overprotection and underprotection. The risk issues in this debate focus on the differences between visions of the future, basic values and convictions, and the degree of confidence in human ability to control and direct its own technological destiny. These wider concerns, and the people who express them, must be included within the risk management process.

Risk managers should thus initiate a broader societal discourse to enable participative decision-making. These discursive measures are aimed at finding appropriate conflict-resolution mechanisms capable of reducing the ambiguity to a manageable number of options that can be further assessed and evaluated. The main effort of risk management is, hence, the organization of a suitable discourse, combined with the assurance that all stakeholders and public groups can question and critique the framing of the issue as well as each element of the entire risk chain.

The distinction between four classes of risk strategies according to risk characteristics should be regarded as a simple heuristic tool developed to assist all parties in designing appropriate risk management options. One may choose either a more risk-based management approach (guided by risk–benefit analysis or risk–risk comparisons), a more resilience-oriented approach (guided by precautionary measures such as ALARA, BACT, or containment strategies) or a more discourse-oriented approach (guided by risk communication and conflict-resolution measures as the best means of dealing with ambiguities). These three classes of management options are neither exclusive nor independent of each other. Rather, they help decision-makers to link management tools to specific overall purposes. I believe that distinctions of complexity, uncertainty and ambiguity serve this task very well. The choice of such management tools depends not only upon the three risk characteristics, but also upon the type of risk and the risk context.

Table 6.2 provides a summary of these four risk strategies and lists the instruments and tools that are most appropriate for each strategy. The list is not exhaustive and can be amended if required.

Managing interdependencies

In an interdependent world, the risks faced by any individual, company, region or country depend not only upon its own choices, but also upon those of others. Nor do these entities only face one risk at a time: they need to find strategies to deal with a series of interrelated risks that are often ill-defined or outside of their control. In the context of terrorism, the risks faced by any given airline, for example, are affected by lax security at other carriers or airports. There are myriad settings that demonstrate similar interdependencies, including many problems in computer and network security, corporate governance, investment in research, and vaccination. Because interdependence does not require proximity, the antecedents to catastrophes can be quite distinct and distant from the actual disaster, as in the case of the terrorist attacks on 9 September 2001, when security failures at Boston's Logan Airport led to crashes at the World Trade Center, the Pentagon and in rural Pennsylvania. The same was true in the case of the August 2003 power failures in the north-eastern US and Canada, when the initiating event occurred in Ohio, but the worst consequences were felt hundreds of kilometres away. Similarly, a disease in one region can readily spread to other areas with which it has contact, as was the case with the rapid spread of severe acute respiratory syndrome (SARS) from China to its trading partners.

The more interdependencies there are within a particular setting (whether a set of organizational units, companies, a geographical area, or a number of countries, etc.) and the more this setting's entities – or participants – decide not to invest in risk reduction while being able to contaminate other entities, the less incentive each potentially affected participant has to invest in protection. At the same time, however, each participant will be better off if all other participants invest in risk-reducing measures. In other words, weak links may lead to suboptimal behaviour by everyone.[4]

For situations in which participants are reluctant to adopt protective measures to reduce the chances of catastrophic losses due to the possibility of contamination from weak links in the system, a solution might be found in a public–private partnership. This is particularly true if the risks to be dealt with are associated with competing interpretations (ambiguities) regarding the type of cooperation required between different epistemic communities, as well as risk management agencies, in order to deal with varying knowledge and competing value claims. Public–private partnerships also provide an interesting alternative in cases where perceptions differ strongly and external effects are expected.

Table 6.2 *Risk characteristics and their implications for risk management*

Knowledge characterization	Management strategy	Appropriate instruments	Stakeholder participation
1 'Linear' risk problems	*Routine-based* (tolerability/acceptability judgement) (risk reduction)	→ Applying 'traditional' decision-making • Risk–benefit analysis • Risk–risk trade-offs • Trial and error • Technical standards • Economic incentives • Education, labelling and information • Voluntary agreements	Instrumental discourse
2 Complexity-induced risk problems	*Risk-informed* (risk agent and causal chain)	→ Characterizing the available evidence • Expert consensus-seeking tools: – Delphi or consensus conferencing – Meta-analysis – Scenario construction, etc. • Results fed into routine operation	Epistemic discourse
	Robustness-focused (risk-absorbing system)	→ Improving buffer capacity of risk target through: • Additional safety factors • Redundancy and diversity in designing safety devices • Improving coping capacity • Establishing high-reliability organizations	

3	Uncertainty-induced risk problems	*Precaution-based* (risk agent)	→ Using hazard characteristics such as persistence and ubiquity as proxies for risk estimates Tools include: • Containment • ALARA (as low as reasonably achievable) and ALARP (as low as reasonably practicable) • BACT (best available control technology), etc.	Reflective discourse
		Resilience-focused (risk-absorbing system)	→ Improving capability to cope with surprises • Diversity of means to accomplish desired benefits • Avoiding high vulnerability • Allowing for flexible responses • Preparedness for adaptation	
4	Ambiguity-induced risk problems	*Discourse-based*	→ Application of conflict-resolution methods for reaching consensus or tolerance for risk evaluation results and management option selection • Integration of stakeholder involvement in reaching closure • Emphasis on communication and social discourse	Participatory discourse

Source: adapted from IRGC, 2005, p47

One way of structuring such a partnership is to have government standards and regulations coupled with third-party inspections and insurance to enforce these measures. Such a management-based regulatory strategy will not only encourage the addressees of the regulation (often the corporate sector) to reduce their risks from, for example, accidents and disasters. Indeed, it shifts the locus of decision-making from the government regulatory authority to private companies, which are required to do their own planning as to how they will meet a set of standards or regulations (Coglianese and Lazer, 2003). This, in turn, can enable companies to choose those means and measures that are most fit for purpose within their specific environment and, eventually, may lead to a superior allocation of resources compared to more top-down forms of regulation. The combination of third-party inspections in conjunction with private insurance is, consequently, a powerful combination of public oversight and market mechanisms that can convince many companies of the advantages of implementing the necessary measures to make their plants safer and to encourage the remaining ones to comply with regulations in order to avoid being caught and prosecuted.

Highly interdependent risks that can lead to stochastic contamination of third parties pose a specific challenge for global risk management (i.e. the management of transboundary, international and ubiquitous risks). Due to the often particularly decentralized nature of decision-making in this area, a well-balanced mix of consensual (e.g. international agreements and standards, and gentlemen's agreements), coercive (e.g. government regulation) and incentive-based (e.g. emission certificates) strategies is necessary to deal with such risk problems. Again, these strategies can be best developed in close (international and transnational) cooperation between the public and the private sector.

Essay 6 *Designing Appropriate Risk Management Strategies*[5]

Introduction

The process of reducing risks to a level deemed acceptable by society, ensuring control, monitoring and public communication, is covered under the term 'risk management' (Zimmerman, 1986; Kolluru, 1995; Aven and Vinnem, 2007, pp2–3). The debate on how to evaluate and manage risks focuses on three major strategies: (Stirling, 1999; Klinke and Renn, 2001, 2002):

1 risk-informed approaches, including, numerical thresholds (quantitative safety goals, exposure limits, standards, etc.);
2 reduction activities derived from the application of the precautionary principle (examples include 'as low as reasonably achievable' (ALARA); best available control technology (BACT); containment in time and space; or constant monitoring of potential side effects); and
3 standards derived from discursive processes, such as roundtables, deliberative rule-making, mediation or citizen panels.

Past experience demonstrates that there is no simple recipe for evaluating and managing risks. In view of worldwide divergent preferences, variations in interests and values, and very few, if any, universally applicable moral principles, risks must be considered as heterogeneous phenomena that preclude standardized evaluation and handling. At the same time, however, risk management and policy would be overstrained if each risky activity required its own strategy of risk evaluation and management. What risk managers need is a concept for evaluation and management that, on the one hand, ensures integration of social diversity and multidisciplinary approaches, and allows for institutional routines and easy-to-implement protocols, on the other.

The main thesis in this essay is to offer a classification of risk management strategies designed according to the three main characteristics: complexity, uncertainty and ambiguity. These three characteristics imply four different cases:

1 the strategy for dealing with linear and routine risks;
2 the strategy for dealing with complex risks;
3 the strategy for dealing with uncertain risks;
4 the strategy for dealing with ambiguous risks.

In addition, one must include the preventive risk management strategy if an immediate and serious threat needs to be addressed (Renn et al, 2003). This essay, however, will focus on the four strategies that can be employed in risk management outside of crisis situations. These strategies include different concepts for selecting objectives, assessing and handling data, and finding the most appropriate procedure for balancing pros and cons. The following sections will deal with these approaches consecutively, using the major steps of decision-making and applying them to complex, uncertain and ambiguous phenomena.

Risk characteristics and their relevance for risk management

Risk decision-making encounters three specific challenges which must be addressed by any type of analytic–deliberative process: complexity, uncertainty and ambiguity (Klinke and Renn, 2002; IRGC, 2005):

1 *Complexity*. Complexity is introduced when the causal relationship forms a multifaceted web where many intervening factors interact to affect the outcome of an event or an activity (WBGU, 2000, pp194ff). Complexity requires sophisticated modelling, which often defies common-sense or intuitive reasoning. Yet, if resolved, it produces a high degree of confidence in the results.
2 *Uncertainty*. Uncertainty reduces the strength of confidence in the estimated cause-and-effect chain (Stirling, 1998; van Asselt, 2000). Risk-based decisions must consider more carefully the uncertainties that characterize both the benefits and the risks.
3 *Ambiguity*. Ambiguity arises when differences exist in how individual actors or stakeholders value some input or outcome of the system (IRGC, 2005). It is based on the question of what our knowledge about risks means for understanding the risk agent's effects on human health and the environment (interpretative ambiguity), and what kind of decisions or actions are justified once the risks and uncertainties are characterized (normative ambiguity). In risk governance, ambiguity plays an important role because plural knowledge and value input are difficult to reconcile, and overarching arguments that might lead to a consensus are hard to find (Harrison and Hoberg, 1994, pp6, 168ff; Horlick-Jones, 1998; Jasanoff, 1998).

Risks that do not rank high on complexity, uncertainty or ambiguity are called routine or linear risks. They are normally easy to assess and quantify, are well known to assessors and regulators, and can be managed by means of risk–benefit analysis, risk–risk comparisons or other traditional instruments of balancing pros and cons. Linear risks may also be large in scope; but they do not raise major controversies, nor do they harbour any unpleasant surprises.

Risks that rank high on complexity but low on uncertainty and ambiguity require more systematic expertise and a deliberative effort to bring different epistemic communities together for producing the most accurate picture of the complex relationships (see also van den Daele, 1992; Charnley, 2000, pp16f). It does not make much sense to incorporate public concerns, perceptions or any other social aspects within the function of resolving complexity, unless specific knowledge of these groups helps to untangle complexity. Complex phenomena demand almost equally complex methods of assessment. These methods can be offered by scientists and experts better than by anybody else. In terms of regulatory actions, quantitative safety goals and consistent use of cost-effectiveness methods are the appropriate tools to deal with complex risk problems that show little uncertainty and no ambiguity.

Risks that rank high on uncertainty but low on ambiguity require a different management approach. Certainty in knowledge is either not available or unattainable due to the nature of the hazard. Further knowledge acquisition may help to reduce uncertainty and, thus, move the risk back to the first stage of handling complexity. If, however, uncertainty cannot be reduced by additional knowledge, or if action is demanded before the necessary knowledge can be obtained, the routine management strategies for resolving complexity (i.e. risk–benefit analysis) would not suffice as the risks and/or the benefits are impossible to quantify in a reliable manner. Under these circumstances, risk managers have to rely upon resilience as the guiding principle for action (Wynne, 1992a; Collingridge, 1996; WBGU, 2000, pp176ff). Decisions based on uncertainty management require, therefore, more than input from risk specialists. They need to include stakeholder concerns, economic budgeting and social evaluations. The focal point here is to find the adequate and fair balance between the costs of being overcautious versus the costs of being not cautious enough (van den Daele, 2000, p215; IRGC, 2005). Since both costs are almost impossible to quantify due to remaining uncertainties, subjective judgements are inevitable. The trade-off ratios determine who will bear the costs – either in the form of additional damages by not being cautious enough or in the form of regulatory costs for being overcautious. It is obvious that those who bear either of the two costs are entitled to be the main negotiators for setting the necessary trade-offs. Management tools that would fit the resilience approach include containment in space and time (to make exposure reversible), constant monitoring, development of equi-functional replacements, and investments in diversity and flexibility (Klinke and Renn, 2001). Classic regulatory strategies such as the ALARA principle, BACT or state of technology are also elements of this strategy.

Risks that rank high on ambiguity (regardless of whether they are low or high on uncertainty) demand multiple trade-offs between conflicting values and objectives beyond a negotiated solution to treating uncertainty. Although scientific expertise is essential for understanding ambiguities, it cannot prescribe the value trade-offs to resolve them (van Asselt, 2000, pp165ff; Renn, 2004b; van den Hove, 2007). In addition, ambiguities cannot be resolved by increased efficiency, since the outcome in itself is controversial, not just the distribution of costs and benefits. For ambiguous risks, it is necessary to reflect the underlying values and world views and to reach an arrangement that all parties can approve or at least tolerate. Management tools in this strategy demand, in particular, communicative and participatory instruments, such as those described in Essays 9 and 10. The ultimate goal of risk regulation in the face of ambiguities is a consensus, or a compromise, between those who believe that the risk is worth taking (perhaps because of self-interest) and those who believe that the pending consequences do not justify the potential benefits of the risky activity or technology.

If ambiguity is the overriding element of the risk debate, discursive methods of deliberation and decision-making are an absolute necessity in the risk management process. Ambiguity itself stems from the psychological mechanisms of risk perception, from real or perceived inequities and unfairness in the distribution of risks and benefits, and from political and social associations linked to the risk, the risk source or the risk-taking circumstances. Often ambiguity goes hand in hand with high uncertainty, complexity or both. When these risk characteristics exist in concert, discursive management strategies must be combined with risk-based and resilience-based strategies.

Table 6.3 provides a summary of the three management strategies and the corresponding instruments. Complex risks require sophisticated methods for assessing and regulating risks. Conflicts arise as a result of cognitive disputes over models and rationales for selecting effective, as well as efficient, risk reduction measures. Dealing with uncertainty involves two objectives: providing resilient strategies to be prepared for surprises and finding an adequate and fair balance between assumed overprotection and underprotection. Ambiguities reflect value conflicts which need reconciling in consensus-seeking exercises.

The following sections deal with these approaches consecutively, highlighting the following elements:

- *Setting the objectives:* how are the risk reduction goals determined? What is the most suited process to develop and define criteria for risk management?

Table 6.3 *Risk management challenges and corresponding strategies*

Challenge	Objective	Function	Strategies	Instruments
Complexity	Effective, efficient and adequate protection	Agreement on causal relations and effective measures	Reducing damage potential; limiting overall risk level	Standards, risk–risk comparisons, cost effectiveness, risk–benefit analysis
Uncertainty	Resilience	Avoiding what is irreversible and vulnerable	Diversity and flexibility limiting range of effects	Containment in time and space; development of substitutes
	Efficient and fair distribution of burden(s)	Balancing of underprotection versus costs of overprotection facing uncertain outcomes	Trade-off analysis	Negotiated rule-making; mediation; roundtables
Ambiguity	Socially acceptable development path	Resolving value conflicts and ensuring fair treatment of concerns and visions	Consensus-seeking discourse	Stakeholder dialogues; citizen panels, consensus conferences

Source: Ortwin Renn

- *Collecting data:* what is the main method or instrument to gather information necessary for prudent risk management? How can further data collection help risk managers to design management options?
- *Choice of options:* what are the main options from which a risk manager can choose? Which options best fit a given risk situation?
- *Weighing and balancing pros and cons*: how can risk managers make a selection among different risk management options? How can regulatory impact assessments be performed?
- *Deliberative requirements:* when and to what end should stakeholders or the public be invited to assist in designing and selecting management options? What deliberative instruments are best suited for what purpose?

STRATEGY 1: HANDLING LINEAR (ROUTINE) RISKS

Setting the objectives

Societies have been used to dealing with many ordinary risks. Some of them, such as driving a car, are quite serious compared to other contested human activities; others are rather negligible compared to many of the perils that humans face in their daily life (such as riding a bicycle). These ordinary risks all have one element in common: statistical analysis provides sufficient and reliable data about the probability of harm associated with them. There is little uncertainty about both the maximum extent of damage, as well as the probability distribution of the various damage categories. There is no, or hardly any, uncertainty about potential side effects, as well as the expected damage over time. For this risk category, the role of the risk manager is straightforward: to make sure that the risk does not exceed a specific threshold of potential damage that society has determined as intolerable by means of political or public deliberation.

Data collection

Assessing consequences describes the *results of actions* and the course of events. In routine risk situations, such assessment of consequences takes place by splitting primary objectives into sub-objectives and assigning scales to attributes (Keeney and Raiffa, 1976, pp39ff). In scientific terms, a set of consequences $K = (K_1,\ldots,K_j)$ is to be determined further with regard to achieving the formulated objectives of the set $Z = (Z_1,\ldots,Z_n)$. To each objective Z_i, an adequate attribute x_i is assigned, for which a measuring scale already exists, or for which a scale can be constructed. The values y_i denote the degree of achievement of Z_i shown on the scale with regard to a certain consequence.

Choice of options

When risk managers are faced with linear risks, they can choose from a wide variety of regulatory options including performance standards, technical standards, subsidies, compensation schemes and informative options (see introduction to Chapter 6 for full list). All of these options can be used individually or in combination to accomplish even more effective risk reduction. Options for risk reduction can be initiated by private and public actors, or both together. Each of the options will have desired and unintended consequences which relate to the risks that they are supposed to reduce. In most instances, a regulatory impact assessment should be conducted according to the following criteria:

- *Effectiveness:* does the option achieve the desired effect?
- *Efficiency:* does the option achieve the desired effect with the least resource consumption?
- *Minimization of external side effects:* does the option infringe upon other valuable goods, benefits or services, such as competitiveness, public health, environmental quality, social cohesion, etc.? Does it impair the efficiency and acceptance of the governance system itself?
- *Sustainability:* does the option contribute to the overall goal of sustainability? Does it assist in sustaining vital ecological functions, economic prosperity and social cohesion?
- *Fairness:* does the option burden the subjects of regulation in a fair and equitable manner?
- *Political and legal implementation:* is the option compatible with legal requirements and political programmes?
- *Ethical acceptability:* is the option morally acceptable?
- *Public acceptance:* will the option be accepted by those individuals who are affected by it? Are there cultural preferences or symbolic connotations that have a strong influence on how the risks are perceived?

Risk managers are well advised to place most weight on effectiveness and efficiency when dealing with linear risks.

Weighing and balancing pros and cons

The next step in designing the best management option to deal with risks is the comparison of costs and benefits or of risks and opportunities. Among the formal balancing procedures that serve as tools in the balancing process, *risk–risk comparisons* (r–r comparisons), cost-effectiveness procedures and cost–benefit analyses are the most suited instruments to perform the necessary balance. All three formal instruments can be of assistance in weighing pros and cons under the condition that there is little complexity, uncertainty and ambiguity.

Deliberation requirements

Routine risk management can be performed by the staff of the respective agency. This management relies, however, on a legal and legitimate rule of acceptable or tolerable risk expressed in either numerical terms (safety goals) or some qualitative specification. If such a goal is missing or contested, a broad new discourse is required to provide a new yardstick or a revised rationale for judging the tolerability of risks in general. We refer to such a broad discourse as the design discourse in Essay 10.

After these broad safety goals are established, risk managers do not need to deal with complexity, uncertainty and ambiguity; but still need a rule for placing the routine risks in one of the three categories (acceptable, need for reduction or intolerable). Once that decision has been taken the major task of risk management is to find the most cost-effective method of reducing the risk until it reaches the tolerable green zone. This task may require intensive interactions with experts and practitioners from the agency, as well as directly involved groups such as representatives from industry, the unions or consumer associations. We have given this type of deliberation the title '*instrumental discourse*'. The objective of this discourse is to make sure that among the options for reaching the prescribed safety level, the most efficient are selected and implemented.

Strategy 2: Handling complex risks

Setting the objectives

Many contemporary risks pose complex problems of linking effects to specific causes and causal pathways. Within our scheme of risk classification, these risks demonstrate high complexity; but they can, in principle, be characterized and numerically assessed with a high degree of reliability. The main challenge here lies in the second step: the collection of data with respect to the potential outcomes of the various risk reduction measures.

Data collection

Assessing consequences denotes the results of actions and courses of events. For linear risks, such assessment of consequences takes place in an undifferentiated way. Statistical analyses are all that risk managers may need. If complexity prevails with regard to the nature and the extent of possible consequences and a high degree of interdependence among the consequences, it is often not possible to measure the consequences by inter-subjectively established measurement procedures. In these cases, it is often necessary to fall back on the collective experience of experts. A number of procedures have been suggested in the literature (Winkler, 1968; Raiffa, 1973, pp274ff; Keeney and Raiffa, 1976, pp599ff; Bacow and Wheeler, 1984, pp76ff). In coping with high complexity, I recommend using Delphi and Delphi-like approaches to resolve potential cognitive conflicts (see Essay 10 in this volume). In addition, I believe that models which combine both expertise and laypeople's perspectives (such as consensus conferencing) are promising, although the potential merits and shortcomings of such joint approaches are still contested (Marris and Joly, 1999; overview in Rowe and Frewer, 2000; see Essay 9 in this volume).

Choice of options

When risk managers are faced with complex risks, they can choose from the same set of options recommended for linear risks. The main problem with complex risk is obtaining the best information to resolve complexity in a scientific and reliable way. Once this knowledge is assessed and evaluated, the familiar methods of risk reduction can be employed. Since high complexity demands robust risk reduction measures, it is prudent to add additional safety margins to technical or health-related standards and to prescribe strict monitoring procedures. A strict liability regime, alongside compulsory insurance for those generating the risk, may provide an additional incentive to reduce disaster potential and to prevent unwelcome surprises. Such measures encourage operators to improve their knowledge and to reduce remaining uncertainties.

Complex risks tend to be large in scale (see the description of Damocles risks in Essay 5). Since it is the high damage potential that triggers concern, risk managers should concentrate their efforts on reducing disaster potential. While this may seem obvious, it has not always been the course of action selected by managers and policy-makers. For example, during the past, the primary risk management strategy of the nuclear energy industry was to reduce the probability of a core meltdown. However, a much more useful approach would have been to design nuclear reactors that have a lower catastrophic potential in case anything goes wrong and a core meltdown actually takes place. Fortunately, the nuclear industry has realized this: in more recent years, it has pursued a strategy of reducing catastrophic potential when developing and designing new reactor types.

Weighing and balancing pros and cons

In this step, there is little difference between linear and complex risk situations once the risk has been adequately assessed. High complexity refers to the cognitive component of risks that provide specific constraints and challenges for data collection and interpretation. Once these conflicts are resolved and reliable data are collected, the risk profile will include many impact categories that can be assessed financially (and then fed into a cost–benefit analysis) or submitted to risk–risk comparisons or cost-effectiveness studies.

Deliberation requirements

Resolving complexity requires deliberation among experts. We have given this type of deliberation the title '*epistemic discourse*' (see Essay 10 in this volume; Renn, 1999c). Within an epistemic discourse, experts (not necessarily scientists) argue over the factual assessment with regard to the causal chain between the initial event and its final consequences. The objective of such a discourse is the most adequate description or explanation of a phenomenon (e.g. the question: which physical impacts are to be expected as a result of the emission of specific substances?). The goal is to achieve a homogeneous and consistent definition and explanation of the phenomenon in question, as well as a clarification of dissenting views. The discourse produces a profile of the risk in question on the selected criteria.

An epistemic discourse may reveal that there is more uncertainty and ambiguity hidden in the case than the initial appraisers had anticipated. If the epistemic discourse includes natural as well as social scientists, future controversies and risk debates may also be anticipated. Risk controversies would be less of a surprise. Suitable deliberative instruments for resolving complexity are meta-analytic workshops; group Delphi; and (scientific) consensus conferences or similar expert-focused workshop methods (see overview in Essays 9 and 10).

STRATEGY 3: HANDLING UNCERTAIN RISKS

Objectives

Dealing with uncertainty makes it more difficult to define the objectives for risk management. There is no clear consensus among the constituents on which targets to include and which to omit. As soon as uncertainty and, in particular, ignorance enters the field of risk analysis, actions to cope with risk are not confined to the single goal of risk minimization, but include other objectives, such as equity, fairness, flexibility or resilience (Vlek, 1996). As a consequence of this expansion of objectives, there have been numerous proposals to change the risk management perspective from minimizing or reducing risks to increasing resilience against the unforeseen as a more adequate means of coping with uncertainties. Rather than investing all efforts to become more knowledgeable about the different components of uncertainty, one can try to develop better ways of living or coexisting with uncertainties. The new key-words here are resilience, vulnerability management, flexible response strategies and similar concepts (Collingridge, 1996; WBGU, 2000, pp284ff). Increasing resilience is also the main motivation for the *precautionary principle*. The European Commission, in its 2000 communication paper on precaution (European Commission, 2000) determined that European environmental policy should be based on the precautionary principle, as stated in Article 174(2) of the European Commission Treaty Establishing the European Community (European Commission, 2002b). In the European context, precaution means that regulatory actions may be taken in situations where potentially hazardous agents might induce harm to humans or the environment, even if conclusive evidence about the potential harmful effects is not (yet) available (see Essay 3). According to the precautionary approach, risk management is driven by making the social system more adaptive to surprises and, at the same time, allows only those human activities or interventions that can be managed even in extreme situations (regardless of the probability of such extremes occurring).

Suitable means for improving the resilience of systems include (Klinke and Renn, 2001):

- additional safety factors (to be on the safe side if impacts are more negative than expected);
- diversity (several equi-functional systems based on different principles);
- flexibility (providing possibilities for reversing a decision once unforeseen negative impacts become visible);

- technical redundancy (doubling or tripling decisive safety provisions) in designing protective measures, whether technical, organizational or financial.

These aspects certainly increase the overall cost of management options and lead to suboptimal solutions when traditional cost–benefit analysis is applied. However, these additional costs may be worthwhile if it is anticipated that the risks will occur more frequently or more intensely than originally envisioned.

Data collection

Data collection on consequences that are uncertain demands the inclusion of probabilistic reasoning. Calculating probabilities for different consequences is then easy if there is enough data from the past, and if, moreover, the external conditions under which the cause–effect relations inherent in the data remain largely stable. In connection with highly uncertain risks, however, there is often a lack of historical data. Frequently, data are of an unacceptable quality or are not representative of future events. In these cases, one has to fall back upon *subjective probabilities* (von Winterfeldt and Edwards, 1986, p93). Subjective probabilities are not to be regarded as pure speculation, but as another form of empirically derived insights. Due to the experience with similar systems or their familiarity with the system components, experts are able to make such estimations better than others (Winkler, 1968). This applies to the issues of technical uncertainties. Nevertheless, when ignorance is likely to dominate the picture, or the uncertainties also cover costs and social impacts, technical experts are less suited and certainly not legitimized to feed in their probability judgements. In this case, stakeholders should be involved in the assessment process.

If uncertainties cannot be resolved through scientific experiments, modelling or simulation, and subjective probabilities are of little validity, proxy criteria can be used for judging the potential for harm. The proxy variables employed will refer to the nature of the hazardous characteristics of the risk in question. These could include ubiquity, bio-accumulation, potential for misuse, and high disaster potential, among others. They have one characteristic in common: they can be assessed scientifically and quantified with a level of precision similar to that of risk assessment. This approach has a clear advantage. Evaluation criteria, such as coherence, consistency, proportionality, accountability and predictability, can be met without giving up the intention of precaution (i.e. to err on the safe side). An example of such an analysis based on hazard characterization is the Pandora risk filter developed by the Swiss chemist Ulrich Müller-Herold and his team (Müller-Herold, 1996; Müller-Herold and Nickel, 2000, Müller-Herold et al, 2005) This risk filter classifies substances according to their global threat potential by measuring two parameters: spatial range and persistence.

Choice of options

When risk managers are faced with uncertain risks, it is necessary to go beyond the list of options mentioned above. First priorities for the systemic risk manager must be the application of measures of resilience and the development of substitutes. What are the options for managing risks on the basis of precaution, and what are the most suitable instruments for dealing with highly uncertain and unforeseen risks? The rule of precaution against the unknown effects of risks is applied according to two different principles (Klinke and Renn, 2001):

1 *The principle of the lowest possible emission (ALARA).* According to this principle, each emission has to be reduced as much as possible, with the limit of the highest reduction cost that is still justifiable from an economic and social viewpoint.
2 *The state of technology or the implementation of the best available control technology (BACT).* According to this principle, every emission that could be avoided with a tried and tested retention technology available on the market has to be avoided.

The application of both principles easily leads in purely economic terms to suboptimal solutions since expenses and benefits are not systematically compared with each other (Rowe, 1979, pp330ff). The application of ALARA and BACT makes sense only if one of the three following preconditions is met (similar list in Fritzsche, 1986, pp72ff):

1 The effects of the respective risks are not (or are only very little) known; but it has to be suspected that harmful effects will occur in the long run.
2 The expenditure for retention of pollutants varies considerably, depending upon the situation, so that with the ALARA principle one can react flexibly (i.e. take the expense of reduction into account). Nevertheless, the determination of what is reasonably justifiable has to be based on a systematic weighing of impacts.
3 The demand for the best available control technology is made in addition to the setting of (health-based) standards in order to reduce pollutants even if this does not seem to be absolutely necessary with regard to their effects, but is technologically and financially acceptable.

During recent years, risk analysts have tried to develop new tools and methods for enhancing resilience and decreasing vulnerability. Management tools that would fit the resilience approach include the following (Bennet, 2000; Klinke and Renn, 2002):

- containment of the hazard in space and time;
- constant monitoring of potential side effects;
- development of functional equivalents with less persistent or ubiquitous consequences;
- promotion of diversity and flexibility;
- capacity-building for organizational competence;
- construction of high-reliability organizations for handling uncertain risks; and
- introduction of strict liability.

On the preventive side, the main focus should be on imposing liability. Its effect is enhanced if the risks in question are insurable because insurance companies will set up expert groups to assess the risks and will arrive at insurance prices that reflect their appraisals. A follow-on outcome is the acceleration of risk-reducing knowledge production: insurer and insured alike will conduct risk research in their own best interests in order to limit the scope and probability of losses.

Weighing and balancing pros and cons

The procedures discussed above on linear or complex risks use the projected consequences of an action as the main criteria for assessing desirability. Such a method is no longer possible if one knows little about the effects of an action under discussion, or if there is so much uncertainty that one does not undertake an assessment of the action. In these circumstances, traditional cost–benefit analysis does little good because such an analysis requires at least reliable expected values for both the expected benefits and the risks. If such estimates are not available, alternative decision rules may be appropriate, including the minimax rule (minimize the maximum conceivable damage) or continuing with a close monitoring programme, in conjunction with the management tool of containment in time and space. The most important objective for dealing with uncertain risks is the avoidance of irreversible commitments. If all eggs are placed in one basket and the basket turns out to be structurally too weak to sustain the eggs, we will lose all eggs at once. Similarly, if a vital service to human society is performed by one or a few technologies or activities with uncertain or unknown risks, the damage will not only be widespread: if the risks materialize, the damage will also be pervasive for a long time since no alternatives are in place.

Another way of reaching closure is to establish safe corridors or 'guard rails' that should not be overstepped or trespassed (WBGU, 2000, pp55ff). An international consensus, however, has rarely been achieved for guard rails for further development and risk-taking, and even the climate change regime is far from being universally accepted. Efforts to formulate and enforce a stringent international guard rail programme and to specifically target the systems are hampered by problems such as limited knowledge of the future consequences of today's actions, different national interests and perceptions, and society's limited capacity to control complex economic and social systems.

Deliberation requirements

The main purpose of a deliberative process for dealing with high uncertainty and ignorance is the assessment of trade-offs between the competing extremes of overprotection and underprotection. We have coined this type of deliberation *'reflective discourse'* (see Essay 9 in this volume; Renn, 1999c). Reflective discourses are primarily appropriate as a means of deciding on risk-averse or risk-prone approaches to innovations. This discourse provides answers to the question of how much uncertainty one is willing to accept for some future opportunity. Is taking the risk worth the potential benefit? The question of how safe is safe enough is replaced by the question of how much uncertainty and ignorance one is willing to accept for some given benefit. It is recommended that policy-makers, representatives of major stakeholder groups and scientists take part in this type of discourse. Political or economic advising committees, which propose or evaluate political options, could also be established to advise this core group. Suitable instruments for such a reflective discourse include stakeholder dialogues, roundtables, negotiated rule-making, mediation, arbitration and other consensus-oriented group decision-making processes (Fiorino, 1995; see Essays 9 and 10).

STRATEGY 4: HANDLING AMBIGUOUS RISKS

Setting objectives

While, so far, the analysis in this essay has assumed *a single decision-maker*, *plural group decisions* with multiple values and visions need to be considered because ambiguity implies multiple perspectives, values and preferences. The purpose of resolving ambiguity is to make a collective consensus possible by finding all chances of consensus, even if they are only latent.

Finding a consensus refers to two aspects: consensus on procedures and consensus on contents (Pinkau and Renn, 1998). A *procedural consensus* is given if all parties agree on a regulation about the method of reaching a decision on some issue – for example, if they (consensually) accept a decision based on majority rule. The procedures for collecting or interpreting data, too, can also be clarified consensually. Thus, the various parties may agree on the method of ascertaining relevant data on the type of risk and its severity, or agree on which groups of scientists should be put in charge of which task.

A *consensus on contents*, on the other hand, requires that all parties unanimously agree on a certain option. Although a consensus on contents comes closest to the ideal of an aggregated Pareto-optimal utility increase, such a consensus is difficult to reach, in practice, because each party can claim a right to veto. Since such a right to veto often leads to an inability to decide, it is often in the interest of the parties to voluntarily constrain the principle of consensus on contents by means of a procedural consensus. This is to be expected, in particular, if group members assign a higher preference to maintaining the discourse or to the necessity of a decision than to emphasizing their individual point (Bacow and Wheeler, 1984, pp21ff).

Finding the appropriate objectives is therefore a crucial task of dealing with ambiguity (Eisenführ and Weber, 1986; Yosie and Herbst, 1998a; Jungermann et al, 2005). Each member of the group will try to include all objectives that seem to serve their interests and exclude those that might jeopardize their position. How can one deal with this problem? One possibility of dealing with this issue and constructing a set of applicable and legitimate objectives is to perform a formal value tree analysis (Keeney et al, 1984, 1987; Renn, 1999d; see Essay 10 in this volume). Value trees represent systematic lists of hierarchically ordered objectives that are generated through an iterative interview process between the decision analyst and each member of the decision-making group.

Data collection

In spite of the problem of ambiguity in selecting evaluative criteria, selecting the indicators and measuring the impacts of each decision option on each objective should be done by experts rather than stakeholders or members of the public. The experts need to represent different viewpoints, disciplines and social environments. Nevertheless, they should have the 'formal' expertise in their respective field to transform normative concepts in attributes, indicators and scales (qualitatively and quantitatively). One should consider these expert teams as providing a service to the decision-makers rather than being co-designers of the decision itself. In highly ambiguous cases, experts should be selected by a consensus decision of the decision-making group itself. This adds legitimacy to the transformation process (US EPA/SAB, 2001).

The experts may use novel methods such as Delphi or consensus conferencing to perform their specific task. The goal of this method is to characterize the complexity, the remaining uncertainties and the ambiguities and to link each option with a multi-attribute profile of likely impacts on each objective that was found relevant during the group deliberations (see Essay 10).

Choice of options

The main task of resolving ambiguities is to find regulatory options that are acceptable for most of the stakeholders involved. The most appropriate way of generating such options is to search for win–win strategies that provide net benefits to all parties (Fisher and Ury, 1981). If such options are not available, compensation methods may be necessary to make those parties that will suffer under the regulation better off. One possibility is to pay subsidies to potential risk victims for insurance or recovery. An alternative approach would be to use a deliberative model inspired by the vision of common good (Webler, 1995). This body could look for options that may violate the interests of some parties, but will enhance the common good. Acceptance of such a 'noble' solution depends upon the willingness of all parties to commit themselves to common values and to the attractiveness of common good orientation in the respective culture or subculture.

Weighing and balancing pros and cons

Special instruments have been developed for reaching a consensus in group decisions. Many of them are based on decision–analytic procedures or game theoretical assumptions (Bacow and Wheeler, 1984; Keeney, 1988, 1992; Gregory, 2004). The main goal here is to divide the problem into single attributes and reach a consensus on each attribute before amalgamating all elements into one whole. This process can be facilitated or accelerated by techniques such as multi-attribute decision-making, meta-plan methods and the morphological box method (see Essay 10).

Deliberation requirements

How can one design effective and efficient models of negotiation that deal with conflicts of ambiguity? Similar to the other risk management strategies, a specific type of discourse is required for this purpose that we have called *participatory discourse* (Renn, 1999c; see Essay 9). Such a discourse is focused on resolving ambiguities and differences about values. Participatory discourses are mainly appropriate as a means of searching for solutions that are compatible with the interests and values of the people affected and of resolving conflicts among them. This discourse involves common procedures for weighting the criteria and a joint interpretation of the results. Issues of fairness and environmental justice, visions on future technological developments and societal change, and preferences about desirable lifestyles and community life play a major role in these debates (Webler, 1999). Among the most suitable instruments are (randomly selected) citizen panels or juries, voluntary advisory groups, consensus conferences and other participatory techniques in order to resolve ambiguities and value conflicts (Rowe and Frewer, 2000; see Essays 9 and 10 in this volume).

CONCLUSIONS

The main task of risk evaluation and management is to develop adequate tools for dealing with the problems of complexity, uncertainty and ambiguity. Based on these three major risk characteristics, we distinguished four strategies of risk management, which are to deal with:

1 linear (routine) risks;
2 complex risks;
3 uncertain risks;
4 ambiguous risks.

The first two strategies provide the baseline for generating, appraising and selecting risk management options. Once the probabilities and their corresponding damage potentials are calculated, risk managers are required to set priorities according to the severity of the risk, which may be operated as a linear combination of damage and probability or as a weighted combination. Risk managers may request better information or more insights into the risk assessment methods applied if complexity seems to play a major role. Furthermore, additional data input illustrating the treatment of variability and extrapolation methods may be necessary to design robust reduction options. Once that knowledge is clarified and qualified, risk reduction measures include technical standards, prescribed procedures, monetary incentives, labels and others. The central evaluation criteria for selecting the most appropriate options are effectiveness and efficiency.

If uncertainty plays a large role, particularly indeterminacy or lack of knowledge, the approach for linear or complex risk management is insufficient. Judging the relative severity of risks on the basis of uncertain parameters does not make much sense. Under these circumstances, management strategies belonging to the resilience strategy are required. Resilience is also the main target for the precautionary approach that has been the basis for much of the European environmental and health protection legislation and regulation. Resilient risk management is guided by the proposition that regulatory options should:

- reflect the established methods of scientific risk assessments;
- be consistent and discriminatory (avoiding arbitrary results) when it comes to prioritization; and
- at the same time, be specific with respect to precautionary measures, such as ALARA or BACT, or the strategy of containing risks in time and space.

This suggestion, however, entails a major problem: looking only to uncertainties does not provide risk managers with the means of setting priorities for risk reduction. Risks vary in their degree of remaining uncertainties. How can one judge the severity of a situation when the potential damage and its probability are unknown or contested? In this dilemma, we advise risk managers to use additional criteria of hazardousness, such as 'ubiquity', 'irreversibility' and 'pervasiveness over time', as proxies for judging severity.

Our approach also distinguishes clearly between uncertainty and ambiguity. Uncertainty refers to a situation of being unclear about factual statements; ambiguity to a situation of contested views about the desirability or severity of a given hazard. Uncertainty can be handled, in principle, by a consensus on how to proceed when uncertain benefits and risks are anticipated; ambiguity also involves multiple objectives and plural value groups. Ambiguity requires discursive procedures that may include legal deliberations, as well as novel participatory approaches. If ambiguities are associated with a risk problem, it is not enough to demonstrate that risk regulators are open to public concerns and address the issues that many people wish them to take care of. The process of risk evaluation itself and the choice of risk management options need to be open to public input and new forms of deliberation. My colleagues and I have recommended a tested set of deliberative processes that are, at least in principle, capable of resolving ambiguities in risk debates (Renn et al, 1995).

Deliberative processes are needed, however, for all three management types. Risk-based management relies on an epistemic format; resilience-based management relies on a reflective format; and ambiguity-based management relies on a participatory discourse format. These three types of discourse could also be combined to form an analytic–deliberative procedure for risk evaluation and management (see Essay 9 in this volume). We see the advantage of a deliberative style of regulation and management in a dynamic balance between procedure and outcome. The procedure should not have priority over the outcome, nor should the outcome have priority over the procedure. An intelligent combination of both can elaborate upon the required prerequisites of democratic deliberation and its substantial outcomes in order to enhance the legitimacy of political decisions about the appropriate and acceptable risk management options.

7

Risk Communication[1]

Effective communication has to be at the core of any successful activity to assess and manage risks. The field of risk communication initially developed as a means of investigating how expert assessments could be communicated to the public best, so that the tension between public perceptions and expert judgement could be bridged. In the course of time, this original objective of educating the public about risks has been modified and even reversed as the professional risk community realized that most members of the public refused to become 'educated' by the experts, but rather insisted on alternative positions and risk management practices being selected by the professional community in their attempt to reduce and manage the risks of modern technology (Plough and Krimsky, 1987).

In a thorough review of risk communication, William Leiss identified three phases in the evolution of risk communication practices (Leiss, 1996, pp85ff). The first phase of risk communication emphasized the necessity of conveying probabilistic thinking to the general public and to educate the laypersons to acknowledge and accept the risk management practices of the respective institutions. The most prominent instrument of risk communication in phase 1 was the application of risk comparisons. If anyone was willing to accept *x* fatalities as a result of voluntary activities, they should be obliged to accept another voluntary activity with less than *x* fatalities. However, this logic failed to convince audiences: people were unwilling to abstract from the context of risk-taking and the corresponding social conditions, and they also rejected the reliance on expected values as the only benchmarks for evaluating risks. When this attempt at communication failed, phase 2 was initiated. This emphasized persuasion and focused on public relations efforts to convince people that some of their behaviour was unacceptable (such as smoking and drinking) since it exposed them to high risk levels, whereas public worries and concerns about many technological and environmental risks (such as nuclear installations, liquid-gas tanks or food additives) were regarded as overcautious due to the absence of any significant risk level. This communication process resulted in some behavioural changes at the personal level: many people started to abandon unhealthy habits. However, it did not convince a majority of these people that the current risk management practices for most of the technological facilities and environmental risks were, indeed, the politically appropriate response to risk. The one-way communication process of conveying a message to the public in carefully crafted, persuasive language produced little effect. Most respondents were appalled by this approach or simply did not believe the message, regardless of how well it was packaged; as a result, phase 3 evolved. This current phase of risk communication stresses a two-way communication process in which it is not only the members of the public who are expected to engage in a social learning process, but the risk managers as well. The objective of this communication effort is to build up mutual trust by responding to the concerns of the public and relevant stakeholders. The ultimate goal of risk communication is to assist stakeholders in understanding the rationale of risk assessment results and risk management decisions, and to help them arrive at a balanced judgement that reflects the factual evidence about the matter at hand in relation to their own interests and values (OECD, 2002). Good practices in risk communication help stakeholders to make informed choices about matters of concern to them and to create mutual trust (Hance et al, 1988; Lundgren, 1994; Breakwell, 2007, pp130ff).

Risk communication is needed throughout the whole risk-handling chain, from the framing of the issue to the monitoring of risk management impacts. The precise form of communication needs to reflect the nature of the risks under consideration, their context and whether they arouse, or could arouse, societal concern. Communication has to be a means of ensuring that:

- those who are central to risk framing, risk appraisal or risk management understand what is happening, how they are to be involved, and, where appropriate, what their responsibilities are (internal risk communication); and
- others outside the immediate risk appraisal or risk management process are informed and engaged (external risk communication).

The first task of risk communication (i.e. facilitating an exchange of information among risk professionals) has often been underestimated in the literature. A close communication link between risk/concern assessors and risk managers, particularly in the phases of pre-assessment and tolerability/acceptability judgement, is crucial for improving overall governance (OECD, 2002). Similarly, cooperation among natural and social scientists, close teamwork between legal and technical staff, and continuous communication between policy-makers and scientists are all important prerequisites for enhancing risk management performance. This is particularly important for the initial screening phase where the allocation of risks is performed.

The second task – communicating risk appropriately to the outside world – is also a very challenging endeavour. Many representatives of stakeholder groups and, particularly, members of the affected and non-affected public are often unfamiliar with the approaches used to assess and manage risks and/or pursue a specific agenda, trying to promote their own viewpoints. They face difficulties when asked to differentiate between the potentially dangerous properties of a substance (hazards) and the risk estimates that depend upon both the properties of the substance, the exposure to humans and the scenario of its uses (Morgan et al, 1992). Also complicating communication is the fact that some risks are acute, with severe effects that are easy to recognize, whereas others exert adverse effects only weakly but over a long period of time. Yet other effects only start to show after an initial delay. Finally, it is no easy task to convey possible synergies of exposures to industrial substances with other factors that relate to lifestyle (e.g. nutrition, smoking or use of alcohol).

Effective communication, or its non-existence, has a major bearing on how well people are prepared to face and cope with risk. Limited knowledge of, and involvement in, the risk management process can lead to inappropriate behaviour in emergency or risk-bearing situations (e.g. when facing an impending flood or handling contaminated food or water). There is also the risk of failed communication: consumers or product users may misread or misunderstand risk warnings or labels so that, through ignorance, they expose themselves to a larger risk than necessary. This is particularly prevalent in countries with high rates of illiteracy and unfamiliarity with risk-related terms. Providing understandable information to help people cope with risks and disasters is, however, only one function of risk communication. Most risk communication analysts list four major functions (Morgan et al, 1992; OECD, 2002):

1 *Education and enlightenment:* inform the audience about risks and the handling of these risks, including risk and concern assessment and management.
2 *Risk training and inducement of behavioural changes:* help people to cope with risks and potential disasters.
3 *Creation of confidence in institutions responsible for the assessment and management of risk:* give people the assurance that the existing risk governance structures are capable of handling risks in an effective, efficient, fair and acceptable manner (such credibility is crucial in situations where there is a lack of personal experience and people depend upon neutral and disinterested information). It should be kept in mind, however, that trust cannot be produced or generated, but only accumulated by performance, and that it can be undermined by the lack of respect for people with critical views about the institution.
4 *Involvement in risk-related decisions and conflict resolution:* give stakeholders and representatives of the public the opportunity to participate in the risk appraisal and management efforts and/or be included in the resolution of conflicts about risks and appropriate risk management options.

Although risk communication implies a stronger role for risk professionals to provide information to the public rather than vice versa, it should be regarded as a mutual learning process in line with the requirements that Leiss (1996) postulated for phase 3. Concerns, perceptions and experiential knowledge of the targeted audience(s) should thus guide risk professionals in their selection of topics and subjects: it is not the task of the communicators to decide what people *need* to know, but to respond to the questions of what people *want* to know (for an explanation of the 'right to know' concept, see Baram, 1984). Risk communication requires professional performance both by risk and communication experts. Scientists, communication specialists and regulators are encouraged to take a much more prominent role in risk communication, because effective risk communication can make a strong contribution to the success of a comprehensive and responsible risk management programme.

Essay 7 *Basic Concepts and Challenges of Risk Communication*[2]

Introduction

The notion of risk preoccupies modern societies. The scale and potential impact of technological developments and the increased sensitivity to health and safety hazards have put risks and environmental quality among the top concerns of the US public, as well as of many other Western industrialized nations (Dunlap, 1991; Dunlap et al, 1992, 1993; Schultz, 2001; Eurobarometer, 2006).[3] This concern highlights, according to the German sociologist Ulrich Beck, a gradual change within the predominant social conflict in modernity (Beck, 1992b; 1995, 2000a). The primary conflict during the early 20th century focused on the distribution of wealth among different social groups; after the Second World War, and particularly during the 1960s, the focus changed to the distribution of power in politics and economics. In more recent times, the major conflict has been about the distribution and the tolerability of risks for different social groups, regions and future generations.

This shift of focus implies new forms of communication and collective decision-making between social groups and between regulators, industry, civil society and the public at large (Luhmann, 1989; Jungermann and Wiedemann, 1995; IRGC, 2005). In addition, the capability of societal institutions to tame powerful natural sources for economic purposes and to reduce the concomitant risks of potential side effects to human health and the natural environment depends largely upon effective communication among institutions and groups (Habermas, 1991a; Leiss, 1996; Jaeger et al, 2001, pp243ff), and the formation of specialized risk or danger cultures (Rip, 1991; Lash, 2000; van Loost, 2002).

Professionalization of risk analysis and institutionalization of risk communication are reinforced by the characteristics of risk phenomena in the political arena. The process of decision-making in most legal and political arenas traditionally relies on deterministic consequence analysis. Anticipating the most likely impacts of a decision and weighing the associated costs and benefits of different options, in terms of formal analysis or by 'bootstrapping' (Fischhoff et al, 1981), are often the preferred methods of policy-making. The questions of how to incorporate relative frequencies or probabilities within the decision process, how to cope with remaining uncertainties, and how to balance options with different compositions of magnitude and probability have not been adequately addressed and assimilated by agencies or risk management institutions that are asked to prepare, release, implement and control collectively binding decisions (US National Research Council, 1996; UK Department of Health, 1998; Zimmerman and Cantor, 2004). A variety of strategies to cope with this new challenge has evolved over time. They include technocratic decision-making through expert committees or ignoring probabilistic information altogether (Löfstedt, 2003, pp423ff). The incorporation of probability assessments within decision-making requires new rationales for evaluating policy options and necessitates a revision of institutional routines (Freudenburg, 1988).

In addition, public perception of probabilities and risks varies considerably from professional analysis (Slovic, 1987; Boholm, 1998; Rohrmann and Renn, 2000; Renn, 2004a; see Chapter 4 and Essay 4 on risk perception in this volume). Whereas experts usually give equal weight to probabilities and magnitude of a given risk, the intuitive risk perception reflects higher concern for low-probability/high-consequence risks (Covello, 1983; Covello et al, 1988; Drottz-Sjöberg, 2003, p16). Thus, risk communicators have to face the institutional problems of coping with the new challenge of stochastic reasoning and, at the same time, with the intrinsic conflict between the perspectives of the scientific community and the public in general (Rogers, 1999; Kahlor et al, 2004; Breakwell, 2007, p161). Both reasons justify the already established practice of highlighting risk communication in contrast to other forms of communication (Renn and Levine, 1991).

As a consequence of this prominence, the interest of public institutions and academia in risk communication has grown considerably during the last decades. Risk communication has become a popular topic in the literature (for overviews on the subject, see Chess et al, 1989; Covello et al, 1989; Leiss, 1989; US National Research Council, 1989; Lundgren, 1994; Gutteling and Wiegman, 1996; UK Inter-Departmental Liaison Group on Risk Assessment, 1998; Covello and Sandman, 2001; Löfstedt, 2001; Morgan et al, 2001; OECD, 2002; Drottz-Sjöberg, 2003; STARC, 2006; Breakwell, 2007, p130ff). Although originally conceptualized as a follow-up of risk perception studies, the work on risk communication has surpassed the limited boundaries of giving public relations advice for information programmes on risk, but extended its focus on the flow of information between subsystems of society (Kasperson, 1986, p275; Plough and Krimsky, 1987; Zimmerman, 1987, p131; Jasanoff, 1993; Fischhoff, 1995; Leiss, 1996; Löfstedt, 2003; OECD, 2003b).

This essay presents the major concepts of risk communication and explains some of the underlying theories based on research in the areas of communication, risk perception, persuasion and attitude change, and institutional trust. The focus will be on the traditional source–receiver model (Lasswell, 1948; Shannon and Weaver, 1949) and the concept of social amplification of risk (Kasperson et al, 1988, 2003; Kasperson, 1992). Based on these two approaches, the essay presents some implications for risk communicators and provides normative suggestions for improving risk communication. Although the risk communication literature includes an abundance of normative advice, only a few attempts have been made to put normative suggestions into the perspective of several theoretical concepts.[4]

Definition and objectives of risk communication

What is risk communication? The 1989 report on *Improving Risk Communication*, prepared by the Committee on Risk Perception and Communications of the US National Research Council, defined risk communication as:

> *... an interactive process of exchange of information and opinion among individuals, groups and institutions. It involves multiple messages about the nature of risk and other messages, not strictly about*

> *risk, that express concerns, opinions or reactions to risk messages or to legal and institutional arrangements for risk management.* (US National Research Council, 1989, p21).

Thus, risk communication fits into classic definitions of communication as a purposeful exchange of information between actors in society, based on shared meanings (DeFleur and Ball-Rokeach, 1982, p133; Keeney and von Winterfeldt, 1986). Purpose is required to distinguish messages from background noise in the communication channel. The term 'message' implies that the informer intends to expose the target audience to a system of meaningful signals, which, in turn, may change their perception of the issue or their image of the sender (Jaeger et al, 2001, pp129ff). Acoustic signals without any meaning do not constitute communication.

If one accepts the premise that risk communication implies an intentional transfer of information, one must specify what kind of intentions and goals are associated with most risk communication efforts. The literature offers different objectives for risk communication, usually centred on a risk management agency as the communicator and the public as target audience (Covello et al, 1986, p172; Zimmerman, 1987, pp131f; Kasperson and Palmlund, 1988; US National Research Council, 1989; Breakwell, 2007, pp155ff). For the purpose of this essay, objectives can be divided into four general categories (see similar classifications in Chess et al, 1988; Covello and Allen, 1988; Hance et al, 1988; Morgan et al, 1992; De Marchi, 1995; Mulligan et al, 1998; Sadar and Shull, 2000; Morgan et al, 2001; OECD, 2002; Löfstedt, 2003; Leiss, 2004):

1. Ensure that all receivers of the message are able to understand its content and enhance their knowledge about the risk in question (*enlightenment function*).
2. Establish a trustful relationship between the sender and the receiver of risk communication (*function of building up confidence in risk management*).
3. Persuade the receivers of the message to change their attitude or their behaviour with respect to a specific cause or class of risk that relates, for example, to workers' protection, smoking habit or nutritional information on food (*function of inducing risk reduction through communication*).
4. Provide the conditions for an effective stakeholder involvement on risk issues so that all affected parties can take part in a conflict-resolution process (*function of cooperative decision-making)*.

These functions require specific types or forms of risk communication. In general, four different forms of communication can be distinguished (Chess et al, 1989; Lundgren, 1994; Renn, 2006c):

1. *Documentation.* This serves transparency. In a democratic society it is absolutely essential that if the public cannot participate in the regulating process, people learn about the reasons why risk managers opted for one thing against another. Here it is of secondary importance whether this information can be intuitively grasped or understood by all. This situation is analogous to the information slips packaged with prescription drugs. Almost no one is able to understand them,

save a few medically trained people. Nevertheless, these slips have important messages for the average patient, too. They illustrate that no information is being withheld (Jungermann et al, 1988).

2 *Information.* Information serves to enlighten the communication partner. In contrast to documentation, information implies that the target group can grasp, realize and comprehend the meaning of the information.
3 *Two-way communication or mutual dialogue.* This form of communication is aimed at two-way learning. Here, the issue is not a one-way street of informing someone, but an exchange of arguments, experiences, impressions and judgements.
4 *Mutual decision-making and involvement.* In a pluralistic society, people expect to be adequately included, directly or indirectly, in decisions that concern their lives. The goal here is to ensure that the concerns of the stakeholders are represented in the decision-making process and that the interests and values of those who will later have to live with the risk effects will be taken up appropriately and integrated within the decision-making process.

Effective risk communication simultaneously implements all four forms of communication. These four forms meet the various needs of diverse publics. Furthermore, these forms can be linked to the four functions mentioned above. Information and dialogue are the most appropriate means of achieving enlightenment; documentation and dialogue (in a conflict situation facilitated by mutual decision-making) of building up trust and of reducing risk, resolving conflict and encouraging mutual decision-making.

The main sections of this essay deal with the first three functions: enlightenment, confidence-building and risk reduction by influencing behaviour. The fourth function of cooperative decision-making will be dealt with in Chapter 8 (see Essays 9 and 10) on stakeholder involvement and public participation. The following sections will introduce some theoretical background, present empirical results related to the discussed function, and articulate conclusions for risk communication.

The function of enlightenment: How to get a message across

The sender–receiver model

The traditional approach to studying and analysing risk communication is based on the communication model of information transfer among sources, transmitters and final receivers. Although the model was originally developed during the late 1940s (Lasswell, 1948; Shannon and Weaver, 1949), it is still the most prevalent framework for communication studies and has been recommended by risk managers (Thomas, 1987; Drottz-Sjöberg, 2003). In a comprehensive review of 31 communication textbooks, Shoemaker concluded that nearly half of the books used the Shannon and Weaver model (Shoemaker, 1987, p120; see also McQuail, 2000, pp10ff). Another approach was the transactional view that emphasizes the creation of shared meaning among senders and receivers. Both approaches can obviously be combined.

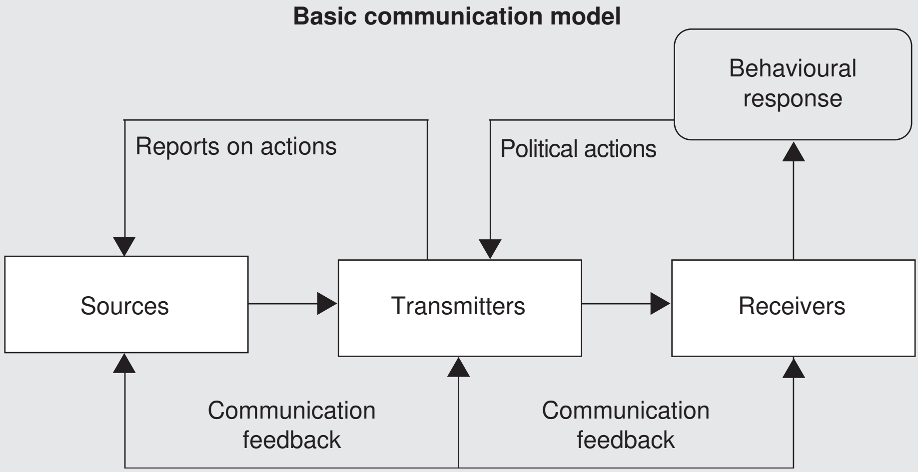

Figure 7.1 *Source–transmitter–receiver model*

Source: adapted from Renn, 1992a, p469

Figure 7.1 illustrates the classic sender–receiver model. A message is composed by the communication source and then sent to a transmitter. The transmitter decodes the message and recodes it for its target audience. The new message is then forwarded to the final receiver who decodes the message and deciphers its meaning. The receiver may respond to the message by sending out his or her own message either to the original sender or to other constituents. The receiver may also feel compelled to take direct action in response to the message(s) received. The original source may collect or process the receiver's responses. Feedback messages may pass through a transmitter station before they reach the original sender. The original messages and, even more so, the feedback messages are distorted with background noise when they are sent through several channels via transmitters and signal amplifiers (see Renn, 1991, for a detailed discussion of the signal-amplifying process).

The sender–receiver model has drawn fire for promoting a mechanistic understanding of communication and for emphasizing a one-way communication route (Otway and Wynne, 1989; Kasperson and Stallen, 1991). Yet, if the model is used only as a sequential illustration of the transfer of messages from one party to another, and if the roles of sources and receivers can be mutually exchanged, it can serve as a powerful tool in analysing the communication processes. It is a structuring tool to illustrate the communication process, and not an empirical model of how communication is factually organized in a society.

Figure 7.2 shows the major actors of risk communication as embedded within the classical communication model (McQuail, 2000, pp10ff). Sources for risk-related information are basically scientists or scientific institutions, public agencies such as the US Environmental Protection Agency (EPA), interest groups such as industries or environmentalists, and, in the case of hazardous events (physical changes caused by

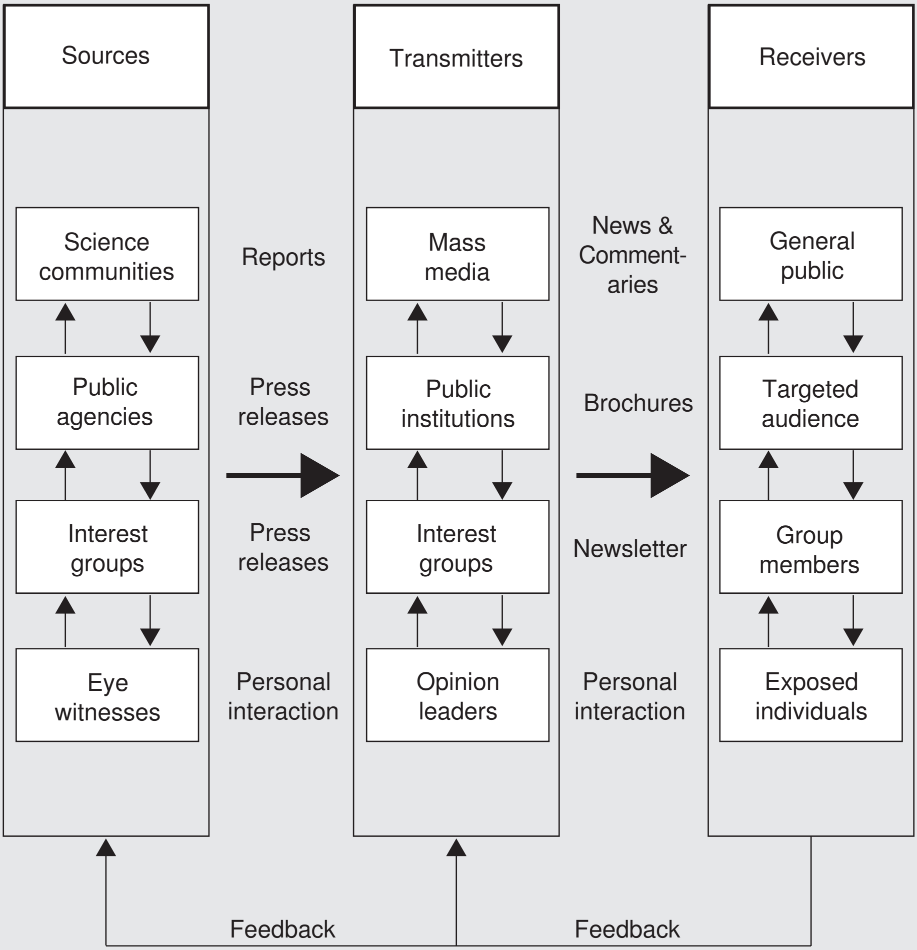

Figure 7.2 *Organizational structure of risk communication*

Source: adapted from Renn, 1992a, p470

hazardous activities), eyewitnesses. These primary sources code information in the form of reports, press releases or personal interviews and send them to transmitters or, occasionally directly, to the final receivers (Renn, 1988, pp101ff).

The second step of communication is the coding and recoding procedure at the transmitting stations. The media, other public institutions, interest groups and opinion leaders are potential transmitters for risk-related information. A press release from the EPA may stimulate industry to hold a press conference or to write an open letter to the agency. Interaction among social groups, particularly among adversaries, often takes place through the media and not via direct communication. The goal is to mobilize public support and to initiate public pressure (Peters, H. P., 1984, p304; Dunwoody, 1992; Wahlberg and Sjöberg, 1998).

The last step is the processing of the recoded messages at the receiver. Again, it is helpful to distinguish between different types of receivers. The media usually serve the general public; but many journals are targeted at specific audiences within the general public. Specialized journals tend to either appeal to professional standards (science communities, business circles, and risk assessors), leisure activities (culture, sports, travelling, etc.) or value groups (environmentalists, religious groups, political camps, etc.). The information will be framed for each audience in a different manner to ensure their attention and to meet their expectations.

The sources of messages

The first stage of communication is the framing of a message by an information source. As H. P. Peters and others have pointed out, topics can be brought and sustained on the public agenda only if the mass media report about the topic and a social institution or group adopts the topic as part of its own agenda (Peters, H. P., 1986, p9; Dunwoody and Peters, 1992).

Indoor radon is a good example. In spite of good relationships with the national press, Joel Nobel, a physician from Philadelphia, US, who detected a concentration of 55 pico-curies per litre (nearly 14 times the benchmark of 4 pico-curies per litre often regarded as a 'safe' level) in his private home in 1981, was unable to gain more than cursory attention by public institutions and the press because he could not interest an agency or social group to share his concern (Mazur, 1987b, p89). Not before the state of Pennsylvania, alarmed by another even more dramatic case in 1985, acknowledged the problem and initiated a state-wide survey programme, did the national press cover the topic at length and trigger the attention of federal agencies, such as the EPA (Fisher, 1987, pp27f; Mazur, 1987b, p90).

In addition to the social support that a message receives, the components of the message themselves play a vital role in the effectiveness of the communication effort. Among the most important elements are symbols and metaphors, which trigger the attention of potential receivers and shape the decoding process (Hovland, 1948, p371; Renn, 1991). If, for example, the information source is described as a group of Nobel laureates, the content of the message may well command public attention. Messages from such sources may successfully pass through the selection filters of the transmitters and receivers and be viewed as credible. A press release by the nuclear industry, by contrast, may command much less credibility unless other aspects of the message compensate for doubts about the impartiality of the source.

Sources or transmitters can amplify the different components of the message by taking advantage of the symbolic connotations. Assume that an industrial spokesperson provides the information that a specific chemical substance has been leaking from a waste repository for two years. One journalist may portray this incident by using phrases such as 'leak in waste disposal at a high-tech park' or 'state-of-the-art technology for monitoring emissions'. Another journalist may describe the same incident by using phrases such as 'air pollution by toxic waste dump' and 'poisoning the air we breathe and the water we drink'.

The following sections deal with each of the three major communication stations separately. The focus will be on the roles and functions of sources, transmitters and receivers in coping with risk information. The special circumstances of risk communication are illustrated in Figure 7.3, which serves as a basic guide for the verbal explanations in the following sections.

The primary sources of risk communication

Nature and technology are both sources of hazardous events, such as earthquakes, fires, explosions, pollution or radiation. Scientific analyses attempt to determine the physical impact of such events (accident analyses) or to hypothesize about the magnitude and the probability of potential impacts (risk analyses). Observation and analysis of actual events and simulation of potential events lead to an estimate of the magnitude of the impacts, the probability of their occurrence, and the distribution of these impacts over time, space and population subgroups (Rowe, 1977; Graham and Rhomberg, 1996). These estimates are coded in the language that the target group, usually other scientists or regulators, uses for communication.

In the risk field, as in many other scientific areas, mathematical expressions and jargon dominate the professional communication process. Such a specialized language is not – as many observers have speculated – a tool to keep outsiders from entering the elite community of scientists, but serves a valuable function by providing a common and precise meaning of all expressions used within the community (ILGRA, 1998; Dunwoody, 1999). The inner scientific communication process is usually not meant to convey information to the public, but to transmit messages to peers. However, in a plural society, such messages are screened by public interest groups and professional transmitters for 'hidden' messages (Peters, H. P., 1995; Löfstedt, 2003). One of the consequences of this mismatch between intention and availability is the wariness of experts to share information with non-scientists and the distrust of many public groups towards the scientific community (Lipset and Schneider, 1983; Breakwell, 2007, p158).

In addition to the problem of shared meaning of messages between an expert community and outside observers, the communication process is further complicated by the difference in assigning importance to various events or disparate information. Each physical event is a source for millions of signals that an observer can collect and process. The collection, however, is necessarily selective and subjective. If there are two witnesses to the same event, such as a car accident, seldom do their reports match. The selection of what types of signals are collected from a physical event or are created by a hypothetical simulation of hazardous events involves individual or group judgements about relative importance. The scientific convention to restrict one's attention to probabilities and magnitude reflects a special strategy (i.e. to abstract and deduce the typical and universal characteristics from a unique event as a means of comparing this event with other similar events or designing measures for reducing the risk of future similar events).

Scientific risk assessment constitutes a deliberate selection of signals that, based on past experience, provide information about the relative potential of hazardous events to produce adverse effects. Events such as earthquakes or chemical spills are scanned for signals that provide the data to construct probability distributions of adverse effects. Other signals about human sufferings, responsibility for the disaster,

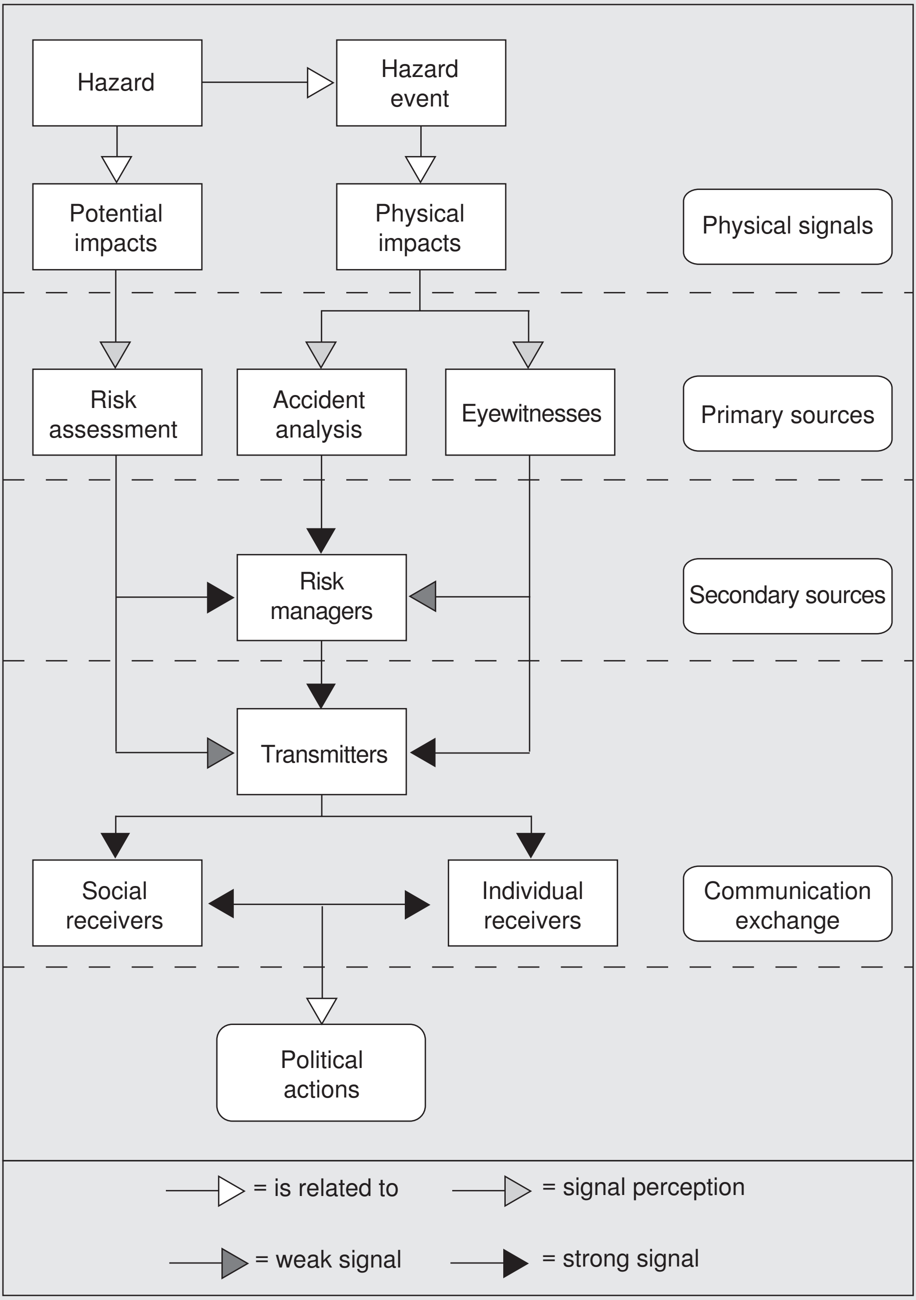

Figure 7.3 *Signal flow model for risk communication*

Source: adapted from Renn, 1992a, p472 inequities in the experience of risk and political implications are deliberately excluded from the signal collection process (Dietz et al, 1989; Stern, 1991).

A parallel signal selection and transformation process of an event occurs in the perception of direct eyewitnesses or affected persons. These individuals produce anecdotal evidence of the hazardous event (Keeney and von Winterfeldt, 1986). This evidence is coded in another language consisting of elements with a different signal value. Here, one encounters expressions of personal anxieties and fear, courage and heroism of individuals, anger and blame, compassion and charity. Anecdotal evidence competes with the systematic and abstract evidence provided by scientists. Both forms of evidence stem from the identical physical phenomena, but they differ in the selection of signals from that event and their mental processing. The language used by both groups to describe the event and its consequences are reflections of different clusters of shared meaning (Rayner, 1990; Horlick-Jones, 1998; Jasanoff, 1999). These reflections are governed by cultural norms and values that characterize the self-image and world view of different groups or society as a whole (Rayner, 1992). The search for human involvement, whether in the form of exceptionally brave behaviour or blame for the culprits, characterizes the common cultural sensitivity of contemporary Western societies for an activist perspective. This world view implies that human interventions are capable of preventing, mitigating or aggravating any type of disaster. Other cultures or predecessors of modern Western cultures have perceived disaster frequently as signs of inevitable fate or God's punishment and have searched accordingly for signs of collective sins rather than individual faults (Douglas, 1966; Douglas and Wildavsky, 1982; Wiedemann, 1993).

The selection process is part of the cultural process of constructing reality. Social constructions harmonize the mental models of a person, group or culture about the world with the perceptions of the physical and communicative signals from the external world (Seiderberg, 1984; Bradbury, 1989; Hacking, 1999; Horlick-Jones, 2007). The deliberate, axiomatic nature of the selection rules holds true for the scientific community, as well as for any other social group. For example, the scientific convention of assigning equal weight to probability and magnitude in risk equations is a 'non-scientific' value judgement that cannot be deduced from purely logical reasoning or empirical evidence (Pinkau and Renn, 1998, pp173ff). Primary sources therefore collect and select signals from the physical world, recode them into verbal expressions, according to their mental models, and assign them different degrees of significance and, often, symbolic value. Some properties of the risk situation may evoke special attention, while others may easily be ignored or attenuated.

Social amplification of risk in message formation

The process of amplifying some signals of the physical event while attenuating others has been a major element of the metaphor of social amplification of risk (Kasperson et al, 1988, 2003; Renn, 1991; Kasperson, 1992; Renn et al, 1992; Kasperson and Kasperson, 1996; Sheehy et al, 2002; Breakwell, 2007, pp224ff; see also Essay 4). The concept rests on the thesis that events pertaining to hazards interact with psychological, social, institutional and cultural processes in ways that can intensify or attenuate individual and social perceptions of risk and shape behavioural responses. Behavioural responses, in turn, generate secondary social or economic consequences. These consequences extend far beyond direct harm to human health or the environment and may include significant indirect impacts, such as liability, insurance costs, loss of confidence in institutions, or alienation from community affairs. Integrating the communication model within the social amplification concept provides a useful insight into signal transformation (Breakwell and Barnett, 2002).

As a starting point, the transformation of physical signals into meaningful verbal expressions forms messages, which are then transmitted through various channels of communication by different societal actors who partially amplify or attenuate them during several transformation processes. The transformed and amplified messages initiate a specific incentive for social groups or individuals to take actions or modify behaviour. Individuals and social actors serve as amplification stations, which process and respond to the information in various ways. Attitudes may change, institutions may decide to redirect their efforts, political pressure may be exerted to imitate political changes, and the risk management system may be reformed. Ultimately, social actions result in changes in the social structure and the physical world. These secondary and tertiary effects of the amplification process can then result in technological and social change (Breakwell and Barnett, 2002). This change triggers off the development of new technologies, new control institutions and new risk policies. The cycle can start anew. This process is illustrated in Figure 7.4.

On the level of primary sources of communication, the selection of signals by at least two divergent groups – the scientists and the eyewitnesses – leads already to different routes of social amplification. Scientific conventions focus on the systematic aspects of risk. They help identify the typical elements of all covered risk situations, but may obscure the uniqueness of the specific event or hazard under consideration. Conversely, anecdotal evidence seems to centre on the uniqueness of the situation and the specific circumstances of the event and to neglect the typical patterns that characterize risk in general. One major problem of risk communication is, therefore, the integration of scientific and anecdotal evidence, a problem that is aggravated by the stochastic nature of risk (Renn and Levine, 1991; Mazur, 1994; Rogers, 1999).

The secondary sources of risk communication

Following the process of risk communication illustrated in Figures 7.3 and 7.4, the messages of the primary sources are sent to secondary sources – mainly risk managers, but also scientific institutions and special interest groups. These organizations are primarily interested in the scientific investigations focusing on dose–effect relationships and probabilities of adverse events. The main objectives of the concerned institutions are to forecast, analyse or manage the hazard. In this respect, they act on the basis of a similar mental model as the scientific community (Bostrom et al, 1992, 1994; Atman et al, 1994).

However, transmitters and the public are, in general, more interested in the specific circumstances of the one incident reported or the consequences of a single hazard event. The intention of the source to communicate the common lessons and to put the risk in perspective conflicts with the interest of the receiver to learn more

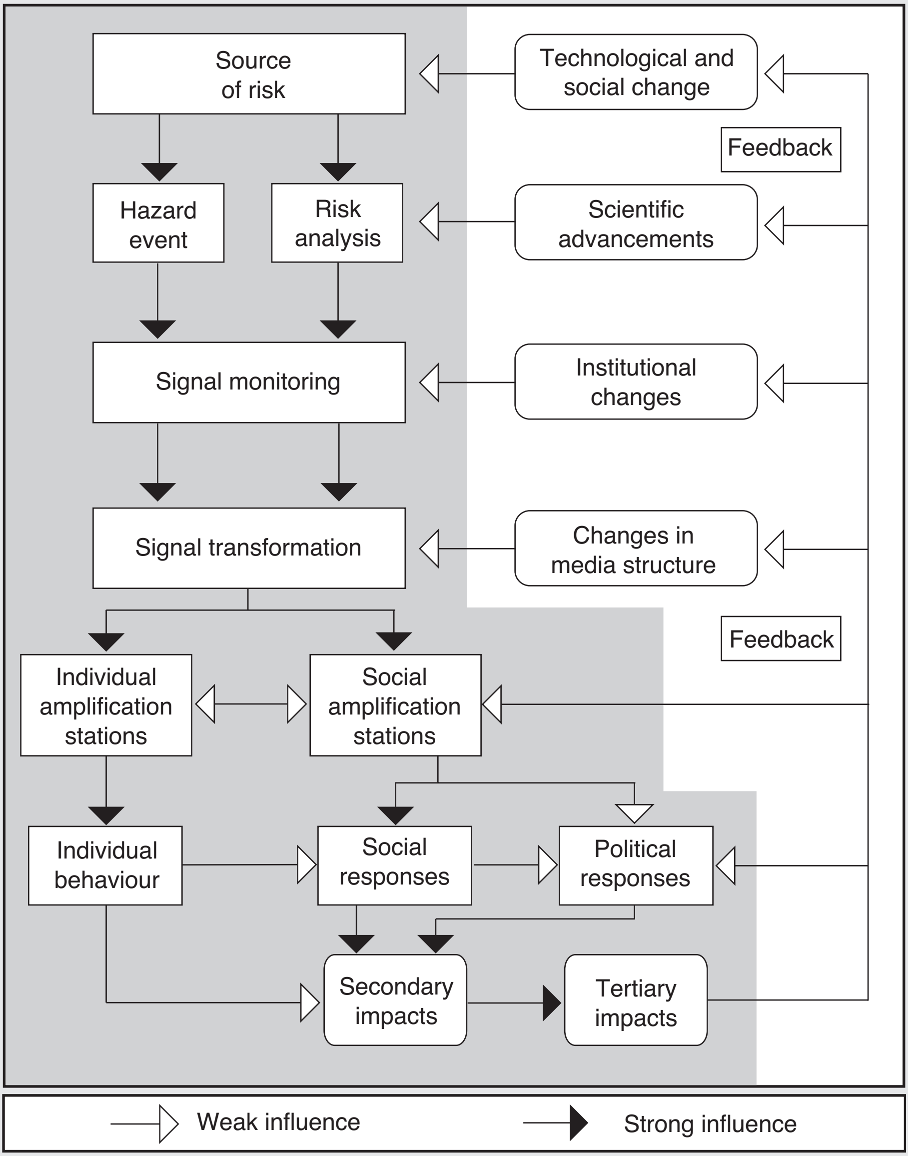

Figure 7.4 *Risk communication according to the concept of the social amplification of risk*

Source: adapted from Renn, 1992a, p476 about the incidents and the real or potential victims. Furthermore, each institutional source is likely to collect and pass on information that supports its designated service and provides good arguments to legitimize its existence and performance (Perrow, 1984; Dietz and Rycroft, 1987, pp54f). Since institutions have different purposes, they will most likely differ in the selection and processing of signals stemming from primary sources. This difference in interpretation may be aggravated by different competing risk assessments that reflect adversarial science camps or result from scientific advocacies within interest groups (Coppock, 1985; Stern, 1991). But even if all of these sources relied on the same primary sources or cited the same evidence, the messages would still look as though they were drawn from completely unrelated databases.

Industry, regulators, scientists and environmental watchdogs focus on different aspects of the problem, and amplify signals that each of them regards as confirmation of their basic philosophy, emphasizing their role and function in the assessment and management of the respective risk (Leiss, 2001). In most cases, competing messages are not a product of misinformation, manipulation or even lying. Rather, every communicator has a different perspective in perceiving and evaluating the issue and is interested in conveying that perspective to the outside world. Fragmentation of information is therefore an inevitable side effect of plural interest articulation (Mazur, 1981; Kahlor et al, 2004). The process of signal reception and recoding in this stage is not so much related to the properties of the hazard – although this information may be packaged within the message – as it is to the efforts of the institution to assess, analyse or manage the risk.

Role of transmitters in communication

The transmitter has two roles in the communication process: first, transmitters receive and process information (see also section on media effects in Essay 4). In addition to personal selection filters and evaluation strategies, professional and institutional rules govern the selection of received signals and their interpretation. Journalists, for example, follow specific professional guidelines, such as hearing both sides in a controversy, as well as institutional rules, such as the required editorial style and the expectations of the perceived target audience for the respective medium (Dunwoody and Peters, 1992).

Second, the transmitter acts as an information source by sending information to the final receiver. The recoding of messages involves conscious or unconscious changes of the original information material. Messages from several sources may be integrated within one new message, or comments may be added. Obviously, both processes take place simultaneously (i.e. understanding and recoding the incoming message is an integral part of the transmitting process; Dunwoody, 1992; Jaeger et al, 2001, p130).

Studies of the effects and impacts of the transformation process have flourished in communication research. The theoretical literature suggests many different concepts about the nature and repercussions of this transformation (Peters, H. P., 1984, 1994, 1995, 2007; Peltu, 1985, pp129f, 1989; Lee, 1986, p175; Shoemaker, 1987, p125; Sood et al, 1987, p30; Coleman, 1993; Dunwoody, 1994; Mazur, 1994; Singer and Endreny, 1994; Tyler and Cook, 1984; Kitzinger and Reily, 1997; Wahlberg and Sjöberg, 1998; Brookes, 1999; Heinrichs and Peters, 2006; Breakwell, 2007, pp156ff; Peters, H. P. et al, 2007). Most of the empirical evidence justifies the conclusion that the media are not mere reflectors of reality or that they are docile instruments of social pressure groups, but reflect and highlight topics and issues that are of concern to society. Media coverage is neither a product of external pressure nor an autonomous subsystem within society (Lowery and DeFleur, 1983; Raymond, 1985; Wahlberg and Sjöberg, 1998; Dunwoody, 1999). It reflects internalized individual values, organizational rules and external expectations. The issue itself, the institutional context and the political salience of the issue determine which of these three factors is likely to dominate the transformation process. A universal theory that explains how transformation takes place is therefore not likely to evolve.

All transmitters convert the original message into a new message according to institutional rules, professional standards, role requirements, anticipated receivers' interests, and personal preferences. The final product is a mix of original and recoded messages, thus leaving it to the final receivers to distinguish between the informational elements provided by the original source and the additions or deletions made by the various transmitters.

The transmitters of information on risks

The media elicit information from direct eyewitnesses of hazard events (anecdotal evidence). They usually have access to the primary scientific reports (scientific evidence), but may prefer to use its popular derivations (such as articles in popular science journals). In addition, they will be bombarded with press releases and other information from managing institutions or socially relevant groups. This abundance of material has to be collected, selected, digested, dissected and, finally, recoded.

The transmitters face a diversity of incoming messages caused by different perspectives on the nature of the risk and its best management. This diversity itself is useful to convey to the final receivers and to add to the impression that the risk issue is a controversial topic with many confusing and often contradictory messages (Dunwoody, 1992; Kitzinger and Reily, 1997; Kahlor et al, 2004). The widely accepted rule of fairness in news coverage demands equal treatment for all viewpoints. This conflicts with the widely accepted rule in scientific disagreements that professional dissent should be reconciled through methodological conventions, factual evidence and peer review, notwithstanding genuine uncertainty about predictions. It also conflicts with the political conflict-resolution mechanism of majority vote. The media, in contrast, transmit the claims of the different camps to the audience, regardless of how much scientific evidence each of them has been able to compile and whether it represents a majority or minority opinion (Peters, H. P., 1995a). Transmitters in a pluralistic society tend to reinforce diversity, dissent and relativity of values (Rubin, 1987, p53). Even specialized journals tend to focus on controversies that fit into their general philosophy. Thus, dissent and ambiguity are inevitable and irreversible parts of risk information, in addition to the uncertainty of the consequences.

In contrast to the scientific community, the nature and magnitude of the original hazard are only of minor interest to most transmitters who prefer to focus on the way in which institutions handle risks and communicate about their activities. Empirical studies demonstrate that neither the number of victims in an event nor the expected number of fatalities are correlated with the volume and intensity of media coverage (Adams, 1986; Singer and Endreny, 1987, 1994; Sood et al, 1987, pp36f; Wilkins and Patterson, 1987, p84; Dunwoody and Peters, 1992).

The literature contains endless lists of factors that are assumed to determine the attractiveness of risk-related messages for transmitters (for an overview, see Wahlberg and Sjöberg, 1998; Breakwell, 2007, pp156ff). Such factors include:

- technologically induced hazards versus natural hazards (Breakwell, 2007, pp156–161);
- the importance of infotainment (Breakwell, 2007, pp156–161);
- the significance of interactions between media (Breakwell, 2007, pp156–161);
- the role of pressure groups (Breakwell, 2007, pp156–161);
- the degree of uncertainty and controversy (Breakwell, 2007, pp156–161);
- the possibility of blaming someone for the outcome (Sandman et al, 1987, p105; Sandman, 2005);
- the cultural distance from the place of occurrence (Adams, 1986);
- human interest;
- drama and conflict;
- the exclusiveness of coverage (Peltu, 1985, pp137f);
- the proximity to politically contentious issues;
- prestige of information source; and
- the degree of conflict among stakeholders (Mazur, 1994; Peters, H. P., 1995).

When reviewing the theoretical insights and partially confirmed empirical results, one might conclude that information processing in the media is almost random or at least void of any systematic pattern. However, some insights have been gained as a result of the media studies carried out so far. The major components of risk studies, probabilities and magnitudes, seem to play only a minor role in media coverage; they are, hence, attenuated (Dunwoody, 1999). Signals relating to conflicts among social groups, however, are intensified, as are contradictions between primary and secondary sources of information, risk events that could have been prevented or mitigated, and the involvement of individuals or organizations with high prestige and political influence (Petts at al, 2001; Breakwell, 2007, pp240ff).

Reception of risk information

The mechanisms and mental processes of individual risk perception have been one of the most studied topics in risk psychology (Covello, 1983; Brehmer, 1987; Slovic, 1987; Gould et al, 1988; Rohrmann and Renn, 2000; Breakwell, 2007, pp44ff;see Chapter 4 and Essay 4 on risk perception in this volume). Risk perception studies focus on four major subjects:

1 intuitive heuristics of forming judgements and the processing of probabilities;
2 qualitative characteristics of risk (regarding perceived severity and acceptability of risk);
3 beliefs associated with the risk itself and the context in which it is embedded, such as the perceived trustworthiness of risk managers and regulators, the perceived motives of main actors and the stigmatization of the risk itself;
4 interests, values and world views that shape people's predisposition to evaluate risks in a specific direction.

These variables have been introduced and explained in Essay 4 on risk perception.

In addition, equity issues play a major role in risk perception. The more that risks are seen as unfair, the more they are judged as severe and unacceptable (Kasperson and Kasperson, 1983; Short, 1984). It should be noted that the estimation of severity and the judgement of acceptability are closely related in risk perception. The analytical separation in risk assessment, evaluation and management, as exercised by most technical risk experts, is not paralleled in public perception. Most people integrate information about the magnitude of the risk, the fairness of the risk situation, and other qualitative factors into their overall judgement about the (perceived) severity of the respective risk (Boholm, 1998).

This list of factors demonstrates that public understanding of risk is a multi-dimensional concept and cannot be reduced to probabilities and consequences. Empirical studies about experts' and laypeople's estimates of the severity of risks show significant differences and highlight varying definitions of risk (Slovic, 1987, 1992; Sjöberg, 2000b). Although risk perceptions differ considerably among social and cultural groups, the multidimensionality of risk and the integration of beliefs related to risk, the cause of risk and its circumstances within a consistent belief system appear to be common characteristics of public risk perception in almost any country in which such studies have been performed (Renn and Rohrmann, 2000).

In terms of risk communication, the patterns of risk perception that shape the receiver's understanding of the message adds additional uncertainty and ambiguity to the final effect that a message may have. It is, therefore, unlikely that a receiver decodes the original intent of a message letter by letter. Through the transmission process, messages are transformed; but this effect is even less dramatic compared to the reception process taking place in the minds of consumers of information. One case study by H. P. Peters (2000) showed that individuals exposed to positive risk information on genetically modified organisms (GMOs) remembered only the negative arguments that were presented in the text. This group also developed a more negative attitude towards GMOs compared to a control group who received a more balanced text (Peters, H. P., 2000). Similarly, a research group from Aarhus University in Denmark concluded from experiments that a positive message about GMOs increased people's reluctance to purchase genetically modified food compared to people who did not receive any information at all and were merely confronted with the choice of two kinds of food (Grunert et al, 2004).

Insights for risk communication

What are the general lessons to be learned from the research based on the traditional communication model and its application for risk communication? How can one design or channel a message so that it is likely to be selected by a transmitter and adopted by the final receiver without major distortions of the original intent of the message?

The common thread running through most risk communication studies is that public understanding is hampered by the complexity of the risk concept (Kahlor et al, 2004; Breakwell, 2007, pp155ff). Furthermore, the multi-stage coding and recoding process during the transmission of messages accounts for numerous errors and misconceptions conveyed to the final receiver. Transmitters and receivers reduce complexity by simplifying the message and focusing on those aspects that they regard as relevant. This is part of the communication reality in modern societies and provides the social framework in which messages are sent and received.

The communication process can be compared to a free-market system in which goods are produced, transported, purchased and consumed. Over the long run, most of the good products will find their market niche, whereas the majority of bad products will eventually fail to meet the market test. Similarly, messages containing important information are more likely to reach their destination; but many trials may be needed to ensure this success. In addition, packaging can help to sell the message faster and to overcome obstacles on the way from the source via the transmitter to the final receiver. The package can help if the message is worth transmitting; but even the best package will fail in the longer term if the message is meagre, dishonest or simply irrelevant.

With respect to the final receiver, risk communication must address the qualitative characteristics of risk and the mechanisms of risk perception. It is not sufficient to confine the communication process to a discussion of probabilities and consequences. Communication should include aspects such as whether the exposure is voluntary, what possibilities exist to exert personal control (or if that is not feasible, what institutions can fill that gap and monitor and control risks on behalf of the public), how the risk and its consequences are managed, and how catastrophic events can be avoided.

Risk communication is particularly difficult with risks belonging to the semantic class of insidious danger (see Essay 4 on risk perception), which are associated with involuntariness, delayed effects, inability to be sensed by human organs, lack of control and unfamiliarity. To address these negative risk characteristics, it may be helpful to point to functional equivalents of these characteristics in a broader societal context. Potential equivalents are the assurance of a democratic decision-making process to counteract the impression of involuntariness and, as a replacement for personal control, the independence and impartiality of operating and regulating agencies. This may produce trust in their capability to monitor routine emissions, check safety devices and intervene if safety in the risk-producing facility is not managed properly (Barr, 1996). In addition, unfamiliarity can partially be compensated for by better functional knowledge about the risk and the associated technology.

With respect to the transmitters, risk communicators should be aware of the major selection rules of the media. The media report about events, not continuous performance. Hardly any journalist is interested, for example, in writing a story about a long safety record of a nuclear power plant. If such a facility, however, faces an accidental release of radioactive material, one can be sure that this event will become headline news. Another major characteristic of the media is their interest in eyewitness reports. These testimonies relate abstract issues or events to unique human experiences (which journalists assume help readers to identify with the victims or heroic managers of the risk). Information that emphasizes the human component and personalizes abstract material is more likely to be accepted by the media than documents about the sequence of events or organizational competence (Peltu, 1989). One should never forget that social stations of information processing are not computers or radios that operate according to pre-structured rules (Rayner, 1988); rather, they constitute thinking beings who reflect the messages they receive and change their selection rules to fit the circumstances.

Interaction among transmitters, plural input from different sources, the coexistence of personal, professional and institutional selection, the presence of amplification criteria, and interaction among different target audiences create enough complexity and uncertainty that the final effect of the communication process can hardly be measured at all, let alone controlled effectively. Even the rather simple step of making a message known to, and understood by, the target audience faces the chaotic conditions of the communication market. Guidelines and recipes to improve risk communication can help to increase the probability that a message will reach its audience, but they will never guarantee its success.

Building confidence and trust in risk management institutions

Trust, confidence and credibility

With the advent of ever more complex technologies and the progression of scientific methods to detect even the smallest quantities of harmful substances, personal experience of risk has been increasingly replaced by information about risks, and individual control over risk by institutional risk management. As a consequence, people rely more than ever on the credibility and sincerity of those from whom they receive information about risk (Barber, 1983; Blair, 1987; Zimmerman, 1987; Johnson, 1999; Löfstedt, 2003, 2005; Breakwell, 2007, pp140ff). Thus, trust in institutional performance has been a major key for risk responses. Trust in control institutions is able to compensate for even a negative risk perception, and distrust may lead people to oppose risks even when they are perceived as small.

Since trust is one major objective in risk communication and also a prerequisite for many other objectives, risk communicators need a better understanding of the meaning and implications of the term trust (Luhmann, 1980; Covello, 1992; Earle and Cvetkovich, 1995; Peters, R. G., 1995; Peters, R. G. et al, 1997; Siegrist and Cvetkovich, 2000; Löftstedt, 2005). For our purpose of defining trust in the context of the communication within social organizations, we suggest the following definition (Renn and Levine, 1991):

> *Institutional trust refers to the generalized judgement whether and to what degree the perceived performance of an organization matches the subjective and/or socially shared expectations of a variety of social actors and the public with respect to its assigned institutional function, including its perceived competence in meeting its tasks and its communication style in dealing with professionals, stakeholders, media and the public at large.*

Although trust and confidence are often used interchangeably, confidence in a source can be distinguished from trust as a more enduring experience of trustworthiness over time. Accordingly, *confidence denotes the generalized impression of an enduring and continuous experience of the trustworthiness of an organization based on its perceived performance record*. This distinction between confidence and trust is sometimes reversed in the literature (Cvetkovich, 2000). In our view, however, the intuitive connotation is that confidence builds upon the experience of trust and not vice versa. People have confidence in an organization if their prior investment of trust in that source has not resulted disappointing over a longer period of time. The last term in this context refers to credibility. This term is related only to communication. As a result, we can define *credibility* as *the degree of shared and generalized expectancy that the communication efforts of an organization match to the subjective and/or socially shared expectations in terms of honesty, openness, responsiveness and professionalism*.

To make these terms more operational, it makes sense to identify the major features that constitute trust, confidence and credibility. The literature includes several approaches (Barber, 1983; McGuire, 1985; Sheridan, 1985; Lee, 1986; Earle and Cvetkovich, 1995; Cvetkovich, 2000, Löfstedt, 2003). In our 1991 review (Renn and Levine, 1991), we tried to amalgamate some of the proposed suggestions from the literature and developed a classification scheme consisting of six components. We later added empathy to this list (Covello, 1992; Peters, R. G. et al, 1997). Table 7.1 lists the seven components (see also Essay 4).

Table 7.1 *Components of trust*

Components	Description
Perceived competence	Degree of technical expertise in meeting an institutional mandate
Objectivity	Lack of bias in information and performance as perceived by others
Fairness	Acknowledgement and adequate representation of all relevant viewpoints
Consistency	Predictability of arguments and behaviour based on past experience and previous communication efforts
Sincerity	Honesty and openness
Faith	Perception of goodwill in performance and communication
Empathy	Degree of understanding and solidarity with potential risk victims

Source: adapted from Renn and Levine, 1991

Trust relies on all seven components; but a lack of compliance in one attribute can be compensated for by a surplus of goal attainment in another feature. If objectivity or disinterestedness is impossible to accomplish, a fair message and faith in the good intention of the source may serve as substitutes. Competence may also be compensated for by faith and vice versa. Consistency is not always essential in gaining trust; but persistent inconsistencies destroy the common expectations and role models for behavioural responses. Trust cannot evolve if social actors experience inconsistent responses from others in similar or even identical situations. Finally, empathy signals the public that the institution cares about the effects of its performance. If people assign high competence to an organization, empathy helps but is not essential. If performance is in doubt, empathy can make all the difference in the world between trust and distrust.

Levels of trust

For analytical purposes, it seems appropriate to distinguish between different levels of trust, confidence and credibility, depending upon the source and the situation. We developed, therefore, a classification scheme that is composed of five distinctive levels of analysis: trust in a message; confidence in a communicator; confidence in an institution based on source perception; credibility of institutions based on institutional performance; and climate for trust and credibility in a macro-sociological context.

Figure 7.5 illustrates the cumulative nature of these five levels and is a simple illustration of the interrelations among the levels. Each level is embedded within the next higher level. Consistent violation of trust-building efforts on one of the lower levels will eventually impact upon the next higher level. Distrust on a high level sets the conditions and determines the latitude of options for gaining or sustaining trust on a lower level. The order of levels is also associated with an ascending order of complexity and abstraction. It is therefore easier to predict how changes in communication may affect trust on the lower levels compared to changes on the higher levels. But the circumstances prevalent in the higher levels operate as constraints on any effort to improve trust on a lower level.

The four levels of analysis enable us to identify the elements that may contribute to trust, confidence or credibility. Table 7.2 illustrates the key variables in each of the levels and shows their interrelations (Renn and Levine, 1991). The 'message' rubric includes all of the variables that influence the perception of competence, fairness, consistency and faith. Personal variables, such as appearance, appeal, style and responsiveness, affect the trust and confidence that a person conveys to his or her audience. Furthermore, institutional performance and image colour the acceptance and evaluation of a message and influence the reception of the communicator by the target audience. All variables that we identified as relevant on this level are summarized in the two rubrics representing the image and performance of institutions. Last, the socio-political climate shapes the readiness of receivers to give credit in terms of prior confidence to a communicator. In a positive social climate, people tend to invest more trust in institutions from the beginning and may be more forgiving if part of this trust is abused. In a negative social climate, people tend to be very cautious in investing trust in any institution and prefer having more control over the

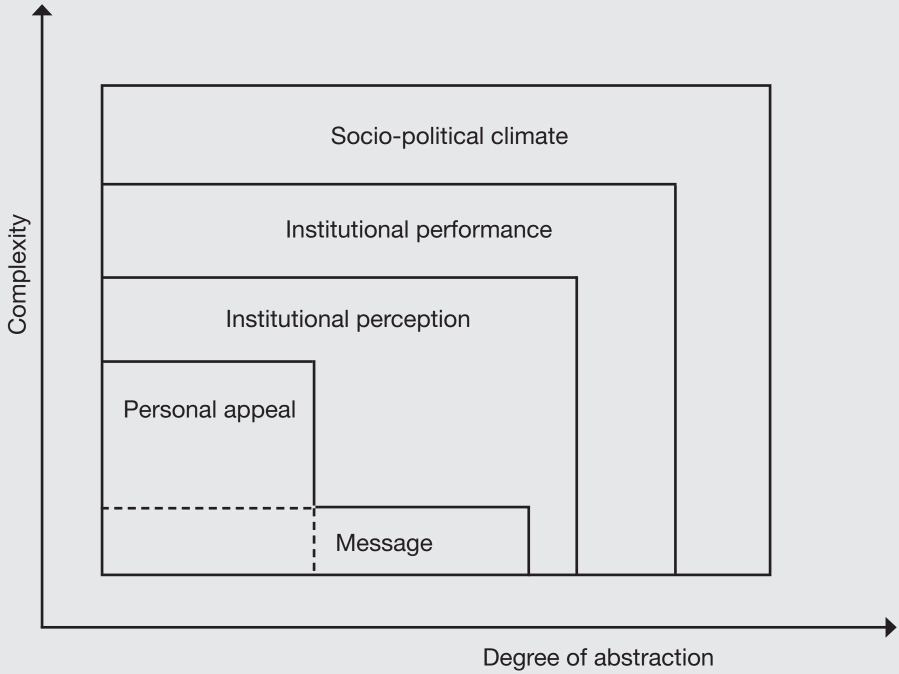

Figure 7.5 *Different levels of trust in risk communication*

Source: adapted from Renn and Levine, 1991

performance of the affected institution. If trust is misused, it takes much time and effort to encourage people to start investing in the trustworthiness of the institution. Under such conditions, active trust management is certainly required. The socio-political climate does not only depend upon time and context, but it also varies from country to country as Ragnar Löfstedt pointed out in his analysis of Swedish versus US and UK regulatory culture (Löfstedt, 2001).

Some empirical research results on institutional trust

This section presents some of the interesting findings of sociological and organizational research with respect to institutional trust and credibility.[5] These findings are derived from surveys and other statistical data. The focus here is only on the results and not on methodology and design. These insights were not made in the risk arena, and one should exercise caution when translating the results from the arena in which they were observed to the risk arena. For a more detailed review, the reader should consult the respective literature (e.g. Katz et al, 1975; Rourke et al, 1976; Lipset and Schneider, 1983; Kramer, 1990; Earle and Cvetkovich, 1994, 1995; Johnson, 1999; Siegrist and Cvetkovich, 2000; Siegrist et al, 2000; Trettin and Musham, 2000; Löfstedt, 2005; Peters, H. P. et al, 2007; Breakwell, 2007, pp140ff and 271f):

Table 7.2 *Factors of credibility for different levels of analysis*

Positive	**Negative**
Message	
Timely disclosure of relevant information[a]	Stalled or delayed reporting[a]
Regular updating with accurate information[a]	Inconsistent updating
Clear and concise[a]	Full of jargon[b]
Unbiased[c]	Biased[c]
Sensitive to values, fears and public perception[c]	Inconsiderate of the public's concerns[d,e]
Admits uncertainty[a]	Claims the absolute truth
From a legitimate reputable source[c,d]	From a questionable source
Organized message[e]	Internally inconsistent, ambiguous[l]
Use of metaphors[e]	Too abstract[e]
Explicit conclusions[e]	Receiver derives own conclusion[e]
Positive information recorded in early part of message[e]	Fear or anxiety arousal in early part of the message[l]
Forceful and intense[f]	Dull[f]
Personal	
Admits uncertainty[a,c]	Self-assured[l]
Responds to the emotions of the public[c]	Indifferent
Appears competent[a,f]	Appears insecure[f]
Similarity to receiver[e,f]	Perceived as an outsider[c]
Has some personal stake in the issue[c]	Seems uninterested or not involved[m]
Clear and concise[a]	Too technical[b,l]
Perceived as an expert[e,f]	Perceived as a person with opinions rather than expertise[f]
Perceived as attractive[e,l]	Perceived as unattractive[m]
Charismatic[e]	Boring, not inspiring[f]
Trustworthy, honest, altruistic and objective[f]	Lack of trustworthiness[m]
Empathy for receiver[n]	Displays no empathy[n]
Institutional	
Positive personal experience[g]	Negative personal experience[g]
Strong, competent leadership[g]	Perceived incompetence[g]
Positive labour relations[g]	Lay-offs/hiring freeze/strike[g]
Sound environmental policy[g]	Irresponsible environmental policy
Produces safe and good services[g]	Poor-quality goods and services[g]
Positive past record of performance[g]	Negative past record of performance[g]
Reasonable rates[h]	Exorbitant prices[h]
Undertakes socially relevant tasks[i]	Seems to be centred on own benefits[n]
Practicable contributions to everyday life[j]	No recourse to everyday life experience[l]
Benefits outweigh costs[k]	Magnitude of risk-taking greater than benefits[k]
Political/cultural context	
Faith in institutional structures[g]	Perception of structural decline[g]
Checks and balances	Poor leadership/incompetence[g]
Well-functioning system	
Integrity of institution[g]	Corruption/scandal[g]
New and innovative ideas[g]	Well-known arguments[g]

Source: modified and updated from Renn and Levine, 1991; also: *a* Hance et al (1988); *b* Parker (1988); *c* Gricar and Baratta (1983); *d* Anderson (1983, pp93–108); *e* Lee (1986); *f* Covello et al (1986); *g* Lipset and Schneider (1983); *h* Burnham (1982); *i* La Porte and Metlay (1975); *j* Pion and Lipsey (1981); *k* Slovic et al (1981b); *l* Breakwell (2007, p132); *m* Breakwell (2007, p133); *n* Peters, R. G. et al (1997, p44)

- Researchers found a *low correlation between the perception of institutional competence and the desirability of the tasks and goals that the institutions were performing*. The institutions that people like most received low ratings on competence and vice versa. Although sympathy helps to attain credibility, perceived competence alone may be sufficient for gaining trust. But the lack of sympathy makes people more critical of the actual performance of the institution. Mistakes are more likely to be forgiven if the communicator can count on a sympathetic audience (Peters, R. G. et al, 1997).
- *Perceived competence of institutions is most likely associated with the perception of a successful performance and the perceived cost–benefit ratio in meeting the task.* In addition, the public image and the social prestige assigned to an institution serve as preliminary heuristic strategies to assign credibility (Matejko, 1988; Slovic, 1993).
- *Perceived fairness and openness,* the second prerequisite for institutional credibility, *is closely linked to the transparency of the decision-making process, the opportunities for public scrutiny and institutional control (checks and balances), and the degree of personal satisfaction* with the rationale and procedures for decision-making in the institution. Surprisingly, the amount of actual opportunities for public involvement and participation is hardly correlated with perceived openness (Lipset and Schneider, 1983; Viklund, 2003; for an exposé of the theoretical concept, see Luhmann, 1980).
- Institutional case studies demonstrated that the *erosion of credibility was often linked to incompetence, poor performance, incomplete or dishonest information, withholding of information, obscure and hidden decision-making processes, denial of obvious problems and denial of vested interests* (Midden, 1988; Löfstedt, 2003, 2005).
- *Credibility can be enforced by good performance, quick responses to public requests, consonance with highly esteemed social values, availability for communication with outsiders, unequivocal and highly focused information transfer, flexibility to respond to crisis situations or new public demands, and demonstration of public control over performance and financial allocation* (Rourke et al, 1976; Löfstedt, 2001; Breakwell, 2007, pp132f).

Success stories of communication efforts in the pharmaceutical and chemical industries clearly demonstrate that overreacting to public requests never hurts (Pinsdorf, 1987). Taking a product off the market, even if only a tiny fraction of the product is contaminated or poisoned, has helped companies in the past to manage a credibility crisis and to regain public confidence. Private institutions were more often able to show such flexibility and immediacy in their response compared to governmental institutions. But the involvement of tax money in public institutions adds a potential risk factor in the trust-building effort. If too much money is spent on communication, the intended effect may be counteracted by outrage over the squandering of public money.

Application to risk communication

In risk debates, issues of trust evolve around institutions and their representatives. People's responses to risk depend, among other things, upon the confidence that they have in risk-initiating and risk-controlling institutions. Since the notion of risk implies that stochastic events may trigger accidents or losses, risk management institutions are always forced to legitimize their action or inaction when faced with an accident. On the one hand, they can cover up mismanagement by referring to the alleged randomness of the event (labelling it as unpredictable or an act of God); on the other, they may be blamed for events for which they could not possibly provide protective actions in advance (Luhmann, 1989).

The stochastic nature of risk demands trustful relationships between risk managers and risk bearers since single events do not prove nor disprove management failures; at the same time, they provoke suspicion and doubt. The slightest mistake by a risk management agency can be sufficient to destroy the delicate balance of trust. The handling of risk by private corporations and governmental agencies has been crucial in explaining the mobilization rate of individuals for taking actions. The more individuals believe that risks are not properly handled (in addition to being perceived as serious threats), the higher is the likelihood that people will be politically active. It has been shown that in the case of nuclear power, the disillusionment of the US population with the nuclear option, as well as the number of people becoming political advocates of anti-nuclear policies, grew simultaneously with the growing distrust in the nuclear regulatory agency (Sandman, 2005). Negative attitudes are a necessary but insufficient reason for behavioural responses. Public confidence in institutional performance is another and even more important element in triggering off behavioural responses.

Lessons for risk communicators

What kind of advice can we give to risk communicators on how to design and implement a risk communication programme that incorporates the findings of past research on trust and credibility, and includes the more anecdotal evidence of risk communication efforts in the past? Using our analytical model for distinguishing between message, person, institution and social climate, we have developed a set of conditions and prerequisites for gaining trust in communicating with the public. These refer to preconditions for risk communication and provide orientations for analysing and designing communication programmes (see similar advice in Chess et al, 1988; Lundgren, 1994; Covello, 1998; Gray et al, 1998; Earle and Cvetkovich, 1999; OECD, 2002; Leiss, 2004; Breakwell 2007, pp155f):

- To improve the *trust in a message,* we recommend explaining the rationale of risk analysis and its role for risk management so that the audience is better prepared about what to expect. In addition, the decision-making process and the past record of the institution should be included in the message so that people can assign competence to the actors and get a better feeling of the trade-offs that were made in meeting the specific risk management task. Evidence of competence, fairness towards other viewpoints, and references to commonly shared values and beliefs will make a message more attractive and could, at the same time, help to address the centrally and peripherally interested audience. Conclusions should be made explicit and vested interests should not only be admitted, but justified in terms of public mandate or economic function.

- To improve *trust in a personal communicator,* the major goal is to develop a climate of communication that enables the audience to identify with the communicator and to share his or her experience and beliefs. The more a communicator manages to avoid the mask of an institutional spokesperson, and the more he or she can express compassion and empathy for the audience, the more likely the audience will identify with the speaker and sympathize with the arguments. As noted throughout this book, conveying probabilistic information is a real challenge, but can be done in reference to everyday experiences of budget constraints and consumer products. Furthermore, evidence of the successful use of risk analyses in hazard management can serve to define the role and limitations of risk analysis in improving public health and safeguarding the environment. Peripheral cues should be confined to commonly shared symbols, appealing formats, and surprises in openness and honesty, and should definitely avoid negative labelling of potential opponents or typical advertising gimmicks. Peripheral cues are important for successful communication; but cues have to be selected carefully to please the peripherally and centrally interested audience.
- To improve the *credibility of an institution,* the vital factor is performance, not public relations. Confidence has to be gained by meeting the institutional goals and objectives. In addition, credibility is linked to the evidence of being cost-effective and open to public demands. These two goals are often in conflict with each other (Kasperson, 1986); but they have to be treated as complementary, and not as substitutive, goals. Fairness and flexibility are major elements of openness. In addition to ensuring sufficient external control and supervision, public participation may be implemented as a means of demonstrating compliance with the political mandate and to avoid the impression of hidden agendas. On the premise of good performance, communication programmes can be designed that reflect these accomplishments. Such programmes should provide honest, complete and accurate information that is responsive to the needs and demands of the prospective audience. This can only be done if the source engages in an organized effort to collect feedback from the audience and to establish a two-way communication process. Involvement of citizens, open-house policies, discussion forums, open TV channels or other means should be explored to ensure the functioning of the two-way communication structure.
- *Improving the social climate* is not within the realm of possibilities for a single communicator. But large-scale organizations or associations of organizations can influence the overall climate. One way of improving the climate is to accept and even endorse checks and balances in the control of the organization. The other obvious solution is to demonstrate the flexibility and foresight of the organization in meeting and anticipating new public claims and values. The impersonal nature of institutions may be mitigated by providing special local services and by engaging in community activities and programmes. Governmental institutions

will receive more credibility if they do not give the impression of permanent crisis management, but of competence and preparedness for long-term threats and challenges (in particular, pertaining to environment and technology).

Many different factors affect credibility. On the personal level, appearance, communication style, honesty and creating an atmosphere of identifying the audience with the communicator are major variables that influence credibility. On the institutional level, the actual performance in terms of role fulfilment, cost effectiveness and public expectations, as well as openness to new claims and demands, constitute confidence and help to build credibility. Furthermore, the social climate and the level of controversy associated with the issue affect the assignment of credibility independent of the performance of the actors involved.

Risk communication as persuasion: The route to behavioural changes

Review of psychological research

Psychological research about attitude and attitude change has shed some light on the conditions under which receivers of information assign trust or one of its building blocks, such as competence, to a communicator. These research results are usually discussed in the framework of persuasion (Petty and Wegener, 1998; Perloff, 2003; Crano and Prislin, 2005). What elements of a message or a communication context are likely to enhance or diminish the persuasive effect of a message? What elements of the message are remembered and which trigger changes in opinions or attitudes?

Before reporting on some of these studies, we should mention their restrictions and limitations to avoid misinterpretation (Anderson, 1983; McGuire, 1985; Breakwell, 2007, p133). Most of the research on attitude change has been performed in laboratory settings with student populations. Most experiments were conducted with a limited set of issues or topics so that it is not clear whether the revealed relationships can be extended to other topics or audiences. Many experiments were conducted during the 1960s and 1970s, both time periods in which the social climate for trust and credibility differed considerably from today. For example, experiments involving experts as communicators usually resulted in considerable 'persuasion' effects during the early 1960s, whereas recent experiments demonstrate more ambiguous results depending upon the existence of social controversy and the expert's own perceptions (Eagly et al, 1981; Heesacker et al, 1983; Ajzen, 1992; Petty and Wegerner, 1998; Cialdini and Sagarin, 2005). But at the same time, many of the research findings have been consistent over time and have been tested with a variety of subjects and topics (Eagly and Chaiken, 1984; Chaiken and Stangor, 1987; Ajzen, 1992; Cialdini, 1995; Stiff and Mongeau, 2003). They can at least be regarded as well-founded hypotheses for application in risk communication until more specific research studies are conducted (a similar conclusion is drawn in Drottz-Sjöberg, 2003).

The following review of research results is based on psychological experiments of persuasion. For the purpose of this essay, we will only present their conclusions and omit their methodologies or designs. Readers interested in a more detailed review should consult the following: Eagly and Chaiken (1984); McGuire (1985); Chaiken and Stangor (1987); Ajzen (1992); Cialdini (1995); Stiff and Mongeau (2003), and, specifically for risk communication, Lee (1986); Wood (2000); Drottz-Sjöberg (2003); Breakwell (2007, pp132ff). Factors that have been found to enhance the persuasiveness of communication include the following:

- *Attractiveness of information source:* attractiveness is composed of similarity of positions between source and receiver, likeability of the source and physical attraction (McGuire, 1985; Lee, 1986; Chaiken and Stangor, 1987; Ajzen, 1992).
- *Sympathy or empathy of the receiver for the source:* this refers to the possibility of a receiver identifying with the source or its motivations (Eagly and Chaiken, 1984; McGuire, 1985; Peters, R. G. et al, 1997).
- *Credibility of source:* among the components tested are perceived competence, expertise, objectivity, impartiality and interest in the source (Tyler, 1984; Rempel and Holmes, 1986; Lee, 1986; Jungermann et al, 1996; Breakwell, 2007, p133).
- *Suspicion of honest motives:* receivers do not detect any hidden agendas or motives behind the communication effort (Rosnow and Robinson, 1967; Eagly et al, 1981).
- *High social status or power of communication source:* the effect of these two variables depends heavily upon the issue and the composition of the audience (McGuire, 1985; Chaiken and Stangor,1987; Cialdini and Goldstein, 2004; Breakwell, 2007, p133).

These factors seem almost intuitively plausible. A communicator is likely to make a longer lasting impression on the audience if the message appears honest, accurate and fair, and if the communicator is a likeable person with whom the audience can easily identify. The more difficult question, however, is how a communicator can impart these impressions to the audience under real-life conditions. What do we know about the effectiveness of message composition and personal appeal that would allow us to tailor information programmes in order to seek more persuasive power?

Unfortunately (or fortunately, depending upon one's perspective), we do not have any recipes to enhance credibility or to increase the persuasiveness of a message. But psychological research during the past two decades has yielded some interesting, sometimes even counter-intuitive, findings that link specific aspects of message composition or personal style of communication with persuasive effect. Many of these findings have been summarized in Table 7.2 under the two rubrics of 'message' and 'personal'. Some of the more counter-intuitive factors deserve special mention:

- *High credibility sources, such as scientists or opinion leaders, produce more opinion change, but no difference in message learning.* The learning of a message is more closely related to the similarity of the message to existing attitudes and beliefs than to status of the communicator (Hovland and Weiss, 1967; McGuire, 1985; Ajzen, 1992).

- *Perceived expertise depends upon many factors.* Among them are status, education, perception of technical authority, age and social class. If the expertise of a communicator is challenged in public, people tend to focus on replacements for expertise, such as suspected interests or reliance on reference group judgements (Heesacker et al, 1983; Stiff and Mongeau, 2003).
- *Stating explicitly the persuasive intent is usually more convincing than hiding such an intent and leaving it to the audience to make their own inferences.* People like to know what the communicator wants them to believe. If it is not openly stated, they will suspect a hidden agenda (McGuire, 1985; Lee, 1986; Cialdini and Sagarin, 2005).
- *Perceived fairness and social status are both variables that can compensate for a lack of objectivity.* Even if people are aware that the communicator has a vested interest in the issue and that he or she argues from a specific viewpoint, they may believe the message or develop confidence in the communicator, provided that the information presented appears to be fair to potential counter-arguments and that it is presented with technical authority (Lee, 1986).
- *Being explicit when drawing conclusions and presenting counter-arguments have proven more effective than operating with implicit conclusions or presenting only one side of the story.* The two often conflicting goals of being fair to the views of the opponents and the honesty of one's own motives have to be reconciled in each communication effort in order to be most persuasive (McGuire, 1985; Ajzen, 1992; Breakwell, 2007, p132).
- *The perception that the goals and motives of the source serve a common interest or refer to highly esteemed social values, such as protection of the environment or public health, enhances public confidence in the communicator but reinforces distrust if the task performance of the communicator is perceived as weak.* People invest more trust in these institutions in the beginning, but tend to be more disappointed if the outcome does not match their expectations (Tetlock, 1986).
- *The agreement to listen to disliked sources increases the probability of attitude change.* Although the likeableness of a source usually enhances the persuasive effect, the mere acceptance of listening to a non-likeable source may motivate the audience to focus on the message instead of the source of communication. The psychological mechanism involved here is called avoidance of cognitive dissonance (Festinger, 1957). One can only justify spending time with a disliked source if the message at least is worth the effort. However, the motivation to engage in communication with an unpopular person may also serve to reassure how bad the source and the message are. Which of the two reactions is likely to emerge as a result of a communication with a disliked source? This depends upon the degree of commitment to one's previous attitude, the strength and salience of the attitude with respect to other beliefs and values, and the perception of the source's vested interests (Fazio et al, 1977; Chaiken and Stangor, 1987; Cooper et al, 2005).
- *Credibility reversal.* When people generate primarily positive thoughts in response to a message (e.g. because the message contains strong arguments) and then learn of the source, high source credibility leads to more favourable attitudes than does low source credibility. When people have primarily negative thoughts

> in response to a message (e.g. because it contains weak arguments), however, this effect is reversed – that is, high source credibility leads to less favourable attitudes than does low source credibility (Tormala et al, 2006).

All of these insights are helpful to design communication programmes and to train communicators for their task. But it should be kept in mind that most of these results were accomplished in rather artificial laboratory environments and may not be valid for the specific risk communication arena. Risk communicators who are familiar with the persuasion literature have assured us, however, that many of the findings from persuasion research match their personal experience with risk communication well. As a result, these studies provide some helpful clues to how to design a more effective communication programme and may serve as a starting point to conduct more specific research projects on trust in risk communication.

The elaboration-likelihood model

One of the most prevalent models of attitude and opinion change is the 'elaboration-likelihood model of persuasion' developed by Petty and Cacioppo during the late 1970s (for an overview, see Cacioppo et al, 1986; Petty and Cacioppo, 1986). The major component of the model is the distinction between the *central or peripheral route of persuasion*. The central route refers to a communication process in which the receiver examines each argument carefully and balances the pros and cons in order to form a well-structured attitude. The peripheral route refers to a faster and less laborious strategy to form an attitude by using specific cues or simple heuristics. When is a receiver likely to take the central route and when the peripheral route?

The peripheral route is taken when the issue is less relevant to the receiver and/or the communication context is inadequate to get the message across. In this case, the receiver is less inclined to deal with each argument, but forms an opinion or even an attitude on the basis of simple cues and heuristics. In Figure 7.6 these peripheral cues are integrated within the source–receiver model and assigned to each step in this model (*source-related, message-related and transmitter-related cues)*. In addition, the context in which the communication occurs provides additional cues for the receiver to generate interest in the message (*context-related cues*).

With regard to the source, aspects such as credibility, reputation and social attractiveness are important cues for receivers to adopt a specific message. It also helps to have the message sponsored by multiple sources (Chaiken, 1980; Midden, 1988). The message factors include the length of a message, the number of arguments, the package (colour, paper, graphic appeal, and so on), and the presence of symbolic signals and cues that trigger immediate emotional responses (Pham, 1996). The transmitter of a message may also serve as carrier for specific cues: perceived neutrality and fairness, personal satisfaction with the transmitter in the past ('this magazine is always right'), similarity with the political or ideological position of the transmitter, and social credibility assigned to a transmitter are major elements in the formation of opinions or attitudes. In addition, specific channel-related aspects, such as visual impressions from the TV screen, are readily accessible cues.

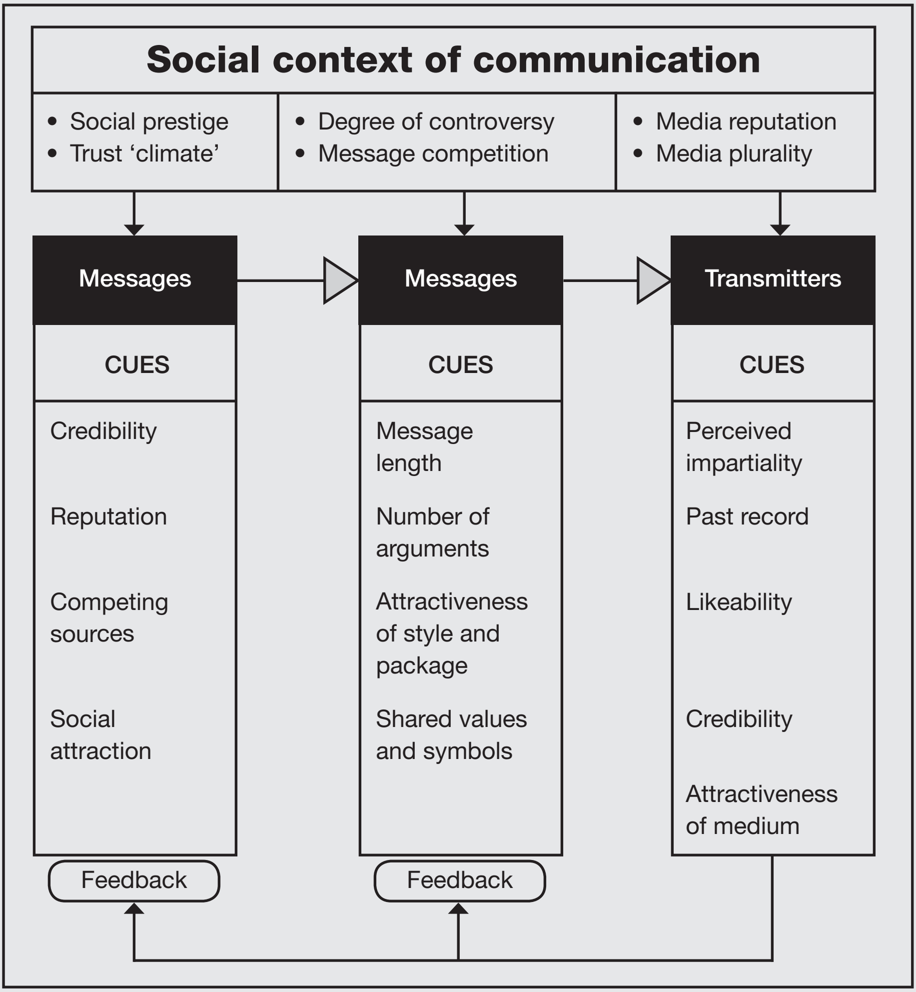

Figure 7.6 *The peripheral cues of persuasion in communication*

Source: adapted from Renn, 1992a, p487

Social context variables that serve as peripheral cues are often neglected in the discussion of the peripheral route. The social climate for trust and credibility and the image of institutions in a society may evoke a specific predisposition to accept or reject the arguments of a source (Slovic and MacGregor, 1994). With respect to the risk arena, the dominant impression of expert controversy and the presence of competing messages are significant cues that initiate a sceptical or at least cautious reception mode (Rogers, 1999). Other variables can be added to this category – for example, the plurality of transmitters or the social reputation of specific media.

A modification of the elaboration-likelihood model

Inspired by the elaboration-likelihood model and based on previous work on stages of attitude formation, Debra Levine and Ortwin Renn have developed a modified version of the elaboration-likelihood model (Renn and Levine, 1991). This model is less specific in terms of identifying the factors that lead either to a central or peripheral route of information reception, but more elaborate with respect to the different sequential stages in selecting, assimilating and evaluating information (see similar attempt in Consola and Wogalter, 2001). The thrust of this model is the simultaneous presence of central and peripheral elements in the different stages of attitude formation.

Figures 7.7 and 7.8 illustrate this model of attitude formation or change. The left-hand column describes the sequential steps of attitude formation, starting with the reception of a message and ending with the post-rationalization of the beliefs (the cognitive components of an attitude). This multi-step breakdown of the attitude-formation process is based on attitude theories by Rokeach (1969), Fishbein and Ajzen (1975), Ajzen and Fishbein (1980) and Ajzen (1988), and was developed and first graphically displayed in Renn (1984). The right-hand column lists the factors that influence each stage of this process and that determine whether the attitude-formation process is terminated prematurely. In concordance with the elaboration-likelihood model, two routes of persuasion exist: a central and a peripheral route.

The first three stages are identical for both routes of persuasion. They refer to the process of becoming aware of the information (attention filters), selecting the relevant parts of the information and processing its cognitive content. The receiver will decide during these three stages whether the issue is of central interest to him or her and whether to terminate the further processing of the information. If the interest is low and if other compensatory cues are missing, then the person is likely to reject or ignore the information. Medium interest or the presence of specific cues will initiate a peripheral route to further process the information. High interest and the presence of many reinforcing cues are likely to produce enough involvement for a recipient to choose the central route. The important factor here is that both routes – the central and peripheral routes – are dominated by peripheral cues in the early process of attitude formation. In addition to the receiver's prior experience and interest in the subject, awareness of a message is enforced by a special set of peripheral cues, such as novelty of the information, the mentioning of prestigious persons or institutions, or specific symbolic key-words or clues that link emotional involvement to the subject (Adaval, 2001).

The third step of intuitive processing of cognitive information refers to the heuristics and common-sense mechanisms of drawing inferences or attributing linkages to the information received (see Essay 4 on risk perception). Although one cannot classify these heuristics as peripheral cues, they are still representations of simple rules to cope with complex information. In the peripheral route, these cognitive heuristics may be partially replaced by even simpler cues, such as credibility of the source. If cognitive information is processed at all, these heuristics will govern the intuitive generalization process regardless of the route of information processing pursued.

The major difference between the peripheral and the central route lies in the process of evaluation: the fourth step of the model. In the central mode, the receiver

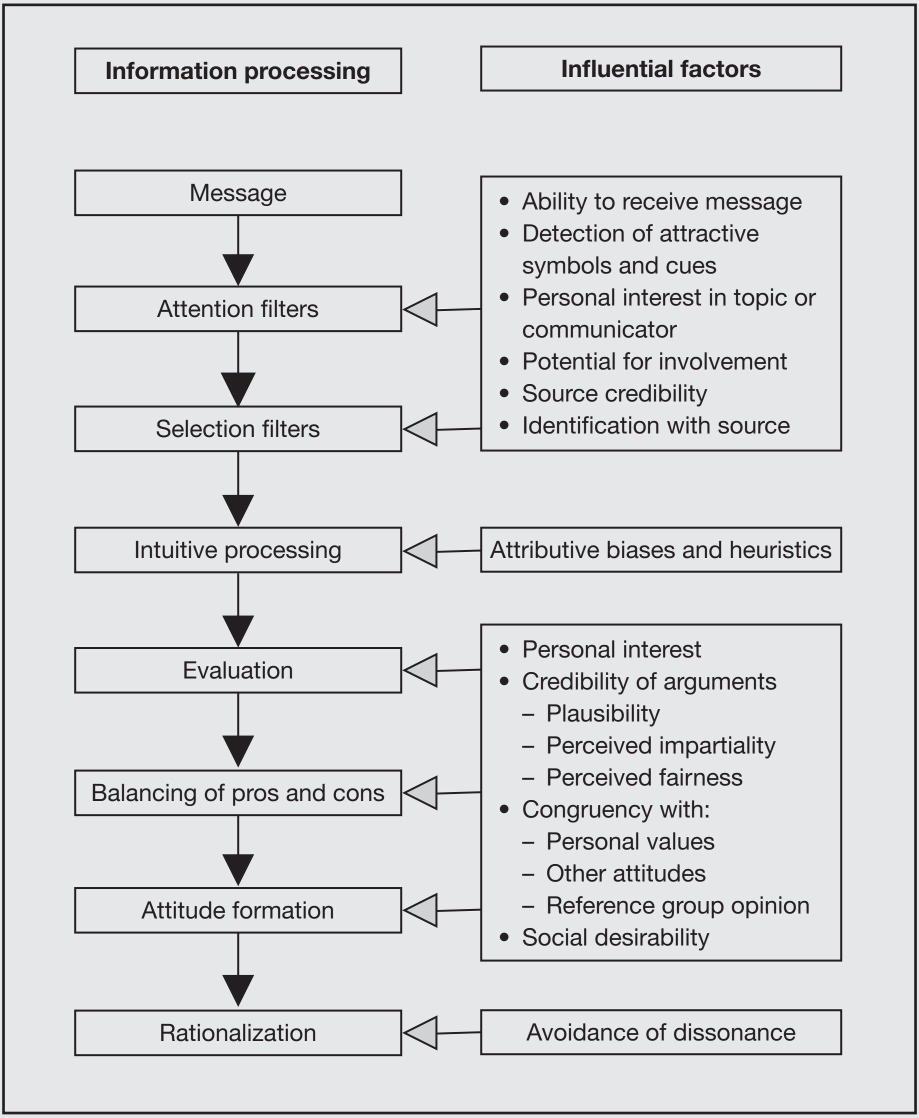

Figure 7.7 *The central route of persuasion*

Source: adapted from Renn and Levine, 1991 and Renn, 1992a, p488

performs two types of evaluation: first, an assessment of the probability that each argument is true; and, second, an assignment of weight to each argument according to the personal salience and emotional value of the argument's content. The credibility of each argument can be tested by referring to personal experience, plausibility and the perceived motives of the communicator. In modern societies with highly

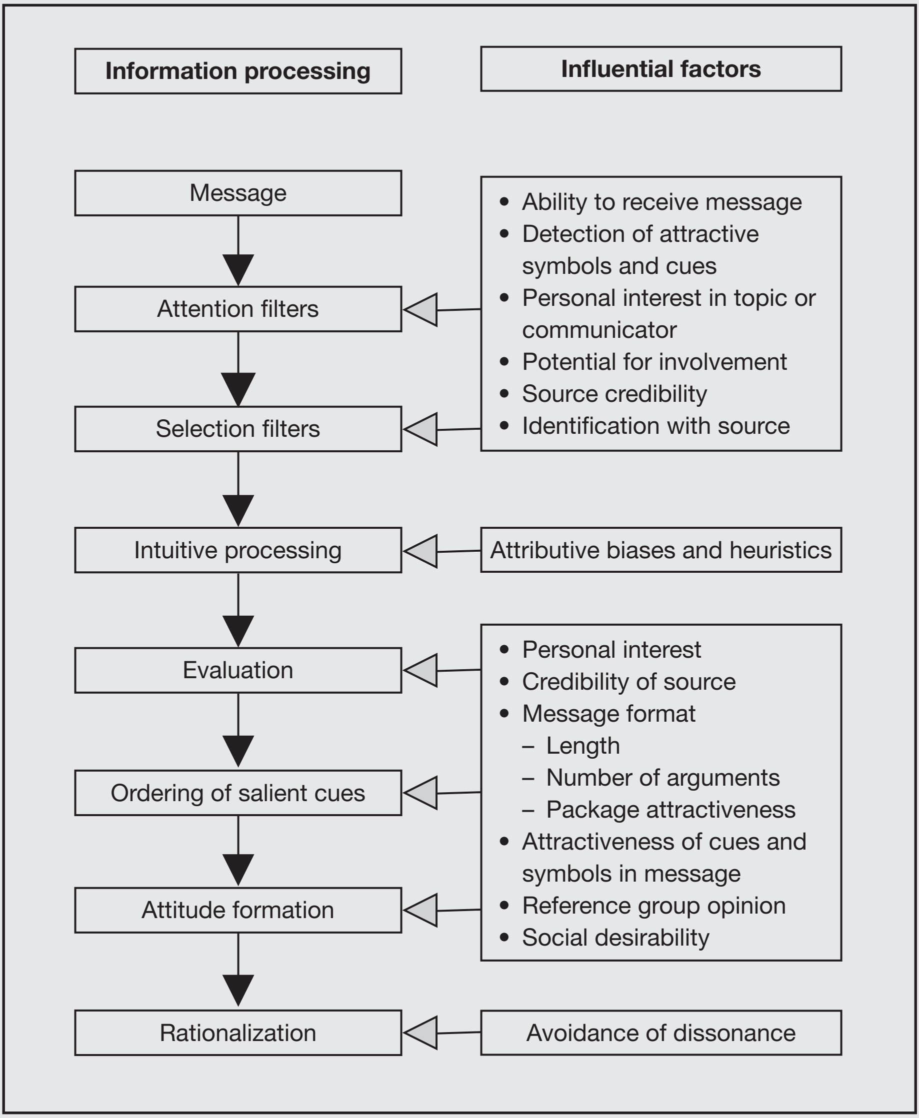

Figure 7.8 *The peripheral route of persuasion*

Source: adapted from Renn and Levine, 1991 and Renn, 1992a, p489

professionalized and differentiated knowledge, experience and plausibility are often weak instruments in evaluating the truth of a statement (Kahlor et al, 2004). No layperson, for example, has any empirical evidence to prove or disprove an expert's claim that low-level radiation causes cancer. Rather, recipients use secondary cues, such as prestige of the source and suspicion of vested interests, to evaluate the accuracy of a statement (Eagly et al, 1981; Heesacker et al, 1983). It is important to note that in these instances, where personal experience is lacking, both the central and the peripheral route are almost identical because they rely on a judgement based on trust or credibility. This judgement is made for each argument in the case of the central route, but is made for the total message, or holistically, for the source in the case of the peripheral route.

Evaluating the salience of each argument is performed by comparing the message with one's personal interests, one's own value system, other major attitudes and beliefs, emotional feelings, reference group judgements, and the perceived social desirability of the intent of the message (Chaiken and Stangor, 1987; Sorrentino et al, 1988; Ajzen, 1992; Slovic et al, 2002). This process may be more or less pronounced, and not all of the comparisons have to be made for each argument. But the major incentives for changing an attitude in the central mode are proximity with, and affinity to, one's own interests, values and world views. In the peripheral mode, receivers do not bother to deal with each argument separately, but look for easily accessible clues to make their judgement on the whole package.

The last two stages refer to attitude formation and rationalization. After the formation process, in which the receiver incorporates the message into his/her attitude system, the potential negative arguments are frequently suppressed or redirected into a positive view. This is done more intensely if the balancing act requires more mental work and pain. This process of bolstering helps to avoid cognitive dissonance and post-decisional regret (Janis and Mann, 1977). The two routes do not differ in these last two stages.

Attitudes and behaviour

Once attitudes are formed, they generate a propensity to take action. As known from many attitude studies, the willingness to take action, however, is only partly related to overt behaviour (Allport, 1935; Rokeach, 1969; Wicker, 1969; Fishbein and Ajzen, 1975; Feldman and Lynch, 1988; Ajzen, 1992; Wall, 1995; Sutton, 1998). A positive or negative attitude is a necessary but not sufficient step for corresponding behaviour. A person's decision to take action depends upon many other variables, such as behavioural norms, values and situational circumstances. Hence, the communication process will influence the receiver's behaviour; but the multitude of sources, the plurality of transmitters and the presence of situational forces on personal behaviour render it almost impossible to measure, not to mention to predict, the effect of a single communication activity.

The weak correlation between attitudes and behaviour is one of the major problems in risk communication that aims to change behaviour (e.g. for emergency responses). Most analysts agree that it is difficult enough to change or modify attitudes through information; but that it is even more difficult to modify behaviour. Some success stories (Salcedo et al, 1974; Fessenden-Raden et al, 1987; McCallum, 1987; Pinsdorf, 1987) in the area of health risks (e.g. reducing cholesterol and pesticide use), as well as some failures (Mazur, 1987b; Sandman et al, 1987; Powell and Leiss, 1997) to promote actions (e.g. protection against indoor radon) suggest that three factors are crucial for increasing the probability of behavioural changes:

1 *continuous transmission of the same information* even after a positive attitude has been formed towards taking action (need for constant reinforcement);
2 *unequivocal support of most relevant information sources* for the behavioural change advocated in the communication process (need for consistent and consensual information);
3 *adoption of the behavioural changes by highly esteemed reference groups or role models* (social incentive for imitation).

Behavioural changes, particularly if they involve painful changes of habits, are rarely triggered by information alone. Rather, information may be effective only in conjunction with other social factors, such as social norms, roles and prestige.

Lessons for risk communication

How can studies on persuasion be helpful in analysing and designing risk communication programmes? Most importantly, they point to the differences in information processing between the peripheral and the central route of persuasion. The centrally interested audience will collect information on pros and cons while the peripherally interested are keen on obtaining easily available clues for orientation (Breakwell, 2007, p134). More specific lessons could also be drawn:

First, the perception of credibility is a major component of the attention and selection filter in both routes and, at the same time, a heuristic tool to assess the probability that an argument is, indeed, accurate and valid. Functional equivalents are available for both routes of persuasion, but specifically for issues in which personal experience and intuitive plausibility are lacking and where trust in the communicator plays a major role. In the central mode, trust is important for judging the credibility of each argument; in the peripheral mode, it is important for evaluating the sources of information.

Second, an effective risk communication programme must contain a sufficient amount of peripheral cues to initiate interest in the message, but also enough 'rational' argumentation to satisfy the audience with central interest in the subject. The problem is how to avoid anger and rejection by centrally interested individuals if they are confronted with 'superficial' cues, such as advertising gimmicks, and how to sustain the interest of peripherally interested people if they are confronted with lengthy argumentation. The problem can be resolved if the message avoids including 'obvious' cues, but relies on cues that are acceptable for both audiences: those centrally and peripherally interested. These cues could be photographic images or interesting narratives that often carry a simple message without making it appear simple.

Third, the complexity and multitude of influential factors that govern attitude formation make it impossible to design fool-proof recipes for influencing (or, even worse, manipulating) people. Internal values, the perception of own interests, external pressures and role models, as well as personal experience, are the most powerful agents in attitude formation. The design and packaging of the message may help to make people aware of the message and to make the message appear at least more credible. But the desired effect of changing people's attitudes or opinions will occur only if the salient influential factors, upon which the communicator has hardly any influence, are already directed in favour of the message.

CONCLUSIONS

The objective of this essay was to review three out of the four functions of risk communication, to present several psychological and sociological insights into communication studies, and to delineate some practical guidelines for risk communicators based on social theory and empirical studies.

Almost all risk communication studies are quick to point out that risk communication is not a public relations problem (Gray et al, 1998; Bennett and Calman, 1999). Advertisement and packaging of messages can help improve risk communication; but they cannot overcome the problems of public distrust in risk management institutions or cope with the incapability of the current risk arena to produce rational and consistent risk policies. The potential remedies to these two problems are: better performance of all institutions dealing with or regulating risks, and restructuring the risk debate to meet the requirements of effective communication.

With regard to a good performance record as a prerequisite for credibility, many risk management institutions face the problem that their specific task is not well understood and that public expectations do not match the mandate or the scope of management options available to these institutions. This is certainly not unique to risk management agencies. Lipset and Schneider (1983) found out that elites in the US complain regularly about the ignorance and misconceptions of the public with respect to their mandate and performance. Regardless of whether this claim is true, a clear gap separates the self-perception of most institutions and the public perception of these institutions. This is specifically prevalent in the risk arena because health and environment top the concerns of the public, and because the stochastic nature of risk impedes an unambiguous evaluation of management success or failure (Johnson, 1993).

In spite of these difficulties, careful management, openness to public demands and continuous effort to communicate are important conditions for gaining trustworthiness and competence. They cannot guarantee the success; but they make success more probable. Therefore, the *first principle of good risk communication practice is to start with a critical review of one's own performance*. Is the performance good enough to justify public trust? Are mechanisms in place that help discern the needs and requests of stakeholders and the general public? Is a two-way communication programme implemented? Is the communication honest, clear, comprehensive and timely?

The second most important principle of risk communication refers to its position in the risk management process. Many risk managers believe that risk communication starts after the management process is completed. Most studies on risk communication demonstrate, however, that risk communication needs to be an ongoing activity during all stages of risk assessment and management (Leiss and Chociolco, 1994; Jungermann and Wiedemann, 1995; Leiss, 1996). *Therefore, the second principle of good risk communication is to design an integrative risk management and communication programme ensuring a continuous effort of communicating with the most important stakeholders and the consumers during the risk assessment and management process*. In the early phases of management, the identification of the problem and the choice of the appropriate objectives and criteria, risk communication needs to address issues such as methods and techniques to identify problems and to ensure public protection. In later management phases, particularly the selection of risk management options and the drafting of recommendations, the rationale for making trade-offs between conflicting objectives and the targeted level of protection need to be addressed. Questions in this context are: how do risk managers detect problems before it is too late? What criteria are being used for evaluating risks? How is the decision process designed to accomplish an optimal trade-off between economic, environmental and public health objectives?

If these questions can be positively answered, the designing of communication can be optimized. *The third principle of good risk communication practice is to tailor communication according to the needs of the targeted audience and not to the needs of the information source*. Information should match public expectations.

The fourth principle of good risk communication practice is to adjust and modify one's communication programme as a result of an organized effort to collect feedback and to sense changes in values and preferences. Many successful programmes of the past have turned out to be inappropriate in addressing the audience of today. Constant adjustment requires efforts to collect systematic feedback from the community, the relevant stakeholders and the general public. This calls for a continuous evaluation programme.

Even if all these suggestions are followed, risk communication may not work (Trettin and Musham, 2000). External influences, the overall climate of distrust, past management failures and specific incidents can transform risk communication into a never-ending frustration. This frustration – so familiar to most risk managers – is an indication of the need for a more fundamental risk discourse. This will be addressed in Chapter 8 on stakeholder involvement and participation.

The ultimate goal of a risk communication programme is not to ensure that everyone in the audience readily accepts and believes all of the information given. Instead, it is to enable the receivers to process this information in order to form a well-balanced judgement in accordance with the factual evidence, the arguments of all sides, and their own interests and preferences. To accomplish this goal, a risk communication programme is needed to provide the necessary qualifications to all participants and to empower them to be equal partners in making decisions about risk.

Essay 8 *Guidance for Effective Risk Communication*[6]

Introduction

Risks from natural or human sources shape our physical, natural and human environment. Most people demand healthy and safe products, trust that technologies that are meant to serve them do not act against their vital interests, and expect regulatory agencies to reduce risk to levels deemed tolerable by the majority of people. The degree of risk that is still tolerable is, however, a question of major controversy (Bandle, 2007; Fairman, 2007) Many people like to act on the assumption 'better safe than sorry' (Lee, 1981; Pielke, 2002). At the same time, however, people have an interest in a large variety of products, low prices and the comfort and convenience of modern technologies. Unless risk information explicitly addresses aspects of potential benefits and social needs, it will not correspond to the expressed and revealed preferences of the people whom it is supposed to serve. For this reason, it is important to address the issue of how to communicate a complete and balanced picture of risk and benefit to stakeholder groups, as well as to the public at large.

Although most people are concerned about the health risks, environmental impacts and safety of technology, they have, on average, but a faint idea about risk assessment and risk management (OECD, 2002). They face difficulties when asked to differentiate between the potentially dangerous properties of a substance (hazards) and the actual risks that depend upon both the properties of the substance, the exposure to humans and the context of its uses. Risks are, hence, difficult to communicate. Most risks from chemicals, technologies or human activities are usually effective only over a longer period of time, may induce negative impacts only in combination with other risk factors (such as lifestyle and nutrition) and can hardly be detected by human senses. Risk communication needs to address the following major challenges:

- Explain the concept of probability and stochastic effects.
- Explain the difference between risk (context-dependent) and hazard (property-bound).
- Cope with different timescales, such as long-term effects.
- Provide an understanding of synergistic effects with other lifestyle factors.
- Improve the credibility of the agencies and institutions that provide risk information (which is crucial in situations where personal experience is lacking and people depend upon neutral and disinterested information).
- Cope with the diversity of stakeholders and parties in the risk management phase.
- Cope with inter-cultural differences within pluralist societies and between different nations and cultures.

Risk communication is a necessary and popular activity, which is partly mandated by governmental laws and regulations, and partly required by stakeholder demand and public pressure. In the light of new activism by consumer and environmental groups, private companies as well as governmental agencies feel obliged to provide more information and guidelines for consumers, workers and bystanders. This new challenge is embedded within a new industrial and political paradigm of openness and 'right to know' policy framework (Baram, 1984; Maxwell, 2003). In addition, globalization and international trade make it mandatory that products which may contain some hazard for the users are properly labelled and potential end users in different countries have sufficient information to handle the products safely.

This essay is designed to assist government agencies, industry and stakeholders to improve their efforts at communicating with other stakeholders, the media and the general public more effectively and efficiently. All advice given in this document rests largely on empirical evidence and research studies. Yet, in instances where empirical data are missing or inconclusive, intuition and experiential knowledge are crucial. However, even the most carefully designed and evidence-based approach to risk communication provides no guarantee that the communication programme will reach its defined goal (Fischhoff et al, 1993; Trettin and Musham, 2000; Löfstedt, 2003; Leiss, 2004). Adherence to effective communication guidelines improves the efficiency of communication but does not determine its effect. Most important for being effective is the public impression that the risk communicator has performed his or her regulatory or risk management task without major flaws. At the same time, risks are only acceptable if the activity causing the risk provides sufficient benefits. Unless risk information explicitly addresses aspects of benefits and social needs, it will probably fail to convince anyone that some residual risks are worthwhile, let alone that it is justified to impose risks on people without their explicit consent. If these two side conditions are met, the following advice will certainly assist policy-makers, private risk managers and regulators in improving their risk communication efforts.

This essay is focused on practical advice and down-to-earth recommendations. The following section introduces some important background information that will help practitioners to understand the rationale for some of the policy advice given later. Other background material and empirical studies that have inspired and enlightened most of the recommendations can be found in Essay 7. The guidance part of this essay distinguishes between guidelines for effective risk communication, the selection of adequate communication instruments, recommendations for dealing with the media, advice for stakeholder dialogue, and involvement and risk communication evaluation. This essay does not address the crucial issue of crisis management. Readers interested in this subject should consult the literature (e.g. Gottschalk, 1993; Fearn-Banks, 1996; Wogalter et al, 1999; Reynolds, 2002, US Department of Health and Human Services, 2002; Swedish Emergency Management Agency, 2003). Since the purpose of this essay is to provide targeted advice to risk communicators, academic jargon has been avoided and the number of scientific references limited to the absolute minimum.

Risk communication in context

Three levels of risk debates

One of the major goals of all risk communication programmes is to reconcile the legitimate intention of the communicator in order to get a message across with the equally legitimate set of concerns and perceptions that each person associates with the risk agent. It is obvious that technical experts try to communicate the extent of their expertise, while most observers are less interested in the technical details but want to communicate about the likely impacts of exposure on their health and well-being. Regardless of the intention of the communicator, the first step in any communication effort is to find a common denominator – a common language – upon which the communication can proceed and develop.

Finding a common denominator, or a common wavelength, requires a good understanding of the needs of the audience. Having investigated many different types of audiences and issues, our own research has led us to a classification of typical communication levels which are normally addressed during a risk debate (Funtowicz and Ravetz, 1985; Rayner and Cantor, 1987; first published by Renn, 1992a; refinement in Renn, 2001). These levels refer to:

- factual evidence and probabilities;
- institutional performance, expertise and experience;
- conflicts about world views and value systems.

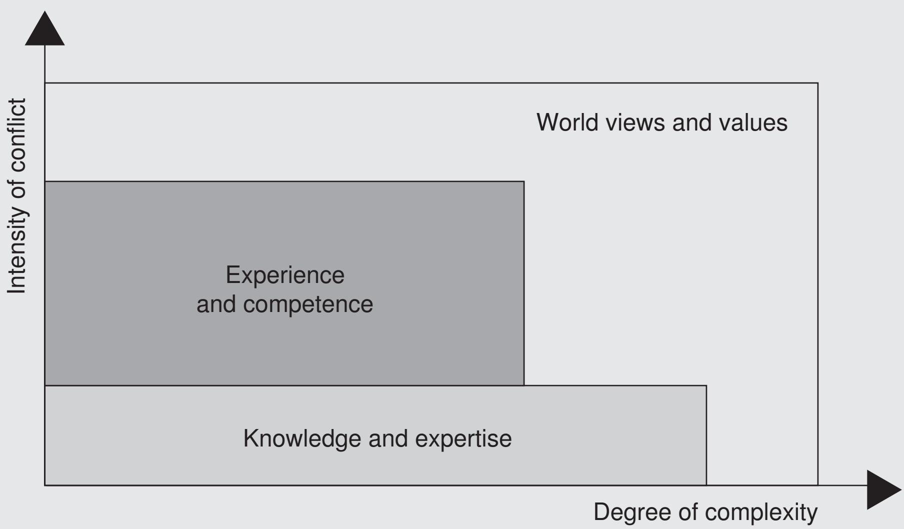

Figure 7.9 *The three levels of risk debates*

Source: adapted from Renn, 1992a, p493; based on the knowledge classification model by Funtowicz and Ravetz, 1985

Figure 7.9 is a graphical representation of this model using a modified version of the original categories. An overview of the three levels of risk debate and their requirements (including elements for evaluation) is also illustrated in Table 7.3. The first level involves factual arguments about probabilities, exposure levels, dose–response relationships and the extent of potential damage. This level also includes the possibility of communicating about the technical methods and instruments in order to identify and quantify risks.

The function of communication on the first level is to provide the most accurate picture of factual knowledge, including the treatment of remaining uncertainties (e.g. what happens below the 5 per cent confidence interval) and assumptions (are the assumed safety factors sufficient?). Even if the objective here is to transfer knowledge or to create a common understanding of the problem, an attempt at two-way communication is needed to ensure that the message has been understood and that the technical concerns of the audience have all been addressed.

The second, more intense, level of debate concerns institutional competence to deal with the risks. At this level, the focus of the debate is on the distribution of risks and benefits, and the trustworthiness of the risk management institutions. This type of debate does not rely on technical expertise, although reducing scientific uncertainty may help. Risk communication on the second level requires evidence that the risk managers of private institutions and public agencies have met their official mandate

Table 7.3 *The three levels of risk debate and their communication needs and evaluation criteria*

Criteria levels	Issue of conflict	Communication needs	Evaluation
1	Technical expertise	Information transfer	Access to audience Comprehensibility Attention to public concerns Acknowledgement of framing problems
2	Experience, trustworthiness and performance	Dialogue with stakeholders and the public	Match between public expectations Openness to public demands Regular consultations Commonly agreed procedures for crisis situations
3	Values and world views	Dialogue and mediation	Fair representation of all affected parties Voluntary agreement to obey rules of rational discourse Inclusion of best available expertise Clear mandate and legitimization

Source: Ortwin Renn

and that their performance comes up to public expectations. In a complex and multifaceted society, such evidence is difficult to provide.

Gaining institutional trust requires a continuous dialogue between risk managers, stakeholders and representatives of the public. The chemical industry's programme, as it was originally designed, on 'responsible care' may serve as an example for such a dialogue (King and Lenox, 2000). The participants expressed their positions on aspects such as emergency planning or accident management; they exchanged interpretations about the current situation or future threats and worked on mutually acceptable means of improving existing risk management practices. In such dialogues, trust can be gained by showing that the risk management institution is competent, effective and open to public demands, even though the citizen advisory groups within the responsible care programme have been established and organized by industry itself.

At the third level, the conflict is defined among different social values and cultural lifestyles, and their impact upon risk management. In this case, neither technical expertise nor institutional competence and openness are adequate conditions for risk communication. Dealing with values and lifestyles requires a fundamental consensus on the issues that underlie the risk debate. This implies that the communication requirements of the first and second level (i.e. risk information or involvement in a two-way dialogue) are insufficient to find a solution that is acceptable to all or most parties. Often, risk communication by private actors or industry may come across as a convenient strategy to diffuse responsibility and legitimate self-interests or sell products. Public authorities may face major problems if they insist that residual risks are tolerable and can be imposed even upon those who do not share the benefits of the respective activity. In particular, the label 'unavoidable' for some residual risk may trigger off major controversies. Are pesticide residues unavoidable? Greenpeace and other more radical environmental groups would probably oppose this statement. The main point here is that the use of the word 'unavoidable' may trigger a debate on the third level and fuel (and reinvigorate) the old controversy between the right and the left, between industrialists and environmentalists and other value-driven groups (Mazur, 1981; Schwarz and Thompson, 1990; Stern, 1991).

Third-level debates require new unconventional forms of stakeholder involvement, such as mediation, citizen panels, open forums with special groups and others (see Essays 9 and 10 on stakeholder involvement and participation). The main task of such exercises is to reflect on the relevant values that apply to the situation; to search for solutions that all participants find acceptable or at least tolerable; and to build an atmosphere of mutual trust and respect.

There is a strong tendency for risk management agencies to reframe higher-level conflicts into lower-level ones: third-level conflicts are presented as first- or second-level conflicts, and second-level conflicts as first level. This is an attempt to focus the discussion on technical evidence, in which the risk management agency is fluent. Stakeholders who participate in the discourse are thus forced to use first-level (factual) arguments to rationalize their value concerns. Unfortunately, risk managers often misunderstand this as 'irrationality' on the part of the stakeholders. Frustrated, many stakeholders then turn to direct action and protest. In the end, there is only disillusion and distrust.

What is the appropriate level of the debate? Are conflicts on the first level (factual dissent), the second level (institutional performance) or the third level (values and world views)? Which of the three levels is most important for the communicator and which for the audience? Depending upon the answer to these queries, different risk strategies are required. These strategies will be laid out later in this essay.

Four types of risk

The three levels of risk debate correspond to the nature of the risk under question. It makes sense to distinguish four types of risk for which different communication strategies are appropriate (IRGC, 2005; Renn, 2007b). The first two categories relate mostly to level 1 of risk debates, the third category to level 2 and the fourth to level 3. Yet, there are, as usual, interactive effects between and among these categories:

- *Linear (routine) risks:* these risks are well known to scientists; risk managers are aware of the potential consequences, and few uncertainties remain. In addition, conventional methods, such as using specific chemicals in the prescribed way or in order to operate a specific technology, are sufficient to protect oneself. Communication for this type of risk requires mainly the assurance that the risk is, indeed, a routine case and that all management organizations are well equipped for performing the necessary tasks for consumer protection. Specific information about the risk includes technical guidance on the proper use of this specific chemical (first-level debate).
- *Highly complex risks:* these risks are characterized by a complex web of relationships between the cause of a risk and its effect. Often, it is difficult to identify and quantify causal links between a multitude of potential causal agents and their specific adverse effects. The nature of this difficulty may be traced back to a number of different factors, which are subsumed under the term complexity: interactive effects among the causal agents (mutual strengthening or weakening), positive and negative feedback loops, long lapses of time between cause and effect, inter-individual variation and intervening variables. These are but a few of the multiple factors that give hints as to complexity. It is precisely these factors that make high-level scientific investigations necessary since the cause–effect relationships in complex risks are neither obvious nor directly observable. The global decrease in biodiversity is an impressive example of a risk that is characterized by high complexity. There are many factors (such as the destruction of the natural habitat of endangered species; increasing land use for housing and industry; landscape fragmentation; intrusion of invasive species caused by globalized transport and travel; climate change; and environmental pollution) whose interdependencies cannot completely be identified or quantified. The complexity of the causal relationships necessitates sophisticated scientific models and often leads to scientific dissent about what data are relevant, what methods are adequate, and what models are appropriate. Risk communication here is first directed towards an exchange between professional risk analysts and managers, and, secondly, towards stakeholders and the general public. The level of debate oscillates between level 1 and level 2.

- *Risks with high uncertainty:* uncertainty may result from high complexity if scientific research is unable to provide unambiguous results. In this case, risks are less well known and may lead to consequences that are not fully understood by risk professionals. Some health effects and the full scope of environmental impacts may still be under debate. In these situations, risk managers need to address fears of the unknown. The main goal here is to address the competence of risk management organizations to monitor impacts, to reverse decisions if negative impacts become visible and to proceed in a precautionary way in order to avoid irreversible damage. The public will demand specific information on the trustworthiness of the agencies or organizations, rather than on the product itself. Most risks with high uncertainty require communication on risk level 2 and occasionally on 3.
- *Risks with high potential for ambiguity and controversy:* these risks may be uncertain or not; but they trigger highly controversial or emotional responses. Often, public outrage is associated with these risks (Sandman, 1988, 2001). The controversies are frequently caused by different views about the legitimacy of the product or its release. A good example may be exposure to electromagnetic fields from mobile phone base stations (MacGregor and Morgan, 1994; Covello, 1998; Wiedemann and Schütz, 2000, 2005). Many people feel involuntarily exposed to this risk, fear long-term impacts on their health and regard this risk as a violation of fairness since they might not use mobile phones themselves. Risk perception research has identified the main risk characteristics that trigger or amplify public concern and anxiety (details are in Essay 4 on risk perception). Risk communication in highly controversial settings requires discussion of public values, lifestyles and world views. Stakeholder involvement is an inevitable element of an effective communication programme if highly controversial risks are at stake. These risks require debates on risk level 3.

The risk communication advice that follows in this essay includes guidelines for all four types of risk.

The characteristics of the audience: Addressing different subcultures in society

Another major problem of risk communication is to tailor the content of the communication process to the interests and concerns of the different social and cultural groups within a society. One major element of understanding the needs of the target audience is the distinction between centrally and peripherally oriented receivers (see Essay 7). This distinction helps communicators to place more emphasis on arguments or on peripheral associations (Petty and Wegener, 1998). Of major assistance to risk communicators is also the crude characterization of the audience according to cultural beliefs. This is not only a means of avoiding the 'fuzziness' of peripheral cues in persuasion, but also addresses the arguments that the audience understands and finds 'acceptable'. Often, a few words used without much further thought may ignite public outrage, whereas long arguments may not even be followed by those who are centrally interested in the subject. Again, it is futile to try finding a classification that provides a full representation of all potential audience types. But it has been helpful

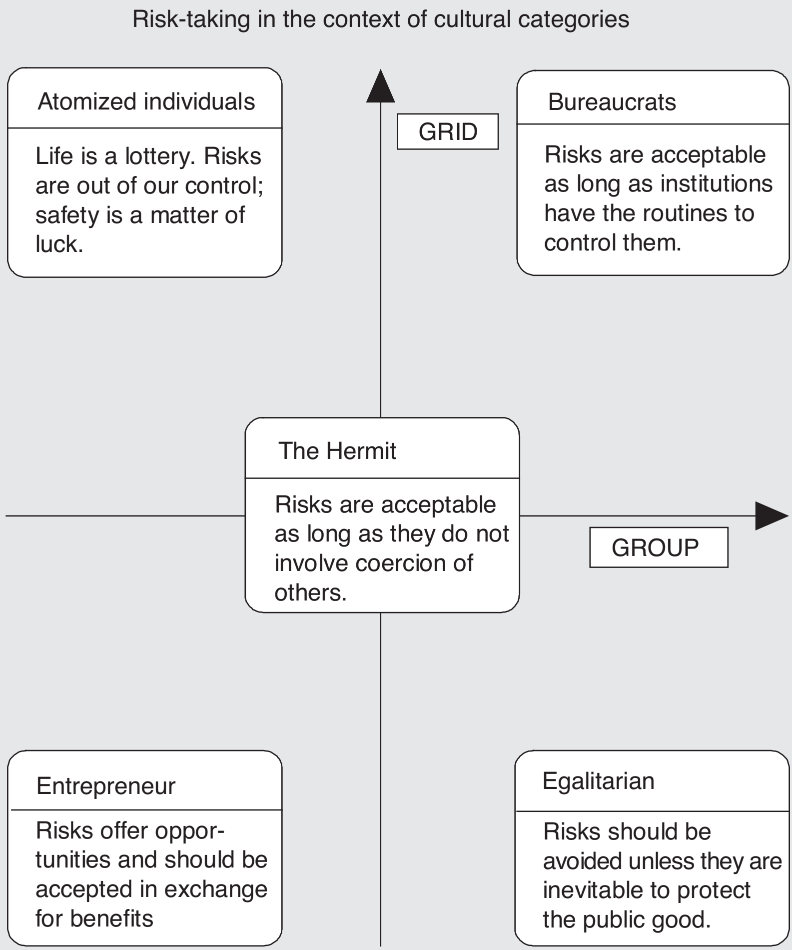

Figure 7.10 *Risk-taking in the context of cultural value clusters*

Source: adapted from Thompson et al, 1990 and Renn et al, 2007, p57

to work with a classification which has been labelled (in our opinion, mislabelled) as a cultural approach to risk.

A group of distinguished anthropologists and cultural sociologists, including Aaron Wildavsky, Mary Douglas and Michael Thompson, have investigated the social response to risk and have identified four or five patterns of value clusters that separate different groups in society from each other (Douglas and Wildavsky, 1982; Schwarz and Thompson, 1990; Thompson et al, 1990; Rayner, 1992). These different groups have formed specific positions on risk topics and have developed corresponding attitudes and strategies. They differ in the degree of *group* cohesiveness (the extent to which someone finds identity in a social group) and the degree of *grid* (the extent to which someone accepts and respects a formal system of hierarchy and procedural rules).

These groups comprise entrepreneurs, egalitarians, bureaucrats, stratified individuals and (in some publications) hermits, who can be localized within the group–grid space (see Figure 7.10). Organizations or social groups belonging to the *entrepreneurial* prototype perceive risk-taking as an opportunity to succeed in a competitive market and to pursue their personal goals. They are characterized by a low degree of hierarchy and a low degree of cohesion. They are less concerned about equity issues and would like the government to refrain from extensive regulation or risk management efforts. This group contrasts most with organizations or groups belonging to the *egalitarian* prototype, which emphasizes cooperation and equality rather than competition and freedom. Egalitarians are also characterized by low hierarchy, but have developed a strong sense of group cohesiveness and solidarity. When facing risks, they tend to focus on the long-term effects of human activities and are more likely to abandon an activity (even if they perceive it as beneficial to themselves) rather than take any chances. They are particularly concerned about equity.

The third prototype – the *bureaucrats* – relies on rules and procedures to cope with uncertainty. Bureaucrats are both hierarchical and cohesive in their group relations. As long as risks are managed by a capable institution, and coping strategies have been provided for all eventualities, there is no need to worry about risks. Bureaucrats believe in the effectiveness of organizational skills and practices, and regard a problem as solved when a procedure to deal with its institutional management is in place.

The fourth prototype, the group of *atomized or stratified individuals,* in principle, believes in hierarchy, but it does not identify with the hierarchy to which they belong. These people trust only themselves, are often confused about risk issues and are likely to take on high risks for themselves, but oppose any risk they feel is imposed upon them. At the same time, however, they see life as a lottery and are often unable to link harm to a concrete cause.

In addition to the four prototypes, there may be a hybrid group called the *autonomous individuals, or the hermits*, who can be grouped at the centre of the group–grid coordinates. Thompson (1980) describes autonomous individuals as self-centred hermits and short-term risk evaluators. They may also be referred to as potential mediators in risk conflicts since they establish multiple alliances with the four other groups and believe in hierarchy only if they can relate the authority to superior performance or knowledge.

This theory has been criticized on several grounds (Nelkin, 1982; Sjöberg, 1996; Breakwell, 2007, pp72ff; see Essay 4). The debate is still proceeding without a clear consensus in sight. Most risk communicators have assured me, however, that this classification has helped them tremendously in preparing communication programmes for different audiences. There is sufficient anecdotal evidence that people with an entrepreneurial attitude react very differently to specific arguments compared to people with an egalitarian or bureaucratic attitude. For example, a reference to cost–benefit ratios makes perfect sense when presented to an audience of entrepreneurs, but would trigger off outrage when referred to in a group of egalitarians.

Recommendations for effective risk communication

Minimum requirements

The content of any risk communication programme will depend upon the specific circumstances of the case at hand, including the precise nature of the hazard(s) and the nature of the risk (including dose–response, exposure and/or vulnerability). *Every effective programme must address, in as much detail as possible, the particular concerns of affected or interested parties in the specific case at hand.* However, prior experience with risk issues tells us that all risks have many aspects in common, no matter the differences in composition or causation. Therefore, it is possible to specify on this basis the *minimum required content* of any effective risk communication effort at any level and for any risk type:

- Begin with a statement of commitment to maintaining a communication flow of information *pertinent to public concerns* about the case at hand.
- Distinguish clearly between hazard (the type(s) of possible harm) and risk (the likelihood for individuals or populations to suffer those harms).
- If the type of possible harm has special qualities, eliciting feelings of 'dread' or heightened fears, be aware of them and acknowledge them in the communications.
- Specify what is known about exposures and whether it is likely that sensitive populations (especially children) will be exposed.
- Indicate the quality of the knowledge base, how it is expected to improve through further research, and who is responsible for improving it.
- Describe qualitatively the uncertainties in the knowledge base and what further steps might reduce these uncertainties and when.
- Describe both quantitatively and qualitatively the estimates of probability that have been made, if available, or if not available when they might be expected.
- Provide a justification for what is thought to be a tolerable or acceptable level of risk in this case, using either risk–risk or risk–benefit trade-offs, or both, and communicate a willingness to discuss alternative viewpoints on where this line should be drawn.
- Provide a clear and compelling justification for the type of action response that has been chosen or recommended in this case.
- Specify how the potential victims of risk may protect themselves against the known or potential risk and if (and how) it may be fully controlled; provide contact information where responses to questions may be obtained.

Message composition and design

No matter what audience, what risk level or risk type is chosen, there are a number of general rules that, if followed, will assist risk communicators in achieving maximum impact for their messages:

- *Be clear about your intentions and make them the central message of your communication effort.* Most people have little time to read long essays or detailed descriptions. Be sure that the central message is said in the beginning and that all other material is always related to it. Clarity and unequivocal position are two major conditions for messages to pass though the attention filters of the respected audience (Breakwell, 2007, p132).

- *Simplify your message as drastically as you think you can without being inaccurate.* Messages will be simplified regardless of how well written the text may be. Rather than have the transmitters or final receivers simplify the text their way, the communicator may provide a more accurate overview that is also in accordance with their original intention. Simplification is a very delicate job and needs careful editing and re-editing. Factual information should be made as clear as possible; but information about the decision process, the values that were used to make trade-offs and the remaining uncertainty should not be omitted, as this information is crucial for building credibility and trust.
- *Never assume technical knowledge about the issue unless the audience is clearly from a technical community.* Most people have experienced some physics, chemistry or natural sciences in school; but during their work life they have not been exposed to much technical information and probably have forgotten most of it. Even if you think that the terms or concepts you have been using are straightforward, this is probably not the case. People are generally well educated; however, given the vast amount of knowledge in the contemporary world, nobody can claim to have universal access to the information of all disciplines. Therefore, avoid technical jargon, do not presuppose any systematic knowledge of the subject and explain only those elements that are essential to understand the message.
- *Place your simple messages at the beginning of a text and gradually add the complex issues.* Although simplicity is a virtue for the whole information process, it is advisable to start with basic messages and to add more complex and detailed information at the end. This structuring of the information serves two purposes: it attracts the attention of the peripherally interested audience and, at the same time, pleases the well-educated audience, who expect detailed argumentation and sufficient evidence. The only way to please both audiences (aside from splitting the information) is to give the general information first and add the specifics later.
- *Anticipate the interests of your target audience and design your communication programme to match their needs.* This guideline is the most often violated rule in risk communication. Experts in institutions have the irresistible tendency to package a whole education programme in every endeavour to communicate with the public. But most people have neither the desire nor the time to become chemical experts, toxicologists or statisticians. Most people want to know the consequences of a risk, the circumstances of its occurrence, the possibility of mitigating the risk, and the management efforts by the respective institutions. Depending upon the desired level of the risk debate, communication should focus on the scientific evidence, the management record of the institution, or the world views and philosophies that govern institutional performance.

Apart from these general guidelines for designing and composing effective messages, there are additional points of advice for dealing with specific risk issues, such as probabilities, hazards, risk comparisons and low-probability/high-consequence risks. These can be summarized as follows:

- *Place risk in a social context and report numerical probabilities only in conjunction with verbal equivalents.* The functioning of the intuitive heuristics and biases in processing probabilistic information mandates a verbal explanation of numerical probabilities. Most people have difficulty in understanding the meaning of probabilities and tend to focus on obvious consequences. This verbal explanation should attempt to put risk in perspective in relation to other risky activities. Nevertheless, numerical probabilities should be mentioned because they are the most accurate indicators of the relative severity of the risk and, thus, a vital component of all risk policies. In addition, the more interested and well-educated audience demands such information and will suspect an attempt to hide relevant facts if the numerical data are withheld. Empirical research suggests that the form of numerical information (such as $1/x$ or 4×10^{-x}) hardly makes any difference as long as numerical and verbal data are displayed in parallel (Jablonski, 1994; Johnson and Slovic, 1995).
- *Be cautious with using risk comparisons in the message. Risk comparison should rely only on those risks that are perceived as comparable by the public.* Risks with identical benefits are certainly better suited to risk comparisons than risks with divergent benefits. It has also been suggested that comparisons should be based on the situation with and without the cause of risk or include only risks that lead to an identical set of consequences. But the major point is the purpose of risk comparison. Comparisons should only serve the purpose of illustrating the meaning of abstract probabilities. Risk comparisons for the purpose of suggesting judgements about acceptability should be avoided: they are neither logically defensible nor convincing in the eyes of the public.
- *Relate risk information to the life-world of the audience.* It may be useful to insert anecdotal evidence or report about identifiable victims when communicating about familiar and unspectacular risks, such as smoking or synthetic drugs. Attention is almost assured if the receivers perceive the risk as a potential threat to themselves or their primary group. Moreover, receivers will more easily relate to and remember messages that are conveyed in a narrative, rather than an analytical, format. Dramatic and unfamiliar risks and risks from consumer products are likely to arouse special public concern. In the case of low probability of harm, these concerns should be met by focusing communication on the unlikely circumstances under which the risk may, indeed, materialize. One can also point to positive experiences of the past.
- *Include as part of your information a consideration of the qualitative characteristics that people associate with risk.* These characteristics include dread, familiarity, personal or institutional control, perception of fairness in risk–benefit distribution and assignment of blame. It is important to address these concerns rather than focus on probabilities and magnitude of risk. Demonstrate how some of these qualitative characteristics have been considered when designing the risk management programme. Risk communication should also address how deficiencies in these qualities have been compensated for or will be handled.

- *Point out the importance of exposure and dose when communicating about risks.* Often, consumers may confuse hazards with risks, and they may be unaware of how dose and circumstances of exposure determine risk. If a product contains an ingredient which may have been found to be toxic or carcinogenic at a higher dose than is present in the product, most people will be concerned that the presence of this ingredient poses a risk to the user of the product. Provide simple examples that show the difference between risk and hazard. Describe what is known about the relationship between exposure, dose and risk.
- *Avoid linking the risk communication effort to a non-health-related interest.* If risk communication is perceived as a new strategy by industry to avoid risk reduction measures or a clever plot of risk regulators to put the responsibility on the back of consumers, the communication programme will be rejected by most observers. Rather, risk communication programmes should stress the potential benefits of a regulatory regime that takes all serious risks into account and that ensures that the benefits are equally shared by industrialists, environmentalists and consumers. It needs to be proven that public health is served better if risk regulation is based on thorough assessments rather than on suspicions.

How to gain or sustain trustworthiness

With the advent of ever more complex technologies and the progression of scientific methods to detect even the smallest quantities of harmful substances, personal experience of risk has been increasingly replaced by information about risks, and individual control over risks by institutional risk management. As a result, people rely more than ever on the credibility and sincerity of those from whom they receive information about risk (Löfstedt, 2001; Walls et al, 2004). Thus, trust in institutional performance has been a major key for risk responses (Earle and Cvetkovich, 1995; Löfstedt, 2005; Breakwell, 2007, pp243f). Trust in control institutions is able to compensate for even a negative risk perception, and distrust may lead people to oppose risks even when they are perceived as small. Indeed, some research shows clearly that there is a direct correlation between low perceived risk and public trust, and vice versa (Siegrist et al, 2000; Eiser et al, 2002; Sjöberg, 2001 is more critical).

Trust is based on open information exchange. If the communicator can demonstrate that all relevant information is shared with other institutions and the affected populations, trust will gradually grow. Even mishaps or minor failures will be accepted if the overall climate between risk managers and affected people is characterized by mutual respect, openness and honesty. There are some technical and organizational measures that risk management institutions can take in order to facilitate such a climate:

- *Share technical information, lab results, hazard data or any other relevant product information with the consumer and public interest groups.* If you claim that you have nothing to hide, then demonstrate it by being open to public scrutiny. Many chemical companies, for example, send their lab data or toxicological results directly to public interest groups and ask for their feedback. Even if one or the other group may misuse such an open-book policy, the net effect of such a policy outweighs by far the potential damage. There should be ways to provide this information without compromising legitimate confidentiality concerns.

- *Publish risk-related results in the daily newspapers or the journals that consumers read.* Even if many consumers may not understand exactly the meaning of the data, the mere fact that you publish results in highly visible journals enhances your credibility and gives the information that you have nothing to hide.
- *If labels are required on the product or if hazard information is necessary to warn people of potential health effects or possibilities of misuse, do not pursue the 'fine print option'.* Make the label highly visible, ensure that it is comprehensible and place it on a prominent spot on the package. Negative labels do not deter committed customers, but give them the information they need to protect themselves, which demonstrates that the industry or institution is committed to making their product as safe as possible. This has been proven by empirical research on the public's perception of information sheets attached to commercially available pharmaceuticals (Jungermann et al, 1988).

Without credibility, risk managers and governmental agencies will not reach their institutional objectives. But the opposite is also true. Without excellent performance, institutions will not gain or even sustain trust and credibility. Successful communication begins before imparting information. *Institutional performance is the major key to trust and credibility. The more one can demonstrate that the institution did a good job, the more one can expect trust.* On the premise of good performance, communication programmes can be designed that reflect these accomplishments.

INSTRUMENTS OF RISK COMMUNICATION

Brochures and written leaflets:

Written material is still the most popular form of communicating with different audiences on a large scale. The material should be designed in such a way that it corresponds with the audience's needs, concerns and level of knowledge. As a result, the first steps in preparing a written statement are to:

- define the major messages that you would like to convey;
- determine the types of audience whom you would like to address;
- get a feeling for the social and political context in which the issue is placed;
- articulate the message in a way that it meets the needs of the audience and corresponds to the social and political context;
- compose the whole communication package; and
- determine the channel of transmission.

Before sending out any information, it is important to test the effectiveness of your statement in meeting the needs of the audience for information. Have you provided all the information available and necessary for the audience to reach their own conclusions about the risk? One way of doing this is to conduct a pre-test exposing the material to small samples of the target audiences. One could also organize focus groups who, upon reading the material, are free to voice their impressions, opinions and criticism in a group context. You may choose to use the cultural categories of entrepreneurs, egalitarians and bureaucrats to form the composition of the focus groups. Sending out brochures with reply envelopes is another method of collecting information about the communication needs of the public that is fairly inexpensive. One may also combine this method with a sweepstake contest or some other form of incentive. The most important element here is to test understanding of the message and comprehension of the communicator's intention.

Information videos or internet presentations

In addition to the normal written information, new channels of multimedia presentations may also be used as a means of communicating with the consumer. All of the practical guidelines presented above also apply to multimedia presentations; but there is a set of additional requirements that you need to take into account:

- *Be fast, responsive and brief when using the opportunities of the new media.* The web and other electronic channels of communication rely on speed and intuitive comprehensibility. Customers expect routinely updated information, a good graphical design and little text to go with it. You can add longer texts for downloading; but these text elements should be clearly separated from your message part. Be sure to update your information at least once a month. Many search engines list the entries in the order of the dates of last change. A frequent update enhances the visibility of your message.
- *Make sure that the main search engines register your entry.* It is advisable to not only place important risk information under your normal homepage, but to also install a separate web page for this purpose. This is a good strategy to get registered in the search engines. In addition, add a list with key-words at the beginning of your message. Many search engines look for key-words when conducting a search.
- *Provide sufficient links to other organizations and information sources that deal with the same issue.* This allows viewers to get another opinion or to obtain more detailed information. You may demonstrate fairness and openness by including links to organizations that do not share your viewpoint.
- *Be sure to provide opportunities for viewers to respond.* Provide them at least with an email address where they can voice their opinion. If you offer this opportunity, make it clear as to whether or not you intend to respond to all feedback, a task that is not trivial and may consume considerable resources. Whether or not you respond to everything, such feedback can provide important insights and help to establish a productive dialogue with your audience.

Public lectures and discussions

Personal contact and appearance is certainly more convincing than anonymous written information. In addition to the message (form and content), lectures allow the audience to associate a human face with the message. It is therefore essential that the two tally. Most people have developed a fine sensitivity for individuals who role-play or try to sell them something. Formal training in speech and rhetorical skills is certainly helpful in addressing public audiences; but it is far more important that the communicator personally believes in what she or he is communicating to others. Being sincere, honest, open-minded, caring for the concerns of the audience and responsive to people's questions and comments makes it more likely that the audience will be open to considering the communicator's message than being elaborate, smooth and well spoken. With respect to risk communication, the effectiveness of lectures and public appearances can be improved by following some additional practical guidelines:

- *Explain the risk rationale to your audience and demonstrate the logic and adequacy of this rationale without claiming superiority.* Explaining the rationale of risk analysis and its role for risk management prepares the audience to acknowledge the basic principles of risk management decisions. The decision-making process and the past record of the institution should also be included in the message so that people can assign competence to the actors and get a better feeling of the trade-offs that are proposed or accepted by the communicator in meeting the specific objective. Evidence of competence, fairness towards other viewpoints, and references to commonly shared values and beliefs may make the audience more open to hearing the message and could help to address the centrally and peripherally interested audience at the same time. Conveying probabilistic information is a real challenge, but can be done in reference to everyday experience of budget constraints and consumer products. Furthermore, evidence of the successful use of risk analyses in hazard management can serve as a demonstration to define the role and limitations of risk analysis in improving public health and the environment.
- *Use visual aids when presenting technical information, but limit your central messages to less than seven for each presentation.* Most technical experts have a problem in limiting the amount of information they would like to convey. Psychological research has shown that most people in the audience will not follow a presentation for more than 20 minutes (at least then they should have a break), will not read a viewgraph that contains more than 20 words, and will not absorb more than a maximum of seven central messages during the entire presentation (Miller, 1956; Simon, 1974; Malhotra, 1982). This is why conclusions should be limited to seven or fewer points. The most effective lectures are those that have one focal message which is explained and illustrated throughout the talk.
- *Allow sufficient time for discussion when giving lectures to public audiences.* If you address a small audience (less than 50 people), it is wise spending half of the time of your total presentations for questions and answers. This helps the communicator to address the issues that people are interested in, rather than lecturing on points that are not relevant to the audience. The effectiveness of a lecture depends

upon the ability of the target audience to understand and comprehend the information, hear answers to their concerns and develop their own viewpoint. Motivation to learn can be enhanced if the lecture is organized in the form of a dialogue. If people can voice their concerns, they are more inclined to engage in mutual learning. This is why dialogic approaches to public lectures are much more effective than straight talks (as good as they may be). Immediately after the lecture, however, people may feel hesitant to ask the first question. You may ask a person, whom you know and trust, in advance, to raise the first question so that the 'ice is broken'. If you face a larger audience, discussions often become mere rituals of window dressing performed by representatives of interest groups. In this case, it may be better to organize small discussion groups of ten or fewer individuals and have spokespersons of each group pose the questions to you later in a plenary session.

- *Be available after the lecture for further requests or enquiries.* Many people who attend lectures need some time to digest what they have heard and to articulate questions or doubts about the content of the lecture. Therefore, it is important to convey to them that you, or somebody else, are/is available if these questions arise after the talk. You may distribute leaflets containing some major points of your presentation and your email address or a telephone number (much better than the usual business cards). You can also close your presentation with a slide showing opportunities for further information.
- *Distribute a handout or other written information after the talk.* People who have attended a lecture have shown their interest in the subject. The interest may fade away over time so that it is advisable to have written material available on the spot. A one-page leaflet is normally sufficient if it contains sources for further information (or websites). Personal lectures can trigger a snowball effect if they are linked to the other settings mentioned above.

Exhibitions, educational fairs, participation in science centres and visits to schools

Being involved in an educational effort is a long-term strategy to improve risk literacy among the population. This strategy is ineffective if it is meant to get a timely message about a risk or a risk management effort out to the public. One should also keep in mind that education is not a one-way street where individuals absorb what is fed to them. Audiences select what they find interesting, forget what they find boring and evaluate information according to their own sets of values and beliefs. Nevertheless, being involved in educational programmes has the advantage that basic knowledge in applied sciences and basic understanding of probabilistic reasoning can be made the main target of the communication effort. Sponsoring educational programmes is usually expensive and requires a long time commitment. One single science fair does not fully inform about the topic. Here again a few practical guidelines:

- *Develop educational programmes and projects with professionals in the field.* We all have plenty of anecdotal knowledge of what works and what does not work in education and student learning. We may waste a lot of money if we rely on this anecdotal wisdom. There is sufficient reliable and valid knowledge in the field of education and didactics that allows risk communicators to design educational programmes effectively and efficiently. Professionals in this field are available and can assist the communicator with specific knowledge and know-how.

- *Cooperate with institutions that specialize in education or training.* Almost any country has a broad infrastructure of educational institutions ranging from schools, training centres, evening schools, universities, colleges, science centres and museums, to community centres or health clinics. All of these institutions offer facilities and access to different audiences. There is no need to add yet another educational facility or centre unless you have a strong commitment from your organization to build an educational programme of your own.
- *Focus on interactive, life-world-related learning programmes.* Most professionals of the educational sciences agree that effective learning depends upon an interactive exchange of ideas, arguments and observations between teacher and student. This is also true for artefacts in science centres. Stuffed animals as shown in old natural science museums have no appeal to modern audiences. Artefacts should provide opportunities for interactive learning through experimentation and observation. In addition, respondents need to get involved in the material presented to them. Involvement is enhanced through intensive discussions about the messages received and through associations with the everyday life-world of the respondent. Again, it is advisable to link educational experience with written material, personal lectures and internet presentations.

Public dialogue and two-way communication

Any type of risk communication has to address public expectations and public knowledge about the risk under consideration and include public preferences about risk reduction measures before it can deal with actual management results and before it can hope to gain trust. Such an approach implies that the communicator makes an honest effort to listen to public concerns and to clearly demonstrate that concerns have been adequately addressed (Renn, 1998). *Risk managers have to learn from the public as much as the public can learn from them.* Two-way communication is clearly a prerequisite of successful communication; but it is often hard to implement and requires flexibility and the willingness to adapt to public concerns on the side of the communicating institution. Forms of two-way communication include:

- public meetings;
- public forums or panel discussions;
- face-to-face meetings between sceptics of the organization and organization leaders;
- talk shows on TV or the internet;
- internet chat rooms;
- inspection tours of facilities (open houses, special events in house, etc.).

In all of these forms of two-way communication the risk communicator is in direct contact with the target audience, and the members of the audience are equal partners in the exchange of arguments, ideas, impressions, evaluations and statements. The interaction among the communication partners follows the route of action and reaction, stimulus and response, questions and answers, claims and counter-claims. The main feature is the constant change of roles between being an active listener and a responsive presenter. Two-way communication can only succeed if all partners respect each other and are willing to engage in mutual learning. What are the main practical guidelines for conducting and participating in two-way communication programmes?

- *Be honest, complete and responsive in your contact with the target audience.* Honesty is a vital condition for gaining credibility. Honesty will not automatically be rewarded; but dishonesty will certainly create negative repercussions among the members of your audience. The same effect will take place when sources withhold relevant information or tell only one side of the story. The goals of honesty and completeness include another, often overlooked, aspect: institutions with vested interests should put their cards on the table and justify their position. Credibility is often assigned by speculating about the true motives of the source. If profits or other vested interests are obvious motives, it is better to address these issues and make clear that such interests do not automatically preclude public interest or the common good. Industries could, for example, argue that companies with a good risk reduction and control programme are more likely to attract better-qualified personnel, to enhance their corporate reputation and to avoid costly litigation. Regulators can make the argument that effective and efficient regulation helps the agency to have a better reputation, to obtain more resources and to be consulted if major political decisions are made. This is not to say that they should be shy about their public duty to protect the consumers; but they should show that this task is also in the best interest of the agency itself.
- *Try to escape from role expectations by using a personal approach and by framing the communication to the personal experience of the target audience.* Communication partners, particularly peripherally interested individuals (the term peripherally interested or centrally oriented person is explained in Essay 7), are inclined to select information that contains surprises or unexpected insights. Even if the material of the message does not offer anything new, a communicator can attract attention by avoiding the stereotypes of his or her role and by personalizing the message. This is particularly effective in face-to-face interactions, panel discussions or talk shows. Without denying their affiliation to their home institution, communicators may report about their personal feelings when they first heard about the risk source and what kind of actions they took to protect themselves. They may even convey their own feelings and show compassion for the anxieties and fears of the addressed audience, demonstrating respect for their rationality. In addition, avoiding role stereotypes confronts the audience with some cognitive dissonance that may be resolved by accepting the new message. To be honest is an absolute precondition for such an attempt because most people have developed an awareness of fake feelings.
- *Demonstrate your competence and have empathy when dealing with highly dreaded risks.* Establishing trust is particularly difficult for risks with disastrous

consequences, such as cancer or children suffering. These risks are associated with involuntariness, dread, lack of control and unfamiliarity. To address these negative risk characteristics, it may be helpful to emphasize the competence, independence and impartiality of operating and regulating institutions. At the same time, it is important to show compassion for those who are suffering from the disease or fear that they could be affected. This may produce trust in the capability of the regulator to monitor impacts on health, check safety devices and intervene if the safety of consumer products is jeopardized.

It may also be helpful when preparing oneself for two-way communication to distinguish between different trust-building elements. The following points refer to trust-building exercises with respect to message composition, personal appearance and institutional setting:

- *When dealing with risk management decisions, the communicator should explain the procedures of the decision-making process and refer to the past record of the institution.* The objective here is to prove competence, fairness and consistency. It is also important to communicate the rationale of the trade-offs that are deemed necessary in meeting the specific risk management task. Evidence of technical competence, reference to other viewpoints and respect for commonly shared values and beliefs could also help address the centrally and peripherally interested audience at the same time. Conclusions should be made explicit and justified on an institutional (this is our task) and personal (and I agree with it) level.
- *Be personal and caring, but also decisive and inspirational in your performance.* The major goal is to develop a communication climate that enables the audience to fully process information. Identification with the communicator, which may make the audience share his or her experiences and beliefs, is conducive to this goal. The more a communicator manages to avoid the mask of an institutional spokesperson and the more he or she exercises compassion and empathy for the audience, the more likely the audience will identify with the speaker and feel compelled to consider the arguments. Conveying probabilistic information is a real challenge, but can be done in reference to everyday experience of budget constraints and consumer products. Furthermore, evidence of the successful use of risk analyses in hazard management can serve to define the opportunities and limitations of risk analysis in improving public health and the environment. One should definitely avoid negative labelling of potential opponents or typical advertising gimmicks.
- *Don't be reluctant to act as the spokesperson of the institution that you are representing; but do not sell institutional viewpoints if you do not believe in them.* The best way to elicit trust in the institution is to demonstrate that the institution has met the institutional goals and objectives assigned to it. In addition, credibility is linked to the evidence of being cost effective and open to public demands. These two goals are often in conflict with each other. However, they have to be treated as complementary, and not as substitutive, goals. A conflict arises if the communicator does not share the decisions or policies of his or her home institution. In this case, the communicator should never lie or try to defend

a position that she or he does not share. Either the communicator explains the institutional position, mentioning that she or he, in this specific case, would have made another decision (yet identifies with the institution, in general) or asks another person from the institution who shares the institutional perspective to explain and defend this position. It must be clear that the communicator is in line with the overall performance and perspectives of his or her home institution, but may have different opinions on specific issues. Over-compliance with institutional policies makes people sceptical about the validity and honesty of the messages and will, in the long run, destroy trust.

These guidelines should not be regarded as recipes, but as normative suggestions of what to take into account when approaching the public with risk-related information. Social interaction is too complex for designing 'fool-proof' guidelines. Different hazards and risks demand different approaches. But the most important reservation is that *the best communication process will not lead to any success if it is meant to compensate for shortcomings or failures in the task performance of the communicator or to hide management mistakes*.

Communicating with the media

Press releases

A press release is a written communication between the risk communicator and the media. Generally, press releases are distributed to all of the relevant media at the same time. One can also design special versions of press releases for different media types. A press release to a major tabloid may look different from a release sent to a specialized economic journal. One should be careful, however, in trying to anticipate the interest of the respective press organ. Many journalists are very sensitive to real or alleged attempts of manipulation. Press releases should state the most important aspects in the beginning (the famous who, when, what, to which purpose and why?) and the details at the end. With respect to risk communication, press releases do not lend themselves to educating the public about science, toxicology, probabilities or complex regulatory issues. They should be linked to special events (otherwise they will be ignored), provide some background information on why special decisions have been made, and add special context features, such as legal requirements, past observations and institutional responsibilities. In addition to this general guideline, I would recommend the following:

- *Devise varying communication programmes for different target audiences.* In addition to designing various texts for different media types, one can operate with a variety of packages containing the same message, but using different channels for transmission. A message to the national wire services should contain only the basic facts and some general conclusions; a press release to a daily newspaper may also incorporate some discussion of the results, anecdotal evidence, if suitable, and reference to actual events (otherwise it will not pass the selection filters of these transmitters). Manuscripts for science supplements in newspapers or specialized journals can be more problem oriented and offer a novel or interesting perspective in the analysis of the issue.

- *Be aware of the media's major selection rules.* The media report about events, not continuous performance. Hardly any journalist is interested, for example, in writing a story about a long safety record of a product or a production process. If an accident happened or somebody was affected by a chemical, even if somebody claims that a hazard is present, one can be sure that this event will become headline news. To get a message across, communicators need to link their message to events, not necessarily physical events. Social events, such as a celebration of 25 years of safe performance of a nuclear power station or a completion of a scientific study, can also meet the event requirement.
- *Use the media as a sounding board for your risk communication programme.* Press releases should be distributed on different channels, and feedback communication should be stimulated and encouraged as much as possible. A good press release strategy should not only address different audiences by using different transmitters, but should also take advantage of the different available channels. Press releases are one major medium for communication; but press conferences, participation in talk shows, appearances in hearings and public events, letters to the publisher, and direct mailings are often complementary ways of conveying a message. Press conferences and talk shows allow immediate feedback from the transmitter so that the information can be better tailored to the needs of the receiver. In addition, monitoring the process of recoding (through content analysis of media messages) and of the receiver's responses (through evaluating letters to the editor or direct survey methods) provides valuable information about the comprehensibility of the original information and its effects on the receiver.
- *Be careful in selecting the right cues for appealing to the peripheral audience without offending your central audience* (the difference between the two is explained in Essay 7). Peripheral cues in press releases should be confined to commonly shared symbols, appealing formats, and a high degree of openness and honesty. They should definitely avoid negative labelling of potential opponents or typical advertising gimmicks. Peripheral cues are important for successful communication, but they have to be selected carefully to please the peripherally and centrally interested audience alike.
- *Allocate enough time for packaging your message, but do not change your message in order to make the package more attractive.* The packaging of the message is important for the success of your press release. A good package implies that the formal requirements for a news story are met and that the message contains the relevant clues that are attractive to your target audience. But packages are not ends in themselves. If the message has been simplified and tailored to the needs of the receiver, it should not be further compromised by adjusting it to the most attractive package. This is the major difference compared to advertising, where people do not expect strictly factual information, but entertaining persuasion. Risk communication is based on different expectations: most receivers expect honest, clear and complete information. This kind of information may generate trust in the communicating institution. People do not mind if an advertisement for margarine

is entertaining or even silly; but they expect information on risks to be honest and serious.

Press conferences

The second most popular form of communicating with the media is the organization of press conferences. Journalists will only attend such conferences if they are sure to obtain new and newsworthy information there. Press conferences are mandatory in crisis situations. In direct contact with journalists, many risk managers have difficulty in getting their messages across. Journalists are always eager to 'squeeze' information from the risk manager and to lure them into making statements that they might regret later on. This is why press conferences should be organized and managed by the professional public relations manager of the organization. They know the interests and the strategies played out by journalists and can provide training before and protection during the conference. With respect to risk communication, the following guidelines should be considered:

- *Focus on the event and its implications during a press conference.* Press conferences, as well as press releases, are the wrong instruments for conveying detailed scientific background information or introductions to probabilistic reasoning. Journalists want to find out what happened, who was at fault and what will be done next. You need to address these issues even if they are painful. Be precise, clear and straightforward when responding to questions.
- *Admit uncertainties and demonstrate concern for unknown impacts.* Particularly in crisis situations, risk communicators tend to leave the impression of more certainty than is justified. Nothing is more detrimental than stating something is absolutely safe and then admitting later that, at the time of the statement, not all of the information was available and the judgement had to be revised. The media expect fast and accurate responses even in crisis situations. But you can allude to the remaining uncertainties as long as you assure the audience that your organization is doing everything to reduce uncertainty and to obtain more reliable information. Most studies on crisis situations show clearly that risk managers do much better if they admit remaining uncertainties and do not exclude even unlikely consequences. Product recalls as a result of only minimal risks proved much more cost effective than waiting too long and leaving consumers confused or, worse, further exposed to an avoidable risk. Agencies that use risk communication to attempt to calm down rather than fully inform the public in crisis situations (such as the BSE case) are often perceived as irresponsible agents and violators of the public good. Risk managers should communicate fully about uncertainties related to risks in ways that inspire the public's confidence in their ability to manage the crisis or to determine what to do next. A good example here is the anthrax cases in the aftermath of the 2001 terrorist attacks on the World Trade Center in New York: officials honestly reported risk uncertainties along with the rationale for their response; by doing so, they inspired greater confidence than if they had simply emphasized their control over the situation and their ability to figure out what to do. Competence is a major ingredient for being credible.

- *Rely on systematic evidence and eyewitness reports.* A major characteristic of the media is their interest in eyewitness reports. These testimonies relate abstract issues or events to unique human experiences (which journalists assume help readers to identify with the victims). Information that emphasizes the human component and personalizes abstract material is more likely to be accepted by the media than documents about the sequence of events, the scientific background or organizational competence. Therefore, risk communicators should try to find eyewitnesses for the message that they want to convey (e.g. people who experienced major benefits from a product, or people who have been saved, thanks to current regulations, etc.). However, risk communicators should be aware that 'packaging' the information for the purpose of pleasing the transmitter always faces the risk of creating suspicion and distrust. Journalists often associate good packaging with the intent to manipulate the audience.

There are many other forms of communicating with the media that belong to the area of public relations rather than risk communication. Public relation managers are experts in building bridges between the media and the managers of the communicating organizations: they cultivate contacts, make sure that the needs of the media are met and provide background briefing for those journalists whom they trust. Recently, the internet has begun to play a major role in facilitating contacts between the media and the risk communicator.

Communicating with stakeholders

Stakeholder communication and involvement require an organizational or institutional setting into which the various procedures for implementing involvement can be incorporated. The most important aspect to keep in mind is that stakeholder involvement is a form of risk communication that is made before the final (regulatory) decision is taken. Nobody likes to approve something that has already been determined by the organizer. The timing of involvement is, therefore, a crucial task.

A more detailed analysis of the concepts, structures and instruments of stakeholder involvement and participation is provided in Essays 9 and 10. The following guidelines may assist organizers in making the processes of stakeholder involvement more effective and productive:

- *Try to find out the basic (mental) representations of the risk issue under dispute among the stakeholders or the participants of the discourse.* One way of expanding your knowledge about the concerns of participating stakeholders and members of the public is to use a mental model approach (Bostrom et al, 1992; Atman et al, 1994). The mental model procedure focuses on face-to-face in-depth ethnographic interviews with experts (expert model), on the one hand, and targeted groups or stakeholders (participant model), on the other. The outcomes of the two models are then used to steer the drafting of the textual risk communication message, as well as the agenda for the discourse setting that was selected. The mental model approach is a newer risk communication tool and is currently being successfully used in practical and theoretical settings in North America (Morgan et al, 2001).

- *Ensure that, whatever instrument for stakeholder involvement you are using, all participants are aware of the common mandate and the objectives of the deliberations.* Participation of stakeholders and the public requires a clear and unambiguous mandate of what the deliberation process should produce or deliver. Since dialogues with stakeholders are informal instruments, there should be a clear understanding that the results of such a dialogue cannot claim any legally binding validity (unless it is part of a legal process such as arbitration). All the participants, however, should begin the dialogue with a clear statement specifying their obligations or promises of voluntary compliance once an agreement has been reached. As a pre-decisional setting, the results of such dialogues should be regarded as consultancy reports, similar to those produced by scientific consultants who convey technical recommendations to the legitimate authorities. Risk managers from the public or private sector need to acknowledge and process the outcome of the deliberations, even if they are not obliged by law to follow the recommendations. However, the process will fail its purpose if deviations from the recommendations are neither explained nor justified to the participants.
- *Make sure that there is still openness to the options to be discussed in the involvement process.* A dialogue will never accomplish its goal if the decision has been made (officially or secretly) and the purpose of the communication effort is to 'sell' this decision to the other parties. Individuals have a good sense of whether a decision-maker is really interested in their point of view or if the process is meant to pacify potential protesters.
- *Make sure that all participants are aware of the legitimate options and the permissible outcomes of such a process.* The world cannot be reinvented by stakeholder involvement; nor can historically made decisions be deliberately reversed. All participants should be clearly informed about the ranges and limits of the decision options that are open for discussion and implementation. If, for example, the product is already on the market and fully licensed, the dialogue can only focus on issues such as labelling, voluntary actions or long-term substitution plans. But the range of permissible options should be wide enough to provide a real choice situation to the participants.
- *Make certain that you allocate sufficient time for the dialogue, but also definite time limits.* It is necessary to allocate sufficient time for all the deliberations; but a clear schedule including deadlines is required to make the dialogue effective and product oriented.
- *Treat all members of the discourse with mutual respect and give them equal opportunities to make claims and react to claims by others.* All dialogic procedures need the climate of a 'powerless' environment. This does not mean that every party has the same right to intervene or claim a legal obligation to be involved in the political decision-making process. However, the internal rules of the dialogue have to be strictly egalitarian; every participant must have the same status in the group and the same rights to speak, make proposals or evaluate options. Two requirements must be met. First, the decision about the procedure and the agenda must rely on consensus; every party needs to agree. Second, the rules adopted

for the dialogue are binding on all members and no party is allowed to claim any privileged status or superior decision power. The external validity of the discourse results are, however, subject to all legal and political rules which are in effect for the topic in question.
- *Be sure to engage a professional, neutral and knowledgeable moderator or mediator.* The mediator or moderator who facilitates such a process should be neutral in his or her position on the respective risk management issue, and respected, and authorized by all participants. Any attempt to restrict the manoeuvrability of the mediator should be strictly avoided.

The idea behind all the guidelines for stakeholder involvement is to find a common understanding of the goals and visions of industry, society and social affairs. Protection from risks is one element in this larger framework of social concerns, ranging from social justice to societal responsibility for personal growth and well-being. That regulatory agencies, as well as industrial representatives, are expected to participate in such debates as this is part of the legitimizing efforts of social forces in a plural society. At the same time, issues of ambiguity in risk management demand more elaborate discourse-based activities which provide reassurance to each actor that all views are taken into account, and which offer sufficient incentives for reaching common grounds or even a common consensus (Renn, 2004b).

Evaluation

Why evaluation?

Risk communication campaigns deal with important objectives: human safety, health, and sometimes even survival, may be at stake, as well as social relations between customers, regulators and industry. Consequently, it is crucial that pertinent risk communication activities actually achieve their stated goals. To provide evidence for this, empirical evaluation research is indispensable (Kasperson, 1989). '*Evaluation*' means the scientific assessment of the content, process and effects (consequences, outcomes and impacts) of an intervention (measure, strategy or programme) according to defined criteria (goals, objectives and values). Systematic empirical investigations are required in order to prove the effectiveness of risk communication – simple experience or common sense are not sufficient (Rohrmann, 1992, 1995; Weinstein et al, 1992; Bostrom, 1994; Bostrom et al, 1994; OECD, 2002). There are both substantive and methodological reasons for evaluation studies:

- It is a matter of accountability with respect to one's organization's resources and time to check whether risk information and communication efforts have met the needs of the recipients.
- Evaluation results can demonstrate not only whether but also *why* a programme works (or not) and thus guide further improvement efforts.
- Intuitive assessments of the programme's effectiveness can easily be misleading because of anecdotal cause–effect attributions (spurious causality).

- Evaluation provides an empirical basis for decisions on alternative risk communication programmes.
- Since campaigns are laborious and usually rather expensive (in terms of costs, personnel and time), evaluation can help justify the efforts.

Existing evaluation studies differ considerably in their approach; the main options for a researcher are summarized in Table 7.4.

The most important decision is which aspect of a risk communication programme one intends to evaluate. There are three principal perspectives: *content* orientation (i.e. input and message evaluation), *process* orientation (i.e. evaluation of selected settings and procedures) and *outcome* orientation (i.e. impact evaluation). In each case, advanced research designs are required. Evaluative data can be gathered in an analytical assessment done by experts or in an empirical investigation in which relevant participants are surveyed.

Once the objectives of a particular purpose for the evaluation have been stated by those responsible for the risk communication programme, an evaluator needs to determine the criteria for measuring success or failure. The main criteria are effectiveness (did it reach the predefined goal?); efficiency (were the costs in proportion to the accomplishments?); persistence (did the effect last over time?) and mutuality (did all participants, including the risk manager, learn more about the issue?).

Table 7.4 *Evaluation of the basic considerations of risk communication*

Focus of evaluation	Content oriented (substantive correctness); and/or Process oriented (formative/developmental view); and/or Outcome oriented (summary effectiveness)
Study design	Longitudinal before/after study Control group (not exposed to the intervention)
Information sources	Risk information/communication targets (receivers) Sender, author, or agency
Criteria	Knowledge and competence gain Change of attitudes and mindsets Risk-reducing behaviour Enhancing trustworthiness Joint conflict resolution
Reference for comparisons	Normative programme goals (as stated by institution) Previous situation Alternative information/communication strategies

Source: adapted from OECD, 2002

Methods

With regard to the s*tudy design for the evaluation of risk communication programmes,* crucial issues include the specification of target populations (representing all relevant parties in the communication process), the design for tests and re-tests, appropriate timing of data collections and the inclusion of control groups. There are two focal issues of causality to be considered:

1 Show that intended effects are actually induced by the intervention under examination (and not other concurrent extraneous influences).
2 Clarify whether unintended impacts are caused by the programme.

The following methods are available:

- *Make use of systematic feedback from users of communication material.* This is a low-budget option if there is not enough money for a more comprehensive evaluation programme. Feedback can be collected in almost any form of communication. Attach a response sheet to all written information, provide a feedback channel on all internet presentations, hand out evaluation sheets on personal presentations, and make sure you operate an open forum on the internet. In addition, most public relations departments conduct systematic evaluations of press coverage and letters to the editor. This material can also be used by a risk communicator for collecting and processing feedback. One should be aware, however, that these feedback channels are systematically biased. People at the extreme ends of the spectrum, i.e. those who either hate or love the communication effort, are more likely to voice their responses than people in between the two extremes, i.e. those who feel only partially attracted or repelled by the communication effort. All respondents with free time are also over-represented. Being aware of these biases helps risk communicators to avoid misinterpretation.
- *Pre-test the material or the discourse procedure.* I urgently recommend pre-tests of all risk communication programmes as a means of optimizing the material and enhancing the probability of an effective exchange of information. It is often difficult to understand why organizations spend millions on elaborate risk communication programmes without ever testing the effectiveness of the programme in advance. Such pre-testing can take different forms depending upon the size, the format and the purpose of the communication. To organize focus groups is, in my opinion, the most effective and cost-efficient way of pre-testing material. Simulations and role plays are excellent settings for testing key messages. Pre-tests are not very expensive and should be a mandatory element of any risk communication programme.
- *Devise experimental designs.* The classic form of evaluation is the social experiment. One group is exposed to the risk communication programme (stimulus), while another group, the so-called control group, is surveyed without the stimulus being present. For many risk communication purposes, an elaborated experimental design with many stimuli and different settings appears to be 'overkill' in terms of evaluating a single programme. However, it would be wise to spend research resources on generic risk communication problems, such as finding the most

effective way of conveying probabilistic reasoning or searching for the most intuitively appealing process of putting risks in perspective.

- *Conduct surveys and polls.* One of the most popular forms of evaluation is the organization of surveys among the target population. Systematic surveys are the only means of getting a representative cross-section of the people who have been exposed to the communication. There is not much value in conducting surveys of the total population (although polling companies will tell you otherwise) unless you have launched a nationwide multi-channel communication programme. Rather, risk communicators should send the questionnaire to the targeted audiences. Members in the audience are the only ones who were directly exposed to your programme. Even then, most of the audience may not remember anything if asked some time after the event. We live in a society with an abundance of information floating around. More than 99 per cent of everything that we receive is forgotten within minutes or hours. It is therefore crucial to be as effective as possible when launching a communication programme.
- *Make use of internet chat rooms.* Internet chat rooms can be used for three purposes: first, to get a message to consumers; second, to engage in a dialogue with the target audience; and, third, to collect and process information about one's own performance. There are software programmes available that analyse website users and show their profiles. In addition, a chat room provides direct opportunities for communication partners to voice their impressions and to critique the communication effort. Although such critiques may not be systematic and representative, they are a fast, effective and fairly inexpensive way of being evaluated by the targeted audience.
- *Provide supervision and training.* Risk communicators who are involved in personal contacts with the target audience or who moderate stakeholder sessions need training and continuous advice. Training courses, as well as role exercises, are effective means of being better prepared for face-to-face interactions. In addition, I advise communicators, who are highly visible to the public eye and are faced with numerous requests for participating in TV shows or public forums, to engage a professional supervisor. Supervisors watch all appearances, analyse every performance, provide detailed critique and train the communicator, with special consideration of his or her special talents and shortcomings. Supervising is not cheap; but it may help to save a lot of resources if the front man or woman of an organization is well suited to public communication arenas.

Systematic risk evaluations should be delegated to professionals. They know how to devise a questionnaire, how to conduct focus groups and how to deal with inevitable biases in people's responses. *Make sure that all risk evaluation programmes are assessed in house and, if possible, also by professional outside evaluators.* The right method for evaluation depends upon the communication context and the target audiences. Improvement of risk communication is contingent on continuous learning through evaluation.

Conclusions

The objective of this essay is twofold. First, it is aimed at preparing risk communicators with the necessary context information in order to understand the needs and concerns of the target audiences. Second, it is designed to provide a systematic review of tools and guidelines that help communicators to design the most effective risk communication programme.

The essay stresses the importance of an excellent risk management effort as a means of gaining credibility and trustworthiness. By carefully reviewing in-house performance, by tailoring the content of the communication to the needs of the final receivers, and by adjusting the messages to the changes in values and preferences, risk communication can convey a basic understanding of the choices and constraints of risk management and thus create the foundations for a trustworthy relationship between the communicator and the audience. Although many receivers of risk information may not agree with the actual decisions that institutions have made in setting priorities or selecting management options, they may realize that these decisions are the result of open discussions and the assignment of painful, but reasonable, trade-offs.

The principal objective of risk communication is not to influence or alter people's attitude towards risk sources, but to provide easily comprehensible tools to groups and individuals that enable them to understand the nature of the risks, to process probabilistic information and to evaluate the likely impacts. This goal suggests that the public perception of risk (at least the underlying concerns governing this perception) should be adopted as a legitimate perspective for drafting risk communication programmes (Fischhoff et al, 1993). The legitimacy of public perception points to dimensions that need to be included when communicating in written, oral, electronic or participatory form. The specific circumstances of the risk-related situation, equity issues, catastrophic potential and other qualitative aspects of risk deserve the same attention in the communication package as the calculation of numerical probabilities and consequences. Thus, risk communication must incorporate a broad conception of risk, and operate with the realization that communication is a two-way process in which both sides have something to give and to learn.

8

Risk Participation[1]

Stakeholder involvement and participation

Emphasizing governance rather than governments or administrations is meant to underline the importance of having stakeholders and public groups participate in the risk-handling process and, consequently, establishing adequate public–private partnerships and involvement processes. In the context of the inclusive governance framework I make a distinction between the following (US EPA/SAB, 2001, p7):

- *stakeholders:* socially organized groups who are or will be either affected by or have a strong interest in the outcome of the event or the activity from which the risk originates and/or by the risk management options taken to counter the risk;
- *directly affected public:* individuals and non-organized groups who will experience positive or negative impacts from the outcome of the event or the activity from which the risk originates and/or by the risk management options taken to counter the risk;
- *observing public:* the media, cultural elites and opinion leaders who may or may not comment on the risk issue or influence public opinion;
- *general public:* all individuals who are not directly affected by the risk or risk management and are part of the emerging public opinion on the issue.

Depending upon the risk issue and, as will be explained later, the nature of the risk problem, these different types of audiences need to be addressed and involved in a variety of forms and procedures. Often it is sufficient to include only stakeholders; in other more controversial risk issues, it is crucial to find adequate involvement processes that integrate stakeholders and the public. It would be inefficient and a waste of time and money to include the full scope of public actors in all risk controversies; but it can become very costly in terms of financial, organizational and institutional resources if the involvement process falls short of the expectations that public actors associate with the specific case. It is, therefore, important to develop a diagnostic tool that helps risk managers to design the involvement process in proportion to the degree of public demand and conflict intensity. This tool will be developed in this section.

Each decision-making process has two major aspects: what and whom to include, on the one hand, and what and how to select (closure), on the other (Hajer and Wagenaar, 2003; Stirling, 2004). *Inclusion and selection* are therefore the two essential parts of any decision- or policy-making activity. Classic decision analysis has been offering formal methods for generating options and evaluating these options against a set of predefined criteria. With the advent of new participatory methods, the two issues of inclusion and selection have become more complex and sophisticated than purported in these conventional methods.

The current framework advocates the notion of inclusive governance, particularly with respect to global and systemic risks. First and foremost, this means that the four major actors in risk decision-making (i.e. political, business, scientific and civil society players) should jointly engage in the process of framing the problem, generating options, evaluating options and coming to a joint conclusion. This has also been the main recommendation of the European Union White Paper on European governance (European Commission, 2001b). This document endorses transparency and accountability through formal consultation with multiple actors as a means for the EU to address the various frames of governance issues and to identify culture-sensitive responses to common challenges and problems. In similar fashion to the actors determining the governance of a political union, it is obvious that the actors participating in risk-related decision-making are guided by particular interests that derive not only from the fact that some of them are risk producers – whereas others are exposed to it – but, equally, from their individual institutional rationale and perspective. Such vested interests require specific consideration and measures so that they are made transparent and, if possible, can be reconciled. Inclusive governance, as it relates to the inclusion part of decision-making, requires that there has been a major or clear attempt to (Trustnet, 1999; Webler, 1999; Wynne, 2002):

- involve representatives of all four actor groups (if appropriate);
- empower all actors to participate actively and constructively in the discourse;
- co-design the framing of the (risk) problem or the issue in a dialogue with these different groups;
- generate a common understanding of the magnitude of the risk (based on the expertise of all participants), as well as the potential risk management options, and to include a plurality of options that represent the different interests and values of all parties involved;
- conduct a forum for decision-making that provides equal and fair opportunities for all parties to voice their opinion and to express their preferences; and
- establish a connection between the participatory bodies of decision-making and the political implementation level.

If these conditions are met, evidence shows that actors, along with developing faith in their own competence, start to place trust in each other and have confidence in the process of risk management (Kasperson, 1986; Beierle and Cayford, 2002, pp30f; Viklund, 2003). This is particularly true for the local level where the participants are familiar with each other and have more immediate access to the issue (Petts, 1997). Reaching consensus and building up trust on highly complex and transgressional subjects such as global change is, however, much more difficult. Being inclusive and open to social groups does not, therefore, guarantee constructive cooperation by those who are invited to participate. Some actors may reject the framing of the issue and choose to withdraw. Others may benefit from the collapse of an inclusive governance process. It is essential to monitor these processes and make sure that particular interests do not dominate the deliberations and that rules can be established and jointly approved in order to prevent destructive strategizing.

Inclusive governance needs to address the second part of the decision-making process as well (i.e. reaching closure on a set of options that are selected for further consideration, while others are rejected). *Closure* does not mean to have the final word on a development, a risk reduction plan or a regulation. Rather, it represents the product of deliberation (i.e. the agreement that the participants reached). The problem is that the more actors, viewpoints, interests and values are included and, thus, represented in an arena, the more difficult it is to reach either a consensus or some other kind of joint agreement. However, the empirical analysis of Beierle and Cayford (2002) demonstrated that involvement activities that were directed towards reaching consensus or a mediated resolution of a conflict were more successful in terms of output and process than those directed towards collecting opinions on a variety of options. At the same time, the study made clear that consensus-seeking projects demanded many more resources and a better structure than other types of involvement activities. In particular, it was important to establish common rules for generating and evaluating evidence and to deal with conflicting values. For this purpose, a second set of criteria is needed to evaluate the process by which closure of debates (whether they are final or temporary) is brought forth, as well as the quality of the decision or recommendation that is generated through the closure procedure.

The first aspect, the quality of the closure process itself, can be subdivided into the following dimensions (Webler, 1995; Demos, 2004):

- Have all arguments been properly treated? Have all truth claims been fairly and accurately tested against commonly agreed standards of validation?
- Has all the relevant evidence, in accordance with the actual state-of-the-art knowledge, been collected and processed?
- Was systematic, experiential and practical knowledge and expertise adequately included and processed?

- Were all interests and values considered, and was there a major effort to come up with fair and balanced solutions?
- Were all normative judgements made explicit and thoroughly explained? Were normative statements derived from accepted ethical principles or legally prescribed norms?
- Was every effort made to preserve plurality of lifestyles and individual freedom, and to restrict the realm of collectively binding decisions to those areas in which binding rules and norms are essential and necessary to produce the wanted outcome?

Turning to the issues of outcome, additional criteria need addressing. They have been discussed in the political science and governance literature for a long time (Dryzek, 1994; Rhodes, 1997), and are usually stated as comprising effectiveness, efficiency, accountability, legitimacy, fairness, transparency, approval by the public, and ethical acceptability (see also Essay 9). They largely coincide with those that have been postulated earlier for the assessments of risk management options.

The potential benefits resulting from stakeholder and public involvement depend upon the quality of the participation process. It is not sufficient to gather all interested parties around a table and merely hope for the catharsis effect to emerge spontaneously. In particular, it is essential to treat the time and effort of the participating actors as spare resources that need to be handled with care and respect (Chess et al, 1998; US EPA/SAB, 2001, p12). The participation process should be designed so that the various actors are encouraged to contribute to the process in those areas in which they feel they are competent and can offer something to improve the quality of the final product.

In this respect, the four risk classes discussed earlier (linear, complex, high-uncertainty and high-ambiguity risk problems) support generic suggestions for participation (Renn, 2004b):[2]

- *Linear (routine) risk problems.* When making judgements about linear risk problems, a sophisticated approach to involve all potentially affected parties is not necessary. Most actors would not even try to participate since the expected results are more or less obvious. In terms of cooperative strategies, '*instrumental discourse*' among agency staff, directly affected groups (such as product or activity providers and immediately exposed individuals) and enforcement personnel is advisable. One should be aware, however, that frequently risks that appear linear turn out to be more complex, uncertain or ambiguous than originally assessed. It is therefore essential to revisit these risks regularly and monitor the outcomes carefully.
- *Complex risk problems.* The proper handling of complexity in risk appraisal and risk management requires transparency over the subjective judgements and the inclusion of knowledge elements that have shaped the parameters on both sides of the cost–benefit equation. Resolving complexity necessitates a discursive

procedure that already begins in the pre-assessment phase and continues via the appraisal phase and the phase of tolerability and acceptability judgement to the risk management phase. Input for handling complexity could be provided by an '*epistemic discourse*', aimed at finding the best estimates for characterizing the risks under consideration. This discourse should be inspired by different science camps and the participation of experts and knowledge carriers. They may come from academia, government, industry, or civil society; but their entitlement to participate is their claim of providing the negotiation table with new or additional knowledge. The goal is to resolve cognitive conflicts. Typical forum for such an epistemic discourse include Delphi methods, meta-analysis conferences, scientific consensus conferences and other knowledge-oriented discourse procedures (Webler et al, 1991; Gregory et al, 2001).

- *Risk problems due to high unresolved uncertainty.* Characterizing risks, evaluating risks and designing options for risk reduction pose special challenges in situations of high uncertainty about the risk estimates. How can one judge the severity of a situation when the potential damage and its probability are unknown or highly uncertain? In this dilemma, risk managers are well advised to include the main stakeholders in the evaluation process and to ask them to find a consensus on the extra margin of safety in which they would be willing to invest in exchange, in order to avoid potentially catastrophic consequences. This type of deliberation, called '*reflective discourse*', relies on a collective reflection about balancing the possibilities for overprotection and underprotection. If too much protection is sought, innovations may be prevented or stalled; if we go for too little protection, society may experience unpleasant surprises. The classic question of 'How safe is safe enough?' is replaced by the question of 'How much uncertainty and ignorance are the main actors willing to accept in exchange for some given benefit?'. It is recommended that policy-makers, representatives of major stakeholder groups and scientists take part in this type of discourse. The nature and magnitude of *uncertainty* may dictate the scope and range of people and processes used to characterize uncertainties and to discuss how decisions should be made in the face of irresolvable uncertainties. The *reflective discourse* can take different forms: roundtables, open forums, negotiated rule-making exercises, mediation or mixed advisory committees including scientists and stakeholders (Amy, 1983; Perrit, 1986; Susskind and Cruishank, 1987; Moore, 1996; Gregory et al, 2001; reviews in Fiorino, 1990; Renn et al, 1995; Steelman and Ascher, 1997; Rowe and Frewer, 2000; Stoll-Kleemann and Welp, 2006).
- *Risk problems due to high ambiguity.* If major ambiguities are associated with a risk problem, it is not enough to demonstrate that risk regulators are open to public concerns and to address the issues that many people wish them to take care of. In these cases, the process of risk evaluation needs to be open to public input and new forms of deliberation. This starts with revisiting the question of proper framing. Is the issue really a risk problem or is it, in fact, an issue

> of lifestyle and future vision? The aim is to find consensus on the dimensions of ambiguity that need to be addressed in comparing risks and benefits, and balancing the pros and cons. High ambiguities require the most inclusive strategy for participation, since not only directly affected groups but also those indirectly affected have something to contribute to this debate. Resolving ambiguities in risk debates requires a '*participatory discourse*': a platform where competing arguments, beliefs and values are openly discussed. The opportunity for resolving these conflicting expectations lies in the process of identifying common values, and in defining options that allow people to live their own vision of a 'good life' without compromising the vision of others, as well as in finding equitable and just distribution rules when it comes to common resources and activating institutional means for achieving common welfare so that all can reap the benefits (coping with the classic commoners' dilemma).[3] Available sets of deliberative processes on this third level include citizen forums, citizen panels, citizen juries, consensus conferences, ombudspersons, citizen advisory commissions and similar participatory instruments, in addition to classic stakeholder engagement processes (Crosby et al, 1986; Dienel, 1989; Lynn, 1990; Andersen, 1995; Armour, 1995; Durant and Joss, 1995; Lynn and Kartez, 1995; Applegate, 1998; Joss, 1997, 1998; see reviews in Fiorino, 1990; Renn et al, 1995; Rowe and Frewer, 2000; Hagendijk and Irwin, 2006, Abels, 2007).

Categorizing risks according to the quality and nature of available information on risk may, of course, be contested among the stakeholders. Who decides whether a risk issue can be categorized as linear, complex, uncertain or ambiguous? It is possible that no consensus may be reached as to where to locate a specific risk. In these cases, a detailed (worst-case) analysis of monitoring and surveillance may constitute the only achievable compromise (reversible removal of risk sources, etc.; timely detection of adverse effects; strength of surveillance systems). The best means, however, of dealing with this conflict is to provide for stakeholder involvement when allocating the different risks into these four categories. This task can be located in the phase of screening as the third component of pre-assessment. Allocating risks to the four categories must be done before the assessment procedures start. Over the course of further analysis of risks and concerns, the categorization may change since new data and information are being collected that may necessitate a reordering of the risk. Yet, the risk governance system that is proposed in this document builds upon the need to classify risks at the beginning and to allocate them to different routes of appraisal, characterization, evaluation and management. It seems prudent to have a screening board perform this challenging task. This board should consist of members of the risk and concern assessment team, of risk managers and key stakeholders (such as industry, NGOs and representatives of related regulatory, or governmental agencies). The type of discourse required for this task is called *design discourse*. It is aimed at selecting the appropriate risk and concern assessment policy, defining priorities in handling risks, organizing the appropriate involvement procedures and specifying the conditions under which the further steps of the risk-handling process will be conducted.

Figure 8.1 provides an overview of the different participation and stakeholder involvement requirements for the four classes of risk problems and the design discourse. As is the case with all classifications, this scheme shows an extremely simplified picture of the involvement process and it has been criticized for being too rigid in its linking of risk characteristics (complexity, uncertainty and ambiguity) and specific forms of discourse and dialogue (van Asselt, 2005). In addition to the generic distinctions shown in Figure 8.1, it may, for instance, be wise to distinguish between participatory processes based on risk agent or risk-absorbing issues. To conclude these caveats, the purpose of this scheme is to provide a general orientation and to explain a generic distinction between ideal cases rather than to offer a strict recipe for participation.

The classification in Figure 8.1 offers a taxonomy of requirements for stakeholder and public inclusion based on the characteristics of risk knowledge. Linear risk problems demand almost no effort for the external involvement of stakeholders or the public. Complex problems need the incorporation of knowledge carriers from organized stakeholder groups or scientific communities. The inclusion of all affected and interested stakeholders is required for risks with high uncertainties, and the opening of the risk governance process to the public at large is recommended for highly ambiguous risks. These general guidelines can be further specified by looking into each phase of the risk governance cycle (Renn and Walker, 2008, pp356ff).

Stakeholder engagement during pre-assessment. In keeping with the purpose of the pre-assessment phase, the goal of stakeholder engagement here focuses on the initial framing of the problem: defining boundary conditions, as well as the applicable scientific, political and social conventions, and making a preliminary assessment of the nature of the complexities, uncertainties and normative ambiguities that assessors and decision-makers are likely to face. The main function in this phase is selection (of frames, of information, of process steps, etc.) and priority-setting (what comes first, and what needs to be addressed in what sequence). These choices demand both good insight into the problem area and a legitimate procedure of defining and justifying selection rules and priorities. Organized stakeholders in this phase can contribute their experience with the problem at hand and may point towards desired timeframes, potential urgencies, non-obvious applications, and so on. This discussion between risk regulators, experts and stakeholders is, hence, focused on the design of the risk governance phases that are to follow; in essence, it represents a *design discourse*. As discussed more specifically in Chapter 2, the input from this discourse forms a common thread from the pre-assessment stage to final implementation.

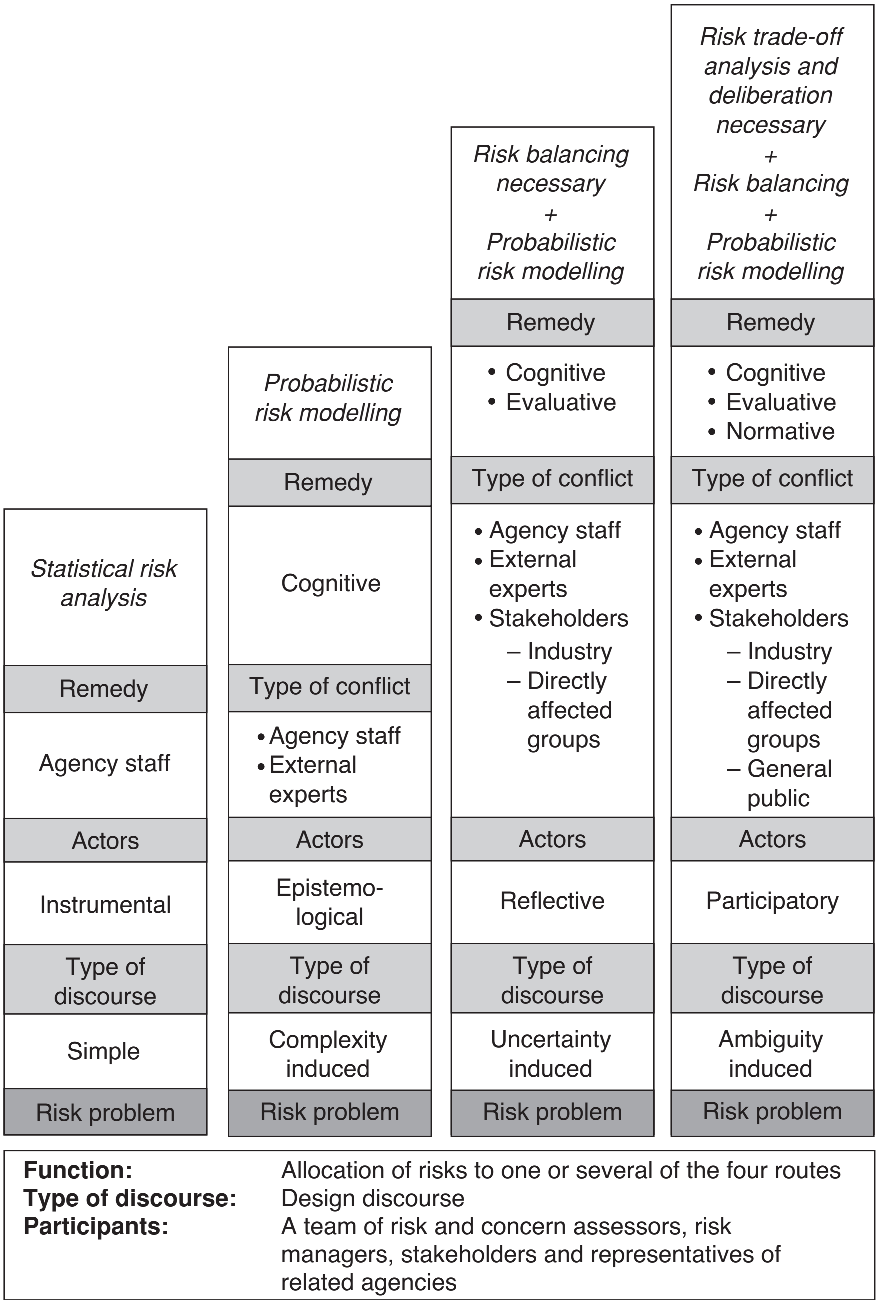

Figure 8.1 *The risk management escalator and stakeholder involvement (from linear to complex and uncertain to ambiguous phenomena)*

Source: adapted from Renn, 2004b, p300 and IRGC, 2005, p53

Stakeholder and public engagement during appraisal. During the risk appraisal stage, the focus of discussions and debate is on the contribution of knowledge or understanding about the limits of knowledge and about the risk(s) being evaluated. Depending upon the issue at hand, both technical experts (e.g. senior risk assessors, scientists, engineers, economists and other specialists) and stakeholders (e.g. affected communities, industries and governments) can offer valuable input into assessing risks and their related uncertainties, and possible approaches to evaluating their impacts on different targets. The experience of local communities possibly affected by a risk, of engineers involved in the design of manufacturing processes, and of others can also provide important realistic input. It is important to note, that it is *not* the task of stakeholders at the appraisal stage to deal with normative questions relating to the tolerability of the risk or risk management options. These normative issues are part of the evaluation and management phases. As a result, the input into this phase is restricted to knowledge in a wider sense. It includes systematic knowledge furnished by scientists and experts, experiential knowledge by those who have gained familiarity with the problem (e.g. plant operators or consumers of specific products) and local and circumstantial knowledge that may reside in a local community or special group. The focus on knowledge has been described by the term 'epistemic discourse' for this type of deliberation.

Stakeholder and public engagement during risk characterization and evaluation. In this phase of the framework, discourse depends upon the nature of the risk characteristics. For linear and complex risks without major uncertainties and ambiguities, an instrumental discourse is sufficient. In this case, existing guidelines or legal prescription are probably available to judge the tolerability or acceptability of the risk under consideration. This changes dramatically if the risks are highly uncertain or even ambiguous. Under these circumstances, existing laws, existing standards and guidelines will not be sufficient to make tolerability and acceptability judgements since the impacts are uncertain and contested. More advanced forms of discourse are required here. A *reflective discourse* seems appropriate for highly uncertain and low to medium ambiguity risks, while a more *participatory discourse* is needed if the degree of ambiguity and controversy is very high. The purpose of stakeholder and public engagement in both discourse types is to ensure that all values and preferences are made clear to the decision-makers ultimately responsible for deciding what to do about a risk. In cases of high uncertainty and low to medium ambiguity, the same kinds of stakeholders who were engaged during the pre-assessment phase should be reconvened to consider the new knowledge from the risk and concern assessments and to draw normative conclusions about the risk under consideration. The main function here is to gain a balanced view on the positive and negative sides of the risk-causing activity or event. This balance is best accomplished if those stakeholders who will have to live with the consequences of the risk management decisions can insert their trade-offs and preferences into the final risk tolerability or acceptability judgement. If the risk is highly contested and associated with a high degree of ambiguity, representatives of the other publics need to be included, particularly those who will be affected by the risk management decision. This can be accomplished by opening public forums on the internet, by organizing public hearings and roundtables and/or by conducting citizen panels or juries (Webler, 1995; Rowe and Frewer, 2000; Renn, 2004b).

Stakeholder and public engagement in management. Stakeholders and the public have frequently been asked to help identify, assess and select different management measures for reducing and managing risks that are not acceptable. The purpose of the discourse here is to look at the variety of possible interventions, to address the pros and cons for each measure or package of measures, and to suggest a set of measures that appear to be effective, efficient and fair. Both relevant knowledge and different preferences need to be considered when selecting one or more management measures. The function in this phase is to provide input for a regulatory impact assessment since regulatory measures normally affect other aspects (which people value), in addition to risk reduction. It may be costly to society to implement risk reduction measures; it may add unnecessary bureaucracy; it may cause more inequities; and it may lead to unsustainable practices and so on. These impacts need assessing in order to balance the goal of risk reduction with the costs of accomplishing this reduction. For identifying and weighing these impacts, it is important to understand how different stakeholders experience these impacts. Normally, a reflective discourse, as described above, would be sufficient to cope with this task. The reflection here is on both the likely consequences of a regulatory option and the desirability of these consequences with regard to other highly esteemed objectives or values. If the different regulatory options cause serious societal concerns (e.g. if a regulatory option on reducing risk from terrorism is associated with a strong infringement on privacy rights or mobility), a participatory discourse might be necessary. Such a broad discourse could develop some major guidelines on how to resolve the difficult value conflict between security and personal freedom.

The design of participatory procedures, at any phase and at any level of intensity, should display these basic features (Laird, 1993; Webler, 1995, 1999; Adler et al, 2000; US EPA/SAB, 2001, p3; Renn, 2004b; Rowe et al, 2004, p93; Blackstock et al, 2007; Goldschmidt and Renn, 2006; Goldschmidt et al, 2008):

- *transparency* from the point of view of third parties in documenting how stakeholders were selected to participate, and how their views were taken into account, as well as from the point of view of the participants with regard to their full understanding of all process steps, communicative procedures, methods of reaching agreements and the future use of the produced results;
- *competence* in terms of ensuring that the state of the art in knowledge of the risk issue is considered during the deliberations and that all participants are made literate in the issue itself and in using deliberative reasoning;

- *fairness* in terms of an adequate representation of the constituencies in the participatory process and in terms of equal speaking and debating opportunities among the participants;
- *efficiency* in terms of a balanced proportion between resources invested in the participatory activities and the envisioned outcome, as well as the cost-effective use of deliberative techniques and methods;
- *clear mandate* of what is being expected from the participatory exercise from the beginning, including a timetable, the scope and range of options, and a clear understanding about the nature and the future use of the outcomes of the deliberations;
- *diversity* in terms of multiple perspectives and disciplines bearing on the risk in question; and
- *professionalism* in terms of structuring, moderating and facilitating the process and summarizing and disseminating the results.

Needless to say, deliberation is not a panacea for all risk problems. If done improperly, it may actually increase overall risk levels, lead to inefficiencies, stabilize existing power distributions, and make ignorance and incompetence the guiding principles for decision-making (Dana, 1994; Löfstedt, 2003, p425). Deliberation may also prolong decision-making and immobilize institutions. All of these risks of deliberation should not be easily dismissed. A competent, accountable agency decision is still better than a superficial consensus among affected parties. At the same time, however, the many arguments in favour of deliberation and its theoretical underpinnings provide ample evidence for its potential contribution to improving risk governance performance. This has been confirmed by almost all recent empirical meta-studies on the effectiveness of public participation in the risk or environmental field (Sherington, 1997; Beierle, 2000; US EPA/SAB, 2001; Beierle and Cayford, 2002; Rowe et al, 2004). Over time, one can expect that inclusive and participatory approaches to risk governance will become common procedures in managing and regulating risks all over the world.

Essay 9 *Integrating Deliberation and Expertise: Concepts, Features and Conditions of Science-based Participation Processes*[4]

Introduction

Deciding about the location of hazardous facilities, setting standards for chemicals, making decisions about clean-ups of contaminated land, regulating food and drugs, and designing and enforcing safety limits all have one element in common: these activities are collective endeavours to understand, assess and handle risks to human health and the environment. These attempts are based on two requirements. On the one hand, risk managers need sufficient knowledge about the potential impacts of the risk sources under investigation and the likely consequences of the different decision options to control these risks. On the other hand, they need criteria to judge the desirability or undesirability of these consequences for the people affected and the public at large (McDaniels, 1998; Rowe and Frewer, 2000; Horlick-Jones et al, 2007). Criteria on desirability are reflections of social values such as good health, equity, or efficient use of scarce resources. Both components – knowledge and values – are necessary for any decision-making process independent of the issue and the problem context. The literature contains countless procedural guidelines for combining knowledge and values in a rational manner (for a brief overview, see Edwards, 1954, or Goodwin and Wright, 2004; a more elaborate review is provided in Hyman and Stiftel, 1988; information related to risk governance is found in von Winterfeldt and Edwards, 1986; Chen and Mathes, 1989; Keeney, 1992; Stern and Fineberg, 1996; US EPA/SAB, 2001; Rauschmayer and Wittmer, 2006; van den Hove, 2007). Yet, decisions on risk pose additional difficulties. They need to address issues such as complex cause–effect relationships; trade-offs between uncertain benefits and damage; the distribution of these potential benefits and risks among different regions, times or social groups; and deep-rooted values or desirable lifestyles (Freudenburg and Pastor, 1992; Viscusi, 1994, 1998; Fischhoff, 1996; Metha, 1998; Wiener, 1998).

Dealing with complex, uncertain and controversial outcomes often leads to the emergence of social conflict. Although everyone may agree on the overall goal of safety and environmental quality, precisely what that goal entails (how safe is safe enough?) and precisely how that goal will be obtained (who bears the risks and who reaps the benefits?) may evoke substantial disagreement (Dietz et al, 1989; Fiorino, 1989a; MacLean, 1986; Rayner and Cantor, 1987; Linnerooth-Bayer and Fitzgerald, 1996; Hagendijk and Irwin, 2006). Typical questions in this context are: what are the criteria for judging risks? What role should the assessment of uncertainty and ignorance play in dealing with risks? How should one balance a variety of options with different compositions of magnitude and probability of impacts, but identical expected values? How should society regulate risks that benefit one party at the expense of potential harm to another?

These crucial questions of risk governance demand procedures of decision-making that go beyond the conventional agency routines. Numerous strategies to cope with this challenge have evolved over time. They include technocratic decision-making through the explicit involvement of expert committees, muddling through in a pluralist society, negotiated rule-making via stakeholder involvement, deliberative democracy or ignoring probabilistic information altogether.[5] The combination of complexity, uncertainty and ambiguity (see Chapter 3 in this volume; Klinke and Renn, 2002) requires new rationales for evaluating policy options on risks. The main thesis of this essay is that risk management agencies are in urgent need of revising their institutional routines and of designing procedures that enable them to integrate professional assessments (systematic knowledge), adequate institutional process (political legitimacy), responsible handling of public resources (efficiency) and public knowledge and perceptions (reflection on public values and preferences).

This essay explores the possibilities and opportunities of developing decision-making procedures for integrating knowledge, for the efficient handling of resources, for political legitimization and for social value reflection. The core focus of this essay is a critical review of the potential promises, merits, problems and pitfalls of what analysts have coined an analytic–deliberative process (Stern and Fineberg, 1996; Chess et al, 1998; Renn, 1999a; Tuler and Webler, 1999; Webler et al, 2001; critical reviews are found in Rossi, 1997; Coglianese, 1999). Such a process is designed to provide a synthesis of scientific expertise, a common interpretation of the analysed relationships and a balancing of pros and cons for regulatory actions based on insights and values. Analysis in this context means the use of systematic, rigorous and replicable methods of formulating and evaluating knowledge claims (Stern and Fineberg, 1996, p98; see also Tuler and Webler, 1999, p67). These knowledge claims are normally produced by scientists (natural, engineering and social sciences, as well as the humanities). In many instances, relevant knowledge also comes from stakeholders or members of the affected public (Horlick-Jones et al, 2007). Deliberation is the term we have adopted from the literature to highlight the style and nature of problem-solving through communication and collective consideration of relevant issues (Stern and Fineberg, 1996, pp73, 215ff; Chambers, 2003; original idea of discursive deliberation from Habermas, 1970a, 1987a). It combines different forms of argumentation and communication, such as exchanging observations and viewpoints, weighing and balancing arguments, offering reflections and associations and putting facts into a contextual perspective. The term deliberation implies equality among the participants, the need to justify and argue for all types of (truth) claims and an orientation towards mutual understanding and learning (Habermas, 1987b, 1989, 1991b; Dryzek, 1994; Sager, 1994; Sclove, 1995; Cohen, 1997; literature that applies to risk management includes the following: Kemp, 1985; Warren, 1993; Tuler and Webler, 1995; Webler, 1995, 1999; Daniels and Walker, 1996; Chilvers, 2005; Stirling, 2008).

In the sections that follow, I discuss the potential benefits and problems associated with the implementation of analytic–deliberative processes in the field of risk management. 'Expertise and deliberation in risk governance' focuses on the requirements of decision-making in pluralistic and democratic societies, and highlights the implications for risk management. It points to the potential contributions of economic, political, social and scientific rationality for risk governance and emphasizes the need for effective, efficient, legitimate and socially reflective risk evaluation and management. 'Basic concepts of participatory and deliberative models' delineates from this theoretical analysis six different concepts of stakeholder involvement and public deliberation. 'Pros and cons of deliberation' examines the advantages and disadvantages of deliberative processes in the risk arena. 'Requirements for analytic–deliberative processes' deals with the interface between the two elements of an analytic–deliberative process: scientific analysis and open deliberation. 'Evaluation of deliberative models' discusses the problem of evaluation and testing. The conclusions in the final section summarize the major results and present some general insights.

Expertise and deliberation in risk governance

Elements of decision-making in pluralist societies

At the foundation of a society is the need for *effectiveness, efficiency, legitimacy and social cohesion.*[6] *Effectiveness* refers to the need of societies to have a certain degree of confidence that human activities and actions will actually result in the consequences that the actors intended when performing these actions. *Efficiency* describes the degree to which scarce resources are utilized for reaching the intended goal. The more resources that are invested to reach a given objective, the less efficient is the activity under question. *Legitimacy* is a composite term that denotes, first, the normative right of a decision-making body to impose a decision even on those who were not part of the decision-making process (issuing collectively binding decisions) and, second, the factual acceptance of this right by those who might be affected by the decision (Suchman, 1995). As a result, it includes an objective normative element, such as legality or due process, and a subjective judgement, such as the perception of acceptability (Luhmann, 1983; Scharpf, 1991). Lastly, *social cohesion* covers the need for social integration and collective identity despite plural values and lifestyles (Parsons, 1971; Renn and Webler, 1998, pp9ff).

Within the macro-organization of modern societies, these four foundations are predominantly handled by different societal systems: economy, science (expertise), politics (including the legal systems), and the social sphere (Parsons, 1967; Münch, 1982; Renn, 1992c; applied to technology assessment in Renn, 1999b). In recent literature on governance, the political system is often associated with the rationale of hierarchical and bureaucratic reasoning, the economic system with monetary incentives and individual rewards, and the social sphere with the deregulated interactions of groups within the framework of a civil society[7] (overviews are provided in Shils, 1991; Seligman, 1991; Hirst, 1994; Amin and Hausner, 1997). Another way of phrasing these differences is by distinguishing between competition (market system), hierarchy (political system) and cooperation (socio-cultural system). Scientific input in these models is seen as an integral part of either politics in the form of scientific advisory committees, or the civil sector in the form of independent institutions of knowledge generation (Alexander, 1993; Held, 1995; specifically for handling

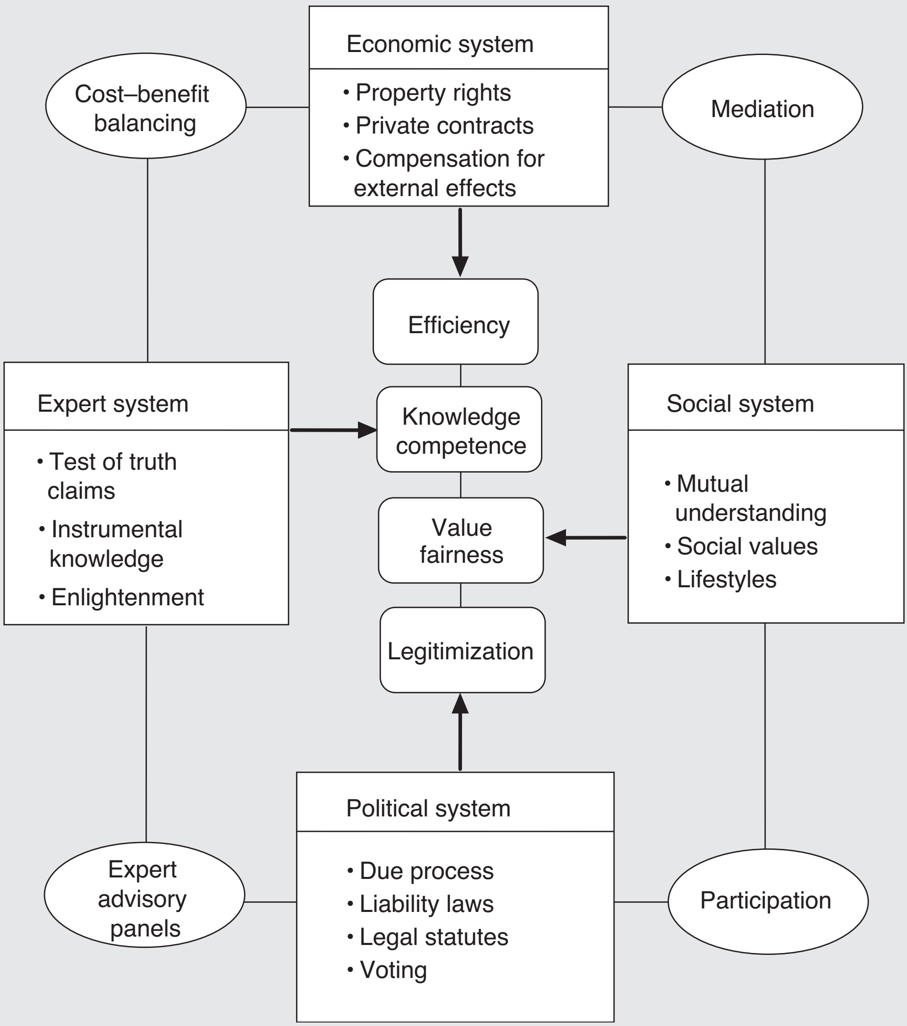

Figure 8.2 *Four central systems of society*

Source: based on Münch, 1982; Joss, 2005; adapted from Renn,1999b

environmental risks, see Hajer, 1995). In the field of decision-making about risks, we prefer to operate with four separate subsystems since scientific expertise is of crucial importance to risk decisions and cannot be subsumed under the other three systems, but forms its own subsystem within the cultural system (similar in Joss, 2005, pp198ff). Since science is a part of a society's cultural system, our proposed classification is also compatible with the classic division of society into four subsystems (politics, economics, culture, and social structure), as suggested by the functional school in sociology (Parsons, 1951; Münch, 1982). The picture of society is, of course, more complex than the division into four systems suggests. Many sociologists relate to the concept of 'embeddedness' when describing the relationships between the four systems (Scott and Meyer, 1991; Granovetter, 1992). Each system is embedded in the other systems, and mirrors the structure and functionality of the other systems in subsystems of its own. For making our argument, however, the simple version of four analytically distinct systems is sufficient.

Each of the four systems is characterized by several governance processes and structures adapted to the system properties and functions in question. The four systems and their most important structural characteristics are shown as a scheme in Figure 8.2. What findings can be inferred from a comparison of these four systems?

- In the market system, decisions are based on the cost–benefit balance established on the basis of individual preferences, property rights and individual willingness to pay. The conflict-resolution mechanisms relate to civil law regulating contractual commitments, Pareto optimality (each transaction should make at least one party better off than the other without harming third parties) and the application of the Kaldor-Hicks criterion (if a third party is harmed by a transaction, it should receive financial or in-kind compensation to such an extent that the utility gained through the compensation is at least equivalent to the disutility experienced, or suffered by the transaction). The third party should hence be at least indifferent between the situation before and after the transaction.[8] Additional instruments for dealing with conflicts are (shadow) price-setting, the transfer of rights of ownership for public or non-rival goods, and financial compensation (damages and insurance) to individuals whose utilities have been reduced by the activities of others. The main goal here is to be efficient.
- In politics, decisions are made on the basis of institutionalized procedures of decision-making and norm control (within the framework of a given political culture and system of government). The conflict-resolution mechanism in this sector rests upon due process and procedural rules that ideally reflect a consensus of the entire population. In democratic societies, the division in legislative, executive and judicial branches, defined voting procedures, and a structured process of checks and balances lie at the heart of the institutional arrangements for collective decision-making. Votes in a parliament are as much a part of this governance model as is the challenging of decisions before a court. The target goal here is to seek legitimacy.
- Science has at its disposal methodological rules for generating, challenging and testing knowledge claims, with the help of which one can assess decision options according to their likely consequences and side effects. If truth claims are contested and conflicts arise about the validity of the various claims, scientific communities make use of a wide variety of knowledge-based decision methods, such as methodological review or re-tests, meta-analysis, consensus conferences, Delphi or (most relevant in this arena) peer review to resolve these conflicts and to test the explanatory or predictive power of the truth claims. These insights help policy-makers to understand phenomena and to be effective in designing policies.

- Finally, in the social system, there is a communicative exchange of interests, preferences and arguments, which helps all actors to come to a unanimous solution. Conflicts within the social system are normally resolved by finding favourable arrangements for all parties involved, using empathy as a guide to explore mutually acceptable solutions, referring to mutually shared beliefs, convictions or values, or relying on social status to justify one's authority. These mechanisms create social and cultural cohesion.

Socially relevant problems are rarely dealt with within the limits of one single system logic. Rather, they go through interrelated procedures, either sequentially or in parallel. For example, the political system can decide on a specific goal or target by parliamentary vote (e.g. a limit on emissions) and then leave it to the market to implement this decision (such as organizing an auction to sell emission rights to all potential emitters). Or a governmental decree is reviewed by an expert panel or a citizen advisory committee. Of particular interest are decision-making processes that combine the logic of two or more systems. The settlement of conflicts with the method of mediation or negotiated rule-making can, for example, be interpreted as a fusion of economic and social rationale. The cooperation between experts and political representatives in joint advisory committees (i.e. the experts provide background knowledge, while politicians highlight preferences for making the appropriate choices) represents a combination of knowledge-oriented elements and political governance. Classic hearings are combinations of expert knowledge, political resolutions and the inclusion of citizens in this process (for comparisons with these models, see also the three political advisory models in Habermas, 1968; and the steering models of power, money and knowledge in Willke, 1995; and more detailed descriptions in Renn and Webler, 1998, pp9ff).

Application to risk governance

Risk decisions are routinely made within all four systems. Managers may decide on a risky strategy to market a product; consumers may decide to eat beef in spite of BSE warnings; scientists may find out that a specific concentration of a new substance may increase the probability of contracting a specific disease; and political bodies may require motorists to wear helmets when driving on public streets. However, almost all risk decisions require input from more than one system. This is particularly true for risk management decisions that impose restrictions on one part of the population to protect other parts or, vice versa, to allow some parts to impose risks on other parts (Kasperson and Kasperson, 1983; Vari, 1989; Kunreuther and Slovic, 1996; Linnerooth-Bayer and Fitzgerald, 1996). In these cases, legitimate decision-making requires the proof that:

- alternative actions are less cost effective (*efficiency*);
- the required course of action (or non-action) would result in anticipated positive results (*effectiveness*);
- the actions are in line with due process and democratic procedures (*legitimacy*); and

- these actions are in line with public preferences and values, and are accepted even by those who disagree with the decision (*reflection of social preferences and values*).

When contemplating the acceptability of a risk, one needs to be informed about the likely consequences of each decision option, the opportunity cost for choosing one option over the other, and the potential violations of interests and values connected to each decision option (Vlek and Cvetkovich, 1989; Gregory et al, 1993; McDaniels, 1996). This is basically true for any far-reaching political decision. Decision-making on risk, however, includes three additional elements already mentioned in Chapters 3, 6 and 8: complexity, uncertainty and ambiguity (Klinke and Renn, 2002; IRGC, 2005).

Complexity refers to a multifaceted web of causal relationships, where many intervening factors may interact to affect the outcome of an event or an activity. The less well known and understood this causal web is, the more uncertainty is introduced into the system. Uncertainty reduces the strength of confidence in the estimated cause–effect chain (Stirling, 1998; van Asselt, 2000). Ambiguity arises when differences exist in how individual actors or stakeholders value some input or outcome of the system (IRGC, 2005, p30). It is based on the question of what our knowledge about risks mean for understanding the effects of the risk agent on human health and the environment (interpretative ambiguity), and what kind of decisions or actions are justified once the risks and uncertainties are characterized (normative ambiguity). For meeting these three challenges risk managers need adequate and accurate expertise, acceptable criteria for conducting cost–benefit trade-offs under uncertainty, legitimate procedures and due process for dealing with conflicting values and adequate methods to incorporate public concerns These demands imply input from the scientific, economic, social and political systems. How processes can be designed and structured with the purpose to manage and organize these inputs from different societal sectors into policy-making will be the main subject of the next sections.

Basic concepts of participatory and deliberative models

The need for deliberation

At the end of the last section, the conclusion was made that decisions and policies that include complex, uncertain and even ambiguous outcomes particularly need input from all four sectors of society. In theory, a benevolent dictator, or an enlightened risk management agency, could provide all of this input without reliance on external feedback. In pluralist and democratic societies, however, division of functional systems into semi-autonomous entities (sociologists call them autopoietic) has produced a self-image of society in which each system insists on generating and providing the functional input to collective decision-making for which it is specialized (Luhmann, 1986a; Scharpf, 1991; Bailey, 1994, pp285–322; Jaeger et al, 2001, pp193ff). In addition, the other systems usually expect that each system provides its specific contribution to collective decision-making (Fiorino, 1989b). Experts expect to be heard and considered when risk managers make factual claims about potential outcomes of risky technologies or activities. Representatives of industry and the unions demand to be included when trade-offs with financial implications for them are made. Communities and affected citizens would like to be consulted if their backyard is being altered by locating a risky facility there.

Not only do system representatives request to be included, it also seems wise from a purely functional viewpoint to use the collective pool of experience and problem-solving capacity of each of the systems, rather than reconstruct a mirror image of all societal systems in each decision-making agency (although some of this may be necessary as well in order to process all of the input from outside sources). Normative democratic theory would also suggest that those who are affected by public decisions should have a right to be involved or at least consulted (Rosenbaum, 1978; Kasperson, 1986; Sclove, 1995). Furthermore, as Joss (2005) has argued, the development towards multi-level governance in the political sphere, the emergence of globalized markets in the economic sphere, the increase of pluralism and individualism in the social sphere, and the growing influence of uncertainties and ambiguities in the science sphere have all contributed to a decline of legitimization power within each sphere and promoted a development towards closer integration of these spheres in terms of integrated decision-making (see also Welp and Stoll-Kleemann, 2006; Breakwell, 2007, pp167ff).

Based on these considerations, risk management agencies have established new routines for outreach as a means of tapping into the experience of other systems. Numerous scientific advisory councils, stakeholder roundtables, citizens' advisory groups and other forms of public outreach give ample testimony to the practice of risk management agencies all over the world to improve their basis for legitimizing decisions and practices.[9] The different forms of cooperation between risk governance institutions and various constituencies of society have been described, analysed and reviewed under different conceptual headings.[10] These reviews unanimously emphasize the need for a combination of methods distinguishing input from science, stakeholders and the general public. The evolving concept of analytic–deliberative processes is one of the promising suggestions for developing an integrative approach to inclusive risk governance based on the inclusion of experts, stakeholders and the general public (Stern and Fineberg, 1996; Chess et al, 1998; Renn, 1999a, 2004b; Tuler and Webler, 1999; Charnley, 2000; Webler et al, 2001; Sweeney, 2004; Niemeyer and Spash, 2001; Chilvers, 2008).

The following sections explain the two components of an analytic–deliberative process (the terms analysis and deliberation) and introduce the different philosophical roots of six genuine concepts of stakeholder and public involvement.

The first component: The role of scientific analysis

The first element of analytic–deliberative processes refers to the inclusion of systematic and reproducible knowledge in risk management. There is little debate in the literature about the inclusion of external expertise being essential as a major resource for obtaining and utilizing risk knowledge (Jasonoff, 1993; Stern and Fineberg, 1996;

Bohnenblust and Slovic, 1998; Horlick-Jones et al, 2007). The degree to which analytic and deliberative forms of decision-making can and should be integrated is, however, contested among participation theorists and practioners. In a recent review article, Chilvers (2008, pp168ff) identified three different camps: those participation analysts that believe that a strict functional separation in analytic and deliberative forms of decision-making is essential to avoid a mix of facts and values, a second camp that proposes that the limit of public engagement in science should be determined by the extent to which non-scientists possess 'contributory expertise' that can complement or enhance certified core-scientific expertise in the technical sense, and a third camp that refuses to separate the scientific from the political dimension and emphasizes the need to negotiate public meanings embedded in science as part of both the analytic and the deliberative mode of decision-making. All these camps, however, agree that regulatory decisions cannot be based on technical expertise alone but need further refinement by stakeholder and/or public involvement.

At the heart of this debate are two fundamental controversies: the first controversy deals with the problem of objectivity and realism; the second with the role of anecdotal and experiential knowledge that non-experts have accumulated over time.[11] This is not the place to review these two controversies in detail (see Bradbury, 1989; Shrader-Frechette, 1990, 1991; Clarke and Short, 1993, pp379ff; Yearly, 2000, Horlick-Jones, 2007). Depending upon which side one stands on in this debate, scientific evidence is either regarded as one input to fact-finding among others or as the central (or even only) legitimate input for providing and resolving knowledge claims. There is agreement, however, among all camps in this debate that systematic knowledge is needed and that it should be generated and evaluated according to the established rules or conventions of the respective discipline. Methodological rigour aiming to accomplish a high degree of validity, reliability and relevance remains the most important yardstick for judging the quality of scientific insights. Most constructivists do not question the need for methodological rules, but they are sceptical about whether the results of scientific enquiries represent objective or (even more so) unambiguous descriptions of reality (Latour and Woolgar, 1979; Knorr-Cetina, 1981, 2002; Latour, 1987; van den Daele, 1992; Jasanoff, 2004). They rather see scientific results as products of specific processes or routines that an elite group of knowledge producers has framed as 'objective' and 'real'. In 'reality', these products are determined by the availability of research routines and instruments, prior knowledge and judgements, and social interests (Wynne, 1992a; Jasanoff, 1996; van den Hove, 2007).

With respect to the analysis of analytic–deliberative processes, the divide between the constructivists and the realists (and all the ones in between) matters only to the degree to which scientific input is used as a knowledge base or as a final arbiter for reconciling knowledge conflicts. The analytic process in itself follows more or less identical rules that are independent of the philosophical stance on realism. A knowledge discourse deals with different, sometimes competing, claims which obtain validity only through a compatibility check with acknowledged procedures of data collection and interpretation, a proof of theoretical compatibility and conclusiveness, and the provision of inter-subjective opportunities for reproduction (Shrader-Frechette, 1991, pp46ff). Obviously, many research results do not reach the maturity of proven facts; but even intermediary products of knowledge, ranging from plain hypotheses via plausible deductions to empirically proven relationships, strive for further perfection (for example, the pedigree scheme of Funtowicz and Ravetz, 1990). On the other hand, even the most ardent proponent of a realist perspective will admit that, often, only intermediary types of knowledge are available when it comes to assessing and evaluating risks (Starr and Whipple, 1980).

What does this mean for analytic–deliberative processes?

- First, scientific input is essential for risk decision-making. The degree to which the results of scientific enquiry are taken as ultimate evidence to judge the appropriateness and validity of competing knowledge claims is contested in the literature and should, therefore, be one of the discussion points during deliberation. The answer to this question may depend upon context and the maturity of scientific knowledge in the respective risk area (a similar assessment is provided in Horlick-Jones, 1998 and Horlick-Jones et al, 2007). For example, if the issue is the effect of a specific toxic substance on human health, anecdotal evidence may serve as a heuristic tool for further enquiry; but there is hardly any reason to replace toxicological and epidemiological investigations with intuitions from the general public. If the issue is the siting of an incinerator, anecdotal and local knowledge about sensitive ecosystems or traffic flows may be more relevant than systematic knowledge about these impacts, in general (a good example for the relevance of personal knowledge can be found in Wynne, 1989).
- Second, the resolution of competing claims of scientific knowledge should be governed by the established rules within the respective discipline. These rules may not be perfect and even contested within the community. Yet, they are usually superior to any other alternative (Shrader-Frechette, 1991, pp190ff; van den Daele, 1992; Harrison and Hoberg, 1994, pp49ff).
- Third, many problems and decision options require systematic knowledge that is either not available or is still in its infancy or in an intermediary status. Analytic procedures are demanded as a means of assessing the relative validity of each of the intermediary knowledge claims, showing their underlying assumptions and problems, and demarcating the limits of reasonable knowledge – i.e. identifying the range of those claims that are still compatible with the state of the art in this knowledge domain (Renn, 1995; US EPA/SAB, 2001, p6).
- Fourth, knowledge claims can be *systematic* and scientific, as well as *experiential* (based on long-term familiarity with the risk cause, the risk agent or the risk-absorbing system), *local* (referring to one's own experience with the local conditions) or derived from *folklore wisdom*, including common sense. All of these forms of knowledge have a legitimate place in analytic–deliberative processes. How they are used depends upon the context and the type of knowledge required for the issue under question (Wynne, 1989; Webler, 1999). For example, if a hazardous waste incinerator is going to be sited, systematic knowledge is needed to understand the dose–response relationships between the flue gas and potential health or environmental damage; experiential knowledge is needed for assessing the reliability of the control technology or the sincerity of the plant's operator to implement all of the required control facilities; local knowledge may be helpful

to consider special pathways of diffusion of gases or special routes of exposure; and common sense or folklore wisdom may assist decision-makers in ordering and prioritizing multiple knowledge claims.

All four points show the importance of knowledge for risk management, but also make clear that choosing the right management options requires more than looking at the scientific evidence alone.

The second component: Deliberation

Overview

The term *deliberation* refers to the style and procedure of decision-making without specifying the participants who are invited to deliberate (Stern and Fineberg, 1996; Rossi, 1997; Chambers, 2003). For a discussion to be called deliberative, it must rely on mutual exchange of arguments and reflections rather than on decision-making based on the status of the participants, sublime strategies of persuasion or socio-political pressure. Deliberative processes should include a debate about the relative weight of each argument and a transparent procedure for balancing pros and cons (Tuler and Webler, 1999). Deliberation is foremost a style of exchanging arguments and coming to an agreement on the validity of statements and inferences. Using a deliberative format does not necessarily include the demand for stakeholder or public involvement. Deliberation can be organized in closed circles (such as conferences of Catholic bishops, where the term has, indeed, been used since the Council of Nicaea), as well as in public forums. Following our arguments, however, complex, uncertain and ambiguous risk decisions require contributions from scientists, policy-makers, stakeholders and affected publics, and a procedure is required that guarantees both the inclusion of different constituencies outside the risk management institutions and the assurance of a deliberative style within the process of decision-making. We suggest using the term *deliberative democracy* when one refers to the combination of deliberation and third-party involvement (see also Fishkin, 1991; Bohman, 1997, 1998; Cohen, 1997; Rossi, 1997; Warren, 2002; Chambers, 2003).

In terms of risk governance, deliberation is required for three major tasks. First, deliberative processes are needed to define the role and relevance of the different forms of knowledge for making informed choices. Second, deliberation is needed to find the most appropriate way of dealing with uncertainty and to set efficient and fair trade-offs between potential overprotection and underprotection (handling uncertainty). Third, deliberation needs to address the wider concerns of the affected groups and the public at large, particularly if the risks are associated with high ambiguity.

Why do we expect that deliberative processes are better suited to deal with these three challenges than using data from surveys among the relevant constituents or organizing focus groups or other participatory instruments to collect systematic feedback from the public? To respond to this question, it is necessary to introduce the different theoretical concepts underlying stakeholder and public involvement in a broader context (Webler and Renn, 1995).

One can differentiate between six distinct prototypes of structuring processes that channel public input into public policy-making. These prototypes can be labelled as functionalist, neo-liberal, deliberative, anthropological, emancipatory and post-modern (Renn and Schweizer, in press). These six prototypes have to be looked upon as abstractions from real-world interaction to the extent that no participation process would be considered as belonging exclusively to one of these categories. Rather, they are ideal types in the Weberian sense (Weber, 1972). Originally, the perspectives on participation were derived from philosophical traditions. Today they serve as mental constructs of social reality, thus empowering research into a variety of instruments that can be linked to the concept from which they were inspired.[12]

Functionalist concept

This approach to citizen participation draws on the functional school of social sciences and evolutionary concepts of social change. Functionalism is originally based on the works of Bronislaw Malinowski and Alfred R. Radcliffe-Brown, the founding fathers of British and US functionalism (Radcliffe-Brown, 1935; Malinowski, 1944; reviews in Coser, 1977, pp140ff; Nassehi, 1999; Lenski, 2005). Functionalism conceptualizes society as a complex structure, recognizing essential functions for social survival either from an individual actor's perspective (Malinowski) or from society's point of view (Radcliffe-Brown). Each social action is assumed to be functional in assisting society's survival (Hillmann, 1994, p252).

As a later development primarily associated with Talcott Parsons and Robert K. Merton, structural functionalism presumes that a system has to meet functional imperatives (adaptation, goal attainment, integration and latent patterns maintenance). These functions are performed by certain structures (Parsons, 1951; Merton, 1959). Therefore, society is a stratified system of structures securing functional needs (Ritzer, 1996). Social differentiation produces structures that specialize in the fulfilment of specific functions (Münch, 1996, p21).

In this sense, participatory exercises are necessary in order to meet complex functions of society that need input (knowledge and values) from different constituencies. Nevertheless, even well-ordered societies change over time. Structural functionalism conceptualizes social change as social evolution. As societies evolve, their subsystems become ever more differentiated. Neo-evolutionary theorists such as Neil J. Smelser and the later Talcott Parsons assume that these new subsystems are more adaptive towards changed social prerequisites than their predecessors. Therefore, they differ in terms of structure and functional significance (Ritzer, 1996, p247).

Integration is the major challenge of functionally differentiated societies. The *telos* of social change is, therefore, the emergence of differentiated, integrated and adaptive systems. Differentiation, integration and adaptation are consequently also the key features of the functional perspective of participatory decision-making. Ongoing social differentiation leads to heterogeneity, which makes integration a vital social imperative. Adaptation is therefore the outcome of functional differentiation and simultaneous integration.

Turning towards participation, the main objective is to avoid missing important information and perspectives, and to ensure that all knowledge camps are represented. Participation is, therefore, seen as a process of getting all the problem-relevant knowledge and values incorporated within the decision-making process.

The goal of 'functionalist' participation is the improvement of political decision-making, in general, and of political policies, in particular. Functionalist decision-making is clearly oriented towards goal achievement and synthesizing knowledge and values towards achieving a predefined goal. In terms of the basic functions of society as outlined above, the model is designed to improve and enhance the *effectiveness* of decision-making. It assumes that representation and inclusion of diversity will result in the improvement of environmental policy-making with respect to the quality of the decisions made. Methods of participation suitable for this approach are expert Delphi methods, negotiated rule-making, hearings and citizen advisory committees (Coglianese, 1997; Checkoway, 1981; Webler et al, 1991; Hadden, 1995; Gregory et al, 2001). These methods of participation are especially suited for the functional perspective because they emphasize the inclusion of various kinds of information for strategic planning.

Neo-liberal concept

This approach to citizen participation draws on the philosophical heritage of liberalism and Scottish moral philosophy (Jaeger et al, 2001, pp20ff). Neo-liberalism conceptualizes social interaction as an exchange of resources. In this concept, deliberation is framed as a process of finding one or more decision option(s) that optimize the pay-offs to each participating stakeholder. The objective is to convert positions into statements of underlying interests (for a general overview, see Fisher and Ury, 1981; Bacow and Wheeler, 1984; Raiffa, 1994; Susskind and Fields, 1996; Knight, 1998; critical review in Nicholson, 1991; review of pros and cons in Friedman, 1995; Jaeger et al, 2001, pp243ff). The rational actor paradigm understands humans as resourceful and restricted individuals who have expectations, engage in evaluation and maximize options (Lindenberg, 1985).

Neo-liberal decision-making consequently focuses on individual interests and preferences. It is assumed that people pursue their individual goals according to their available resources. However, the role of society is not to provide integration, but to grant security for property and personal well-being (Dunn, 1969; Ayers, 1991; Rawls, 1999). Public preferences are seen as varying and unstable. Stakeholder and citizen participation therefore consist primarily in the collection and representation of (well-informed) public preferences.

The market is the place where these preferences can be converted into the appropriate actions under the condition that choices between different options are open to all individuals and that the selection of options by each individual does not lead to negative impacts upon another individual's resources (absence of external effects). If all individuals have the resources to select options and all suppliers have the opportunity to offer options, the market guarantees optimal allocation and distribution of goods.

If, however, the aspired good requires collective action by many individuals, or if an individual good leads to external costs and benefits, the market mechanism will fail and public policies, including collectively binding norms and rules, are needed. These policies should reflect the preferences of all the individuals who are affected by the decision (Fisher and Ury, 1981; Bingham et al, 1987). Since not all preferences are likely to represent identical goals and the means of achieving them, a negotiation process must be initiated that aims at reconciling conflicts between actors with divergent preferences. Within neo-liberal theory, individual preferences are given so that conflicts can only be reconciled if, first, all of the preferences are known in the proportional distribution among all affected parties and, second, compensation strategies are available to recompense those who might risk utility losses when the most preferred option is taken (O'Hare, 1990). The two ideal outcomes of negotiation are, hence, to find a new win–win option that is in the interest of all or at least does not violate anybody's interest (Pareto optimal solution), or to find a compensation that the winner pays to the losers to the effect that both sides are at least equally satisfied with respect to the two choices: the situation before and after the compensation (Kaldor-Hicks solution). Deliberation helps to find either one of the two solutions and provides acceptable trade-offs between overprotection and underprotection for all participants. Under these conditions, participation is required to generate a most truthful representation of public preferences within the affected population (Amy, 1983). The measurement of preferences is, however, linked to the idea that individuals should have the opportunity to obtain the best knowledge about the likely consequences of each decision option (concept of informed consent). Therefore, public opinion polls are not sufficient to represent the public view on a specific public good or norm. Appropriate methods for revealing informed public preferences are referenda, focus groups, (internet) forums, roundtables and multiple discussion circles (Ethridge, 1987a; Dürrenberger et al, 1999). For the second objective to generate win–win solutions or acceptable compensation packages, negotiation, arbitration and, especially, mediation are seen as the best instrumental choices (O'Connor, 1978; Mernitz, 1980; Amy, 1983, 1987; Bingham, 1984; Folberg and Taylor, 1984; Moore, 1986; Bacow and Wheeler, 1984; Baughman, 1995). These methods correspond with the neo-liberal emphasis on bargaining power and balancing individual interests. The main contribution of neo-liberal participation models is to be more *efficient* and, to a lesser degree, to be more *reflective of social values and concerns.*

Deliberative concept

Deliberative citizen participation is mainly influenced by Habermasian discourse theory (Habermas, 1984, 1987a; Apel, 1992; Benhabib, 1992; Brulle, 1992; Webler, 1995; Cohen, 1997; Renn and Webler, 1998, pp48–57). Discourse theory and discourse ethics advocate more inclusiveness for legitimate and sustainable political decision-making. Modern societies are characterized by a plurality of values and world views. According to Habermas (1996, p20), conventional politics and political decision-making cannot deal with this heterogeneity adequately. Modern societies lack moral cohesion that could guide political decision-making. Although mutually binding norms and values are non-existent at the surface, people can allude to their shared reason and experience as human beings. Here, the joined heritage of Habermasian deliberation and 'communitarism' becomes obvious (Benhabib, 1992; Bohman, 1997). Consequently, political decision-making has to find mechanisms that could serve as guidance instruments by enabling citizens to engage in joint rational decision-making.

Habermasian discourse ethics offers a solution to this dilemma. In discourse ethics, only those political and judicial decisions may claim to be legitimate that may find the consent of all affected parties in discursive opinion formation and decision-making processes (Habermas, 1992, p169; Corrigan and Joyce, 1997). Accordingly, legitimate political opinion formation is conceptualized as a process of the competition of arguments. As a result, the procedure of decision-making decides on its legitimacy. Habermas claims that in communication, people always make one or more factual, normative or subjective knowledge claims. These claims allude to the objective world of factual evidence, the normative world of values, moral orientations and world views, and the subjective world of individual experience (Habermas, 1999). Each world has its own rationality and limitations. The objective world is subject to teleological or strategic action. Action alluding to the normative world is obviously governed by norms and values, whereas the subjective world is governed by the dramaturgic action of self-presentation. Only communicative action alludes to each of the worlds simultaneously because it aims for true understanding. Yet, understanding and, consequently, communicative action can only be reached under the ideal conditions of non-coercive discourse. The basic premise of the theory of communicative action is that people are capable of coming to a rationally motivated agreement (i.e. agreements free of coercion of any kind) if they are provided with the optimal discourse setting. Communicative acts are inherently social since they engage two or more speakers and listeners in a social relationship, and are, when conducted in the proper discourse setting, fully dialogical. This setting, where actors can openly and critically reflect, was originally described by Habermas as the 'ideal speech situation', but is now referred to as 'communicative competence' (Habermas, 1970a) and 'unconstrained discourse conditions' (Habermas, 1991b, p113; see also the critical remarks in Warren, 1993; Pellizoni, 2001; Bora and Hausendorf, 2006).

Thus, factual, normative and expressive knowledge claims are settled by alluding to the common rationality of communicative action provided by an appropriate organizational discourse structure. Of course, no real-world discourse can reach the prerequisites of the ideal speech situation (Gripp, 1984; Webler, 1995); yet, practical discourse can aspire to this goal. Discursive decision-making is therefore oriented towards the common good and seeks the rational competition of arguments. It looks for diversity in participants and perspectives in the sense that all potentially affected parties should be able to agree with its outcome. All relevant arguments need including in the deliberation regardless of the extent of their representation within the population. The objective here is to find the best possible consensus among moral agents (not just utility maximizers) about shared meaning of actions based on the knowledge about consequences and an agreement on basic human values and moral standards (Kemp, 1985; Brulle, 1992; Webler, 1995, 1999). The results of discursive decision-making then draw their legitimization from the procedural arrangements of the discourse. Participation methods aim at facilitating mutual understanding and transparent decision-making, thus adding legitimacy to the whole process of policy-making. The best-suited instruments refer to citizen forums, multiple stakeholder conferences and consensus-oriented meetings (Dienel, 1989; Kathlene and Martin, 1991; Stewart et al, 1994; Crosby, 1995; Rowe and

Frewer; 2000; Rowe et al, 2004). The main contribution of deliberative models to society is to enhance *legitimacy* and to reflect *social and cultural values in collective decision-making*.

Anthropological concept

Anthropological citizen participation is mainly influenced by pragmatic Anglo-Saxon philosophy. It is based on the belief that common sense is the best judge for reconciling competing knowledge and value claims. Pragmatism was mainly influenced by the works of Charles S. Pierce and John Dewey (Pierce, 1867; Dewey, 1940; review in Hammer, 2003). Pragmatism postulates that ideas are to be judged against their consequences in the social world. Pierce states that ideas, theories and hypotheses can be experimentally tested and inter-subjectively evaluated according to their consequences (Riemer, 1999, p463). According to Dewey, the thinking process develops over a series of stages from 'defining objects in the social world, outlining possible modes of conduct, imaging the consequences of alternative courses of action, eliminating unlikely possibilities, and, finally, selecting the optimal mode of action' (Stryker, 1980; Ritzer, 1996, p328). This way, science can reach truth by constantly testing and modifying its assumptions. This assumption is equally valid for politics and generally for each individual. Dewey assumes that action gains moral validity by contributing ever more meaning to life (Prechtl, 1999, p218).

For participatory decision-making, this approach has far-reaching consequences. The moral value of policy options can be judged according to their consequences. Furthermore, each citizen is capable of moral judgement without relying on more than their mind and experience. When organizing discourses of this kind, however, there is a need for independence, meaning that the jury has to be disinterested in the topic and there should be some consideration of basic diversity in participants (such as gender, age and class). The goals of decision-making inspired by the anthropological perspective are the involvement of the 'model' citizen and the implementation of an independent jury system consisting of disinterested laypersons who are capable of employing their common sense for deciding on conflicting interests (Laksmanan, 1990; Stewart et al, 1994; Sclove, 1995). Participatory methods granting this kind of common sense judgement are consensus conferencing, citizen juries and planning cells (Crosby et al, 1986; Dienel, 1989; Andersen, 1995; Dienel and Renn, 1995; Joss, 1997, 1998; Andersen and Jaeger, 1999; Einsiedel and Eastlick, 2000; Abels, 2007). The group of selected individuals can be small in size. Most methods do not require more than 12 to 25 participants to accomplish valid results (Stewart et al, 1994). Within that small number, there should be a quota representation of the entire population, thus including the general perspectives of all citizens. The main focus of the anthropological model is to reflect *social values and concerns* in public policy-making.

Emancipatory concept

The basic ideas of emancipatory participation are derived from a Marxist or neo-Marxist social perspective (Ethridge, 1987b; Jaeger et al, 2001, pp232ff). The goal of inclusion is to ensure that the less privileged groups of society are given the opportunity to have their voices heard and that participation provides the means to empower them to become more politically active (Fischer, 2005). In the long run, participation is seen as a catalyst for an evolutionary, or even revolutionary, change of power structures in capitalist societies (Forester and Stitzel, 1989; Fung and Wright, 2001).

The main motive for participation is the revelation of hidden power structures in society. This motive is shared by the post-modern school. Yet, the main emphasis in the emancipatory school is the empowerment of the oppressed classes to, first, acknowledge their objective situation, and, second, become aware of their own resources to change the negative situation in which they live, develop additional skills and means to fight these unjust structures, and, lastly, be prepared to continue this fight even after the participatory exercise is completed. The thrust is the awakening of individuals and groups to make them more politically active and empowered (Skillington, 1997).

The emancipatory perspective has partially been derived from classic Marxist positions, but was also highly influenced by the early works of critical theory (in his later works, Habermas distanced himself from these Marxist roots and developed the deliberative school which deviates in main parts from the original critical theory). It has since been strongly adopted by all variations of liberation theories in the context of development and anti-capitalist movements (Pretty, 1995; Freire, 2000). The goal of empowerment, however, has spread out to more liberal participation contexts, particularly in the pursuit of environmental justice, community development, access to basic services to the poor, and enhancing rural development (Eklund, 1999; Hardina, 2004; Fung and Wright, 2001). Several analysts have linked empowerment and the mobilization of resources to the theory of social capital (Portney and Berry, 1997; Bolland and McCallum, 2002; Larsen et al, 2004).

Methods within the emancipatory concept include activist-driven public meetings, tribunals, science workshops, community solidarity committees, and others (Koopmans, 1996; Wachelder, 2003; McCormick, 2007). The main emphasis is on making sure that the powerless are heard and then empowered to fight for their own interests and values. Although the focus of this concept is on transforming society, it does add to a more balanced *reflection of social and cultural values* in the policy-making process.

Post-modern concept

This approach to citizen participation is based on Michel Foucault's theory of discourse analysis. Discourse analysis rests on the three basic concepts of knowledge, power and ethics. Foucault is interested in the constitution of knowledge. He assumes that knowledge formation is a result of social interaction and cultural settings. Truth then depends upon historically and socially contingent conditions (Foucault, 2003; Jordan and Weedon, 1995).

The archaeology of knowledge shows the underlying sets of rules that determine the formation of knowledge. The conditions of discourse are, therefore, not determined once and for all but are open to (social) change. The relativity of truth and knowledge leads Foucault to the next question. What influences knowledge and truth to develop in the specific way in which they have grown so far? The answer to this question and the second assumption of discourse analysis is that knowledge is constituted and legitimized through power (Foucault, 1979, p39). Power is ubiquitous and permeates society. Power and knowledge are interlinked to the extent that power supports the creation of knowledge, whereas knowledge legitimizes power structures and their social manifestations.

By means of genealogy, Foucault provides an examination of dynamic power structures permeating society. Individuals are therefore faced with the complex social structures of interlinked knowledge and power formation. Ethics and the self-constitution of the individual are Foucault's third topic of interest. It is the task of every person to reflect on the knowledge and power structures surrounding and conditioning them. Insight into the restraints and possibilities of knowledge and power, and how they relate to him or her, transform a person into an individual (Foucault, 1986). However, individuals do not need to accept the conditions of society once and for all. Rather, they have the power to shape the social structures surrounding them.

Thus, ethics and individual 'self-constitution' form the backbone of discourse analysis. In this respect, discourse analysis informs citizen participation with an analytical focus on social power and knowledge formation. In this sense, post-modern decision-making aims at revealing the hidden power and knowledge structures of society, thus demonstrating the relativity of knowledge and values (Fischer, 2005, p25). Reaching a consensual conclusion is neither necessary nor desirable. In its deconstructivist version, deliberation serves as an empty but important ritual to give all actors the illusion of taking part in the decision process. In its constructive version, deliberation leads to the enlightenment of decision-makers and participants (Jaeger et al, 2001, pp221ff). Far from resolving or even reconciling conflicts, deliberation, according to this viewpoint, has the potential to decrease the pressure of conflict, to provide a platform for making and challenging claims, and to assist policy-makers (Luhmann, 1989). Deliberations help reframe the decision context, make policy-makers aware of public demands and enhance legitimacy of collective decisions through reliance on formal procedures (Freudenburg, 1983; Luhmann, 1983; Skillington, 1997). The process of talking to each other, exchanging arguments, and widening one's horizon is what deliberation can accomplish. It is an experience of mutual learning without a substantive message.[13]

Participatory decision-making seeks especially to include dissenting views and social minorities, thus illustrating the relativity of knowledge and power. Appropriate participatory methods include framing workshops, discussion groups, internet chat rooms and open forums because they do not set rigid frames for decision-making (Stirling, 2004, 2008). Rather, they provide insight into stakeholder interests, knowledge bases and power structures. Accordingly, the main function of post-modern discourse is to enlighten the policy process by illustrating the *diversity of factual claims, opinions and values*.

Implications of the different concepts for practical discourse

This review of different background concepts for public participation is more than an academic exercise. Organizers, participants, observers and the addressees of public participation are implicitly or explicitly guided by these concepts. Often, conflicts about the best structure of a participatory process arise from overt or latent adherence to one or another concept. Advocates of neo-liberal concepts stress the need for proportional representation (i.e. representativeness) of participatory bodies, while advocates of deliberative concepts are satisfied with a diversity of viewpoints. For advocates of the anthropological model, representativeness plays hardly any role as long as common sense is ensured. Models driven by emancipatory concepts will judge the quality of participation by the degree to which underprivileged groups have gained more access to power, whereas functionalist models will judge the quality of the process by the quality of the outputs compared to either technocratic or decisionistic (synthesis of knowledge from experts and values from politicians) decision-making models. While neo-liberal concepts will take public preferences as a given prerogative to participatory decision-making, deliberative models are meant to influence preferences and change them through the process.

The diversity of concepts and background philosophies is one of the reasons why participatory processes are so difficult to evaluate in terms of overarching evaluative criteria (Tuler and Webler, 1995; Rowe and Frewer, 2000, Rowe et al, 2004). Although some of these models can be combined and integrated, there are at least differences in priorities. It is obvious that within the functionalist school, the main evaluation criterion is the quality of the output, whereas the models inspired by post-modernism and emancipatory schools are not interested in output but, rather, in the changes that were induced in the minds of the participating people (raising awareness and emancipation).

Within risk governance, there has been a strong preference for the functionalist and neo-liberal view of participation. Many risk management agencies have been, and still are, primarily interested in input from the relevant stakeholders in order to improve the quality of the decisions and to make sure that conflicting values could be resolved in proportion to the representation of the people affected by the decision (Fiorino, 1990). More lately, there has been a shift towards deliberative and emancipatory forms of participation (Bohman, 1998). The discussion on environmental justice, as well as on social capital, has served as a catalyst for these more intense forms of argument-based participation (Dryzek, 1994). In parallel, the anthropological concept has inspired many organizers of participation to model participation in accordance with the well-established jury format of the US judicial system (Armour, 1995; Crosby et al, 1986).

Given this mix of models driven by different concepts, many participation analysts and practitioners have advocated hybrid models that combine elements of different models. One of these models is the analytic–deliberative approach advocated in this essay (Stern and Fineberg, 1996). But there are many other attempts at combining different concepts with new models. Endeavours to combine the neo-liberal with the deliberative concept include the deliberative polling method which has been widely used in several areas of environmental policy-making (Ackerman and Fishkin, 2004). More complex hybrid models try to include even more than two concepts, such as the cooperative discourse model (Renn et al, 1993; Renn, 1999a; see Essay 10 in this volume).

It is not possible to evaluate these models in abstract terms. First, the decision as to which of the six (or perhaps a combination thereof) seems to be most appropriate often depends upon the context; second, it is contingent on the political preferences

Table 8.1 *The six concepts of stakeholder and public involvement and their salient features*

Concept	Main objective	Rationale	Models and instruments
Functionalist	To improve quality of decision output	Representation of all knowledge carriers; integration of systematic, experiential and local knowledge	Delphi method, workshops, hearings, enquiries, citizen advisory committees
Neo-liberal	To represent all values and preferences in proportion to their share in the affected population	Informed consent of the affected population; Pareto-rationality plus Caldor-Hicks methods (win–win solutions)	Referenda, focus groups, internet participation, negotiated rule-making, mediation, etc.
Deliberative	To debate the criteria of truth, normative validity and truthfulness	Inclusion of relevant arguments, reaching consensus through argumentation	Discourse-oriented models, citizen forums, deliberative juries
Anthropological	To engage in common sense as the ultimate arbiter in disputes (jury model)	Inclusion of disinterested laypersons representing basic social categories such as gender, income and locality	Consensus conference, citizen juries, planning cells
Emancipatory	To empower less privileged groups and individuals	Strengthening the resources of those who suffer most from environmental degradation	Action group initiatives, town meetings, community development groups, tribunals, science workshops
Post-modern	To demonstrate variability, plurality and legitimacy of dissent	Acknowledgement of plural rationalities; no closure necessary; mutually acceptable arrangements are sufficient	Open forums, open space conferences, panel discussions

Source: Ortwin Renn

or values of those involved in the process of determining on their own what concept they would like to pursue; third, one must acknowledge the diversity of underlying concepts and ensure that, within a given context, adequate justice is done to all of them if they are represented within the constituency for which the process is designed (Webler et al, 2001). Without any doubt, there will be conflicts since the concepts themselves are often contradictory. The knowledge, however, about these concepts and an explicit inclusion of these concepts within the designing and executing phases of participation are essential for matching purpose and design, and for bringing the aspirations of all parties affected into line with the possibilities that each design can deliver. In this case, theory can enlighten the process of practical implementation. Table 8.1 provides an overview of the six models, their main rationale and some of the instruments which can be associated with them.

Advantages of the deliberative model of participation

Although acknowledging that many models of stakeholder and public involvement coexist, we have a preference for the deliberative model, because it is specifically suited for dealing with risk issues and it can be well combined with analytic processes of knowledge generation and processing (Webler et al, 1995a; Stern and Fineberg, 1996). However, this generic model can be further enriched by elements of the other models: it may incorporate the well-developed techniques of decision analysis which are normally associated with the neo–liberal model; it can borrow communicative strategies and techniques normally employed in post-modern or anthropological models; it can help empower all participants to become more aware of their rights and potentials (emancipatory model); and it can be linked with functional needs, such as resolving a conflict or improving an unsatisfactory environmental condition. Yet, there are substantial conditions that should not be compromised when pursuing a deliberative model (McCarthy, 1973; Kemp, 1985; Habermas, 1991b; Webler, 1995, 1999; Renn and Webler, 1998, pp48ff):

- a fair representation of all relevant viewpoints among the participants (a true proportional representation of viewpoints in the respected population is not necessary);
- equal speaking rights and duties among all participants;
- a consensus on the procedure and the agenda (it is essential that all participants find a common agreement of how to structure the deliberation and to delineate the final product of the deliberation, such as voting, sorting positions, establishing consensual decision-making or involving a mediator or arbitrator);
- inclusion of all factual, expressive and normative claims (all participants have the right to make claims and to critique claims made by others);[14]
- assurance that 'state-of-the-art' scientific knowledge and other forms of problem-adequate knowledge are collected and conveyed to the participants (in the case of dissent, all relevant camps have the right to be represented);
- recognition that the laws of formal logic and analytical reasoning form the basis for all claims and counter-claims;
- common understanding that all relevant values and preferences are made explicit, thus avoiding hidden agendas and strategic game playing;
- common agreement among all participants that all deliberations are structured in a format so that norms of consistent reasoning are met and transparency can be created.

If these conditions are met, what can one expect from a process that follows the rules of deliberation (see also Corrigan and Joyce, 1997)?

Deliberation can produce common understanding of the issues or the problems based on the joint learning experience of the participants with regard to systematic and anecdotal knowledge (Webler et al, 1995a; Pidgeon, 1997). Furthermore, it may produce a common understanding of each party's position and argumentation (rationale of arguing) and thus assist in a mental reconstruction of each actor's argumentation (Warren, 1993; Tuler, 1996). The main drive in gaining mutual understanding is empathy. The theory of communicative action provides further insights in how to mobilize empathy and how to use the mechanisms of empathy and normative reasoning to explore and generate common moral grounds (Webler, 1995).

Deliberation can produce new options for action and solutions to a problem. This creative process can be mobilized either by finding win–win solutions or by discovering identical moral grounds on which new options can grow (Fisher and Ury, 1981; Webler, 1995, 1999). It has the potential to show and document the full scope of ambiguity associated with risk problems, and helps to make a society aware of the options, interpretations and potential actions connected with the issue under investigation (Wynne, 1992b; De Marchi and Ravetz, 1999). Each position within a deliberative discourse can survive the cross-fire of arguments and counter-arguments only if it demonstrates internal consistency, compatibility with the legitimate range of knowledge claims, and correspondence with the widely accepted norms and values of society. Deliberation clarifies the problem, makes people aware of framing effects, and determines the limits of what could be called reasonable within the plurality of interpretations (Skillington, 1997).

Deliberation can also produce common agreements. The minimal agreement may be a consensus about dissent (Raiffa, 1994; Renn and Webler, 1998, p64). If all arguments are exchanged, participants know why they disagree. They may not be convinced that the arguments of the other side are true or morally strong enough to change their own position; but they understand the reasons why the opponents came to their conclusion. At the end, the deliberative process produces several consistent and – in their own domain – optimized positions that can be offered as package options to legal decision-makers or the public. Once these options have been subjected to public discourse and debate, political bodies such as agencies or parliaments can make the final selection in accordance with the legitimate rules and institutional arrangements, such as a majority vote or executive order. Final selections can also be performed by popular vote or referendum (Wehrli-Schindler, 1987). In addition, deliberation creates 'second-order' effects on individuals and society by providing insights into the fabrics of political processes and creating confidence in one's own agency to become an active participant in the political arena (Sabatier, 1988; Sabatier and Jenkins-Smith, 1993). By participating they can enhance their capacity to raise their voice in future issues and become empowered to play their role as active citizens in the various political arenas.

Deliberation may result in consensus. Often, deliberative processes are used synonymously with consensus-seeking activities (Coglianese, 1997). This is a major misunderstanding. Consensus is a possible outcome of deliberation, but not a mandatory requirement (compare van den Hove, 2007). If all participants find a new option that they all value more than the one option they preferred when entering the deliberation, a '*true*' consensus is reached (Renn and Webler, 1998, p69). It is clear that finding such a consensus is the exception rather than the rule. Consensus is either based on a win–win solution (examples in Waldo, 1987) or a solution that serves the 'common good' and each participant's interests and values better than any other solution (examples in Renn, 1999b). Less stringent is the requirement of a *tolerated* consensus. Such a consensus rests on the recognition that the selected decision option might serve the 'common good' best, but at the expense of some interest violations or additional costs. In this situation, people who might be worse off than before, but who recognize the moral superiority of the solution, can abstain from using their power of veto without approving the solution. In our own empirical work, deliberation has often led to tolerated consensus solution, particularly in siting conflicts (one example is provided in Schneider et al, 1998). Consensus and tolerated consensus should be distinguished from *compromise*. A compromise is a product of bargaining, with each side gradually reducing its claim to the opposing party until they reach an agreement (Raiffa, 1994). All parties involved would rather choose the option they preferred before starting deliberations; but since they cannot find a win–win situation or a morally superior alternative, they look for a solution that they can 'live with', well aware of the fact that it is the second or third best solution for them. Compromising on an issue relies on full representation of all vested interests.

Given the many potentials for deliberative actions, one should take a closer look at the potential risks, pitfalls and problems of deliberation as well. This topic will be covered in the following section.

Pros and cons of deliberation

Overview of critical objections

Having explored the potential of the deliberative model of stakeholder and public involvement, one should also be aware of limitations and potential problems. These are first related to the underlying concept of deliberation or participation, second to the purpose that has been associated with each participatory project, and third to a genuine criticism with respect to the functionality and legitimacy of these processes. The main critical remarks can be grouped in three categories (Breyer, 1993; Dana, 1994; Coglianese, 1997, 1999; to some degree also Rossi, 1997; Sunstein, 2001, 2006; Löfstedt, 2003, 2005):[15]

1 Participation *compromises the quality of the output* (due to erroneous laypeople's knowledge and intuitive biases that can only be overcome by rigorous scientific scrutiny).
2 Participation *leads to distortions in the representation of the public will* (due to power differences among stakeholders and the discrepancy between interests that can easily be organized and those interests defying effective organization).
3 Participation produces either *political paralysis or trivial results*, delays the process of decision-making and leads to parallel decision-making processes in addition to the prescribed procedures of representative democracy (due to plural interest,

lack of common-value orientations of the participants and strategic manoeuvring by powerful actors).

Are laypeople able to make unbiased and evidence-based judgements?

One of the major arguments against participation has been that public input to decision-making relies on distorted knowledge and folklore wisdom. The key words here are ignorance and incompetence (Okrent, 1996; Cross, 1998). It is claimed that it is to nobody's advantage to replace the best institutional or scientific knowledge with intuition and personal interest and that public knowledge is usually inferior to the systematic knowledge of the experts (Breyer, 1993; Dana, 1994). Indeed, research shows that public perception of environmental risks differs substantially from professional analysis (Covello, 1983; Fischhoff, 1985; Borcherding et al, 1986; Slovic, 1987, 1992; Boholm, 1998; Rohrmann, 1999; Sjöberg, 1999a; Rohrmann and Renn, 2000; Breakwell, 2007, pp78ff).[16] One of the main insights from the study of human decision-making has been that these biases exist, and that they can distort human judgement. However, several decades of participation research and its critical evaluation have also demonstrated that a simple division into experts and laypersons does not concur with the empirical evidence on bias distribution and does not do justice to perceptions or expertise (Lynn, 1986; Hyman and Stiftel, 1988; McDaniels, 1998; Slovic, 1992; Wynne, 1992a; List, 2006). In many decision-making contexts, experiential and local knowledge have often proved equally important to the systematic knowledge of experts (Wynne, 1989). Furthermore, the evidence of biases also includes professionals, and some of the practices of bounded rationality may even be superior to a fully fledged analysis guided by subjectively expected utility (SEU) or multi-attribute utility (MAU) procedures (Gigerenzer, 1991, 2000; Gigerenzer and Selten, 2001). The juxtaposition of two opposing camps – the rationality camp reserved for experts versus the irrationality camp assigned to a lay public – is not congruent with empirical research results. Both camps have problems with biases and, depending upon context and issue, one may outdo the other. More important, however, is the fact that there is major variation within the expert and the layperson camps that makes predictions about their collective judgemental capabilities very doubtful (Sjöberg, 1999b).

Nevertheless, there is no doubt that preferences which guide social groups and individuals to assign trade-offs between conflicting values may be distorted by misconceptions about the factual relationships between assumed causes and effects. Durodie (2003), for example, observed that people in countries with the least exposure to chemical risks show the highest degree of fear and concerns about chemical risks. They also suffer more than others from multiple chemical syndrome and other psychosomatic diseases which, in Durodie's eyes, have no scientific bearing. To request these people to participate in environmental decision-making would mean spending valuable public resources on those who are already highly protected, probably at the expense of those less attentive to their living situation.

The argument of distorted knowledge and bias comes in many variations. But it is essential to link this argument to the purpose of the participatory exercise.

For example, if one pursues a functional or neo-liberal concept of participation, knowledge distortions do not matter. The idea here is to distinguish knowledge from value input. All systematic knowledge claims need testing against the accepted rules of methodology; in addition, all value judgements must reflect the distribution of the potentially applicable values within the affected population (Kunreuther and Slovic, 1996). The two criteria of 'truth' (as fuzzy as it may appear in many scientific contexts) and 'representativeness' are neither interchangeable nor replaceable. All collectively binding decisions need to meet both criteria. The rationale for direct participation is to provide an opportunity for the people directly affected by a decision to reflect the potential outcomes, to review the (external) knowledge available, and to make a prudent choice based on knowledge and values (Langton, 1978; Barber, 1984; Ethridge, 1987a; Burns and Überhorst, 1988; Dryzek, 1994). Public participation is, hence, not designed to produce better scientific insights, but to explore the preferences of those who will or must live with the consequences of whatever decision option is chosen. In this respect, the knowledge comes from the experts, but the question of how various outcomes are judged – given the present state of (uncertain) knowledge – should be left to the people affected by this decision.

The main task of the facilitators is to ensure that the participants reflect the pros and cons and come to a final judgement which reflects their true preferences (Moore, 1986; Bacow and Wheeler, 1984). Any decision on a variety of options implies crucial value judgements on at least three levels (Renn, 2004b). The first set of value judgements refers to the selection of criteria on which functionally equivalent options ought to be judged. The second set of value judgements determines the trade-offs between these criteria, and the third set of values affects the choice of preferred strategies for coping with remaining uncertainties and ambiguities. Using methods of public participation and deliberation on all three value inputs does not place any doubt on the validity and necessity of applying the best of technical expertise for defining and calculating the performance of each option on each criterion (see also Charnley, 2000). Public input is an essential contribution towards determining the objectives of environmental policies and to weighing the various criteria that ought to be applied when evaluating different options. To know more about perceptions can also help to create a more comprehensive set of decision options and to provide additional anecdotal knowledge and normative criteria for their evaluation (Gregory et al, 1993; McDaniels, 1998).

This distinction in knowledge and values is less pronounced in participatory exercises which are based on deliberative or anthropological models, or are inspired by the goal of participant empowerment. In these models, participants are supposed to, simultaneously, learn and reflect knowledge and value claims (Jasanoff, 1991, 1998, 2004; Daniels and Walker, 1996; Horlick-Jones et al, 2007). These deliberative platforms necessitate reflections about the legitimate role of systematic, experiential, local and folklore knowledge. The true advantage of these platforms is that all types of knowledge are included and their strengths and weaknesses assessed. Selection and evaluation of knowledge is based on discursive methods and procedures, not on individuals (such as experts) or status (Shrader-Frechette, 1991, pp190ff). If the participation succeeds in integrating these different types of knowledge within a coherent and consistent manner, it is even superior to pure analytical procedures, which basically rely on collecting and testing systematic knowledge (Jasanoff, 1993). There is substantial evidence from case study evaluation that this integration can be accomplished and cognitive biases avoided (Roch, 1997; Vorwerk and Kämper, 1997; Beierle, 2000; US EPA/SAB, 2001; Rowe et al, 2004; Rauschmayer and Wittmer, 2006). Until today, however, there is no statistical proof that in a deliberative setting biases can be overcome and different types of knowledge truly incorporated.[17]

Who represents whom in deliberative processes?

The second line of arguments refers to the problem of scale and representativeness. Inviting stakeholders to take part in the process implies giving their specific, often self-centred, interest special weight in the deliberation (Cupps, 1977; Reagan and Fedor-Thurmon, 1987; Lijphart, 1997). This would not be a problem if all social interests were equally represented and if the representation was proportional to the population who will experience the potential advantages and disadvantages of the decision options under deliberation. Analysts of pluralist societies have demonstrated, however, that the relative power of interest groups does not match the relative importance of the issue for society, but depends upon factors such as exclusiveness of representation, availability of power and resources, and potential for social mobilization (Downs, 1957; Olson, 1965, 1984; Breyer, 1993). Particular interests have usually a better chance of dominating the decision-making process and will use the opportunity of deliberation to influence the opinion-forming process and impose their specific interest on the agenda. Under these premises, deliberative bodies constitute mere mirror images of the power distribution in society, rather than a correction of an agency's perspectives (Waller, 1995). This argument particularly refers to deliberative procedures, such as negotiated rule-making or mediation, where stakeholder groups are asked to feed their interest into the decision-making process without further public scrutiny (Schoenbrod, 1983; Edwards, 1986; Renn et al, 1995).

This argument lies at the root of an ongoing debate on the role of representative versus deliberative (or direct) democracy (Radulova, 2007). There is hardly any voice in this debate that would recommend the abolition of representative government.[18] All proposals to increase participation or to make sure that expert judgements and stakeholder values will get more weight in the decision-making process are embedded in a firm commitment towards the institutions of representative government as the final decision-maker on environmental policies and risk regulation. Representatives of legitimate decision-making bodies must, however, prepare decisions carefully. In order to make prudent judgements, they are well advised to consult with experts and the public as a means of serving the common good in a pluralist society (original argument by Mill, 1873; modern version in Dahl, 1989). Any legitimate decision-maker is most likely interested in the consequences that each decision option might produce and how these consequences are evaluated by those who have to live with them (Chess et al, 1998). It is, therefore, a constitutive element of representative democracy to ensure a continuous consulting process through which the decision-makers become familiar with the state of the art in assessing the likely consequences (knowledge), as well as with the preferences of those whom they are supposed to serve (values). Feedback from constituents is a major condition upon which the whole notion of representative government rests (Rushefsky, 1984; Burns and Überhorst, 1988; Lynn, 1990; Lacob, 1992).

In societies where people have major trust in the representative bodies of government, adding elements of deliberative democracy may not be essential for gaining public support (Löfstedt, 2005). In societies, however, where distrust and scepticism with regard to the neutrality and openness of the political representatives prevail, opportunities for deliberative participation may help stabilize political support and increase satisfaction in the political system. In this respect, the argument that participation decreases the legitimacy of representative bodies of democracy is reversed. By preparing the decision options more carefully and by considering the preferences and values of the constituents beforehand, representative bodies of government can enhance their legitimacy and be perceived as being particularly responsive to public needs (Bohman, 1997).

Given this observation, it seems justified and desirable to organize participatory processes in order to inform legitimate representative bodies or agencies about the likely consequences of their decisions and the informed preferences that their constituents share vis-à-vis more or less desirable outcomes of decision options. This is particularly necessary if highly controversial issues are at stake or unexplored.

Organizing a common platform for mutual exchange of ideas, arguments and concerns does not suffice, however, in order to assure fair, efficient and competent results (Lynn, 1986). Some groups will have more power than others and many (legitimate) interests are not organized. Groups with high social status have more opportunities to intervene and more resources to push their point of view into the debate. If the rhetoric of powerful agents replaces value input by those who have to bear the risks, participation would, indeed, produce distorted and illegitimate results.

The argument of distorted representation is very popular in the current discourse on participation and can only be addressed in conjunction with the different participatory concepts. Within the functional concept, participants are selected according to their knowledge or stakes in the issue to be resolved. For example, the classic mediation process involves all parties who benefit or suffer from an existing conflict. If the parties agree to participate, they also agree to an equal level since the instrument of mediation requires that all parties share equal rights and duties regardless of the power distribution outside of the negotiation table (Amy, 1983; Baughman, 1995). The organizers have to ensure, however, that all groups who are or will be affected by the potential conflict are represented at the table. The empirical evidence demonstrates that this goal of equal representation of all parties has, in most cases, been achieved (Cormick, 1980; Bingham, 1984; Moore, 1996).

The neo-liberal concept of participation poses the highest requirement in terms of representation: it is based on the ideal of having a representative sample of the affected public (Hagendijk and Irvin, 2006, p180). This can be accomplished by true random sampling, e-participation or quota selection. Research demonstrates that, even under excellent conditions, a true representation of the public is never achieved; but at least there is high heterogeneity and diversity (List, 2006).

The deliberative and anthropological models of participation do not require representativeness. The rationale of these models relies on the competition of arguments, not on the proportionality of their distribution in the population (Habermas, 1984, 1987b, 1989). The organizers are obliged to ensure that any relevant argument is represented and that each argument is given sufficient room (Webler et al, 1995a). Powerful actors are part of the discourse; but they have no privileged status within the deliberation. Furthermore, all guidelines for deliberative discourse management provide specific advice on how to improve the communicative competence of those who do not have the intellectual or financial resources to discuss issues on an equal stance with the powerful (Moore, 1986). If empowerment is also a goal of participation, organizers are encouraged to include the less privileged in the process and to help them become more resourceful and articulate in pushing for their values and interests (Forester and Stitzel, 1989).

Post-modern models of participation emphasize inclusion and do not provide consensual recommendations in the first place, let alone engage in any voting procedure. The ideal here is to understand the diversity of opinions and concerns that people or stakeholders might associate with the issue of the discourse (Stirling, 2008). Since the output consists of a list of concerns, viewpoints and evaluations, the opportunities for powerful actors to dominate the process are not given or are, at least, less pronounced.

Is consensus more than the most trivial denominator of plural interest groups?

The third line of argument refers to the output of deliberative processes. These processes are supposed to be trivial, overprotective, inefficient, time consuming or disproportional to the threat (Dahl, 1994; Sanders, 1997; Cross, 1998; List, 2006). Many critics claim that people are either unable or unwilling to accept trade-offs and to search for efficient or cost-effective solutions (Zeckhauser and Viscusi, 1996). Participatory processes, in this view, tend to favour solutions that would violate all rules of efficient or cost-effective spending of public money (Cupps, 1977; Rosenbaum, 1978; Graham and Wiener, 1995; Viscusi, 1998). Deliberation may even aggravate environmental damage or impacts upon human health, because it is often focused on one issue and does not take into account the fact that minimizing the impact of one problem usually increases the impact of related problems (Perry 6, 2000). By pursuing priorities which the public demands, regulators are likely to spend time and effort on those environmental threats that are relatively benign but highly visible in the public eye, and neglect those threats that are publicly unknown but very potent in their consequences (Coglianese, 1999, undated). In the long run, more people will suffer from future damage than necessary since the funds for safety and risk reduction are spent inefficiently.

Another argument challenges the feasibility of deliberative procedures in participatory processes (Rossi, 1997). Advocates of this line of criticism do not necessarily argue that participation is bad for democracy; but there is a deep concern that too much participation may disrupt the normal operation of agencies or representative bodies (Aron, 1979; Cross, 1998). Deliberative participation consumes too many resources in terms of time and finances and might result in increased immobility and stalemate. Some European analysts have claimed that the European style of closed-shop negotiation has been much more effective in regulating environmental risks than the adversarial and open style of the US (Coppock, 1985; Weidner, 1993). The more people are asked to take part, the more time it will take to come to any conclusion. Effective government, so the argument goes, rests on a limited opportunity to participate. Too much deliberation immobilizes the political system and delays necessary decisions.

The last argument in this line of reasoning deals with the outcome of deliberative processes. The main criticism is that deliberative processes lead to trivial results (Coglianese, 1999; Mouffle, 1999). The more public input is allowed to enter the process, the more window-dressing is going to occur. If all have to find a common agreement, the language will remain vague and the outcomes will lack specificity and clear direction. This argument is directed, of course, against deliberative procedures that require consensus (deliberative and anthropological model).

The argument that participatory processes produce problematic or suboptimal outputs compared to either scientific or political decision-making bodies depends, on the one hand, upon the nature of the expectations that organizers or users associate with these processes and, on the other, upon the empirical analysis of whether the results meet the expectations. Turning to the expectations, it is again crucial to distinguish between the various models of participation. If a functional or neo-liberal model is used, the expectation is to obtain a representative image of people's or stakeholders' informed preferences. Such an image cannot be trivial, inefficient or disproportional by its own nature. If the votes were taken in a valid and reliable method, they reflect what people would like the government or other players to do after being well informed about the consequences of their preferences (Cohen, 1997). Decision-makers are free to reject such a public preference vote or to focus on their own constituency or exercise 'lonely' leadership in arguing against public sentiment. There is no doubt, however, that public decision-makers should at least consider the informed preferences of their voters or clients. But nobody claims that these preferences should have imperative power.

Turning to the deliberative and anthropological models, the expectation that participatory processes should produce consensus places more stress on the ability of the participants to learn from each other, weigh arguments and act upon substantial rather than strategic gratifications (Daniels and Walker, 1996; Beierle, 2000; Webler et al, 2001; Welp and Stoll-Kleemann, 2006). Many designers of these processes claim that, given the right structure and facilitation process, the expectation of a rational exchange of arguments and a balanced and efficient assignment of trade-offs can be met and in many instances has been met (Renn et al, 1993; Webler, 1995, 1999; Chambers, 2003; Renn, 2004b). In the end, it is an empirical question whether these claims can be validated. The little systematic evidence available shows that consensus-seeking participation processes tend to be more time consuming and intense (Sherington, 1997; US EPA/SAB, 2001; Abelson et al, 2003). They also fail more often than processes that measure public preferences or display the diversity of opinions. However, the quality of the output seems to be better in terms of meeting the expectations of both the participants and the users (Beierle and Cayford, 2002; Hagendijk and Irwin, 2006; Abelson et al, 2003). Furthermore, evaluations of case studies on deliberative processes provide rather convincing evidence that the output of well-designed processes ranks far beyond trivial or inefficient results (Rowe et al, 2004; Rauschmayer and Wittmer, 2006). A comparative review of three pan-European deliberative participation projects revealed that the outputs were well balanced between expected benefits and risks, substantial in their content and articulated in practical terms so they could be implemented in the European policy arena (Goldschmidt and Renn, 2006; Goldschmidt et al, in press).

Models fostering participants' empowerment aspire to have the needs and interests of those who are normally neglected in the public policy arena heard and considered by those who have the legal power to make decisions. The output here will be (and is supposed to be) disproportional to the general public's preference structure. The goal is to generate public pressure to influence policies in the direction of the interests of the less privileged. This objective is certainly not shared by all members of society; but it would be unfair to criticize the output of empowerment projects for being inefficient or disproportionate. The projects do not intend to produce well-balanced and efficient solutions (Koopmans, 1996; Kousis, 1999; Fung and Wright, 2001; Fischer, 2005).

Similarly, post-modern models cannot be evaluated from the viewpoint of the quality of their output. They do not claim to produce policy-ready results. The main idea is to remind policy-makers of the diversity of possible viewpoints, options and expectations (Jasonoff, 1991; Wynne, 1992a; Stirling, 2004, 2008). The criticism that public participation opens up the process but does not provide any closure does not apply here, because it is not intended to produce solutions or consensual policy recommendations.

Merits and limits of deliberative processes

The review of critical remarks demonstrated that participation in environmental decision-making is not a panacea for better-quality outputs, including enhanced legitimacy and higher capacity-building. First, these two main goals can hardly be accomplished to the same degree by any of the currently used models. Second, the critical remarks can serve as a reminder that it often depends upon the match between task, choice of model and its implementation whether the problems and shortcomings materialize and compromise both quality and capacity. Third, one needs to discuss potential problems not in the abstract but in comparison with potential alternatives. Most critics fail to provide convincing arguments that alternatives such as litigation, purely parliamentary decision-making or confinement to agency staff decision-making would fare any better than using participatory procedures. Moreover, evidence shows that if users and participants are highly motivated, even flaws in the design and structure of the process can be overcome (Joss, 1995; Moore, 1996; Beierle and Cayford, 2002). Participation tends to be more robust than critics assume.

Requirements for analytic–deliberative processes

Linking the two components: Analysis and deliberation

One of the most difficult problems in the design and implementation of analytic–deliberative processes is the integration of analytic input within deliberation, and the introduction of deliberative methods to the analytic component. The deliberative process and the process of analytic knowledge generation and processing must be amalgamated. This task can be facilitated by using decision–analytic tools (Merkhofer, 1984; Kweit and Kweit, 1987; McDaniels, 1998; Gregory, 2004; NRC, 2005).[19] Decision theory provides a logical framework distinguishing action alternatives or options, consequences, likelihood of consequences, and value of consequences, where the valuation can be over multiple attributes that are weighted, based on trade-offs in multi-attribute utility analysis (Edwards, 1977). A sequence of decisions and consequences may be considered, and use of mathematical models for predicting the risks of certain events or activities, as well as the consequences of regulatory options, may or may not be part of the process (Humphreys, 1977; Bardach, 1996; Arvai et al, 2001).

The structuring potential of decision analysis has been used in many participatory processes (Paruccini, 1994; Rauschmayer and Wittmer, 2006). It helps the facilitator of such processes to focus on one element during the deliberation, to sort out the central from the peripheral elements (see Essay 7 on risk communication), to provide a consistent reference structure for ordering arguments and observations; and to synthesize multiple impressions, observations and arguments into a coherent framework. The structuring power of decision analysis has often been used without expanding the analysis into quantitative modelling.

The second potential, agenda setting and sequencing, is also frequently applied in participatory settings. It often makes sense to start with problem definition and then develop the criteria for evaluation, generate options, assess the consequences of options, assign probabilities to each outcome, weigh each criterion relative to each other and synthesize all the assessments into a priority list of options (see Table 8.2).

The third potential, quantifying consequences, probabilities and relative weights, and calculating expected utilities, is more controversial than the other two. Whether the deliberative process should include a numerical analysis of utilities or engage the participants in a quantitative elicitation process is contested among participation practitioners (Gregory et al, 2001). One side claims that quantifying helps participants to be more precise about their judgements and to be aware of the often painful trade-offs they are forced to make. In addition, quantification can make judgements more transparent to outside observers. The other side claims that quantification restricts the participants to the logic of numbers and reduces the complexity of argumentation into a mere trade-off game. Many philosophers argue that quantification supports the illusion that any value can be traded off against another, and that complex problems can be reduced to simple linear combinations of utilities (Shrader-Frechette, 1991). One possible compromise between the two camps may be to have participants go through the quantification exercise as a means of helping them clarify their thoughts

Table 8.2 *Generic steps in a decision–analytic approach*

Generic steps of the decision–analytic approach	Example: Municipal solid waste disposal
Structure the problem and specify goals for the situation ahead.	Priorities: reduce waste generation, encourage voluntary reuse and recycling and mandate recycling, incineration and landfills.
Extract appropriate value dimensions from stated goals.	Ensure equity of risk exposure, compensation and cost effectiveness; minimize impacts.
Define criteria and indicators for each value dimension (or attribute).	Provide meta-criteria on health risks, environmental risks, and social and cultural risks.
Assign relative weights to each value dimension.	Health risk = 40%; environmental risk = 35%; cost = 25%.
Describe alternatives or options that seem to meet the criteria.	Option A: regional recycling centres and an expanded landfill. Option B: a new landfill in community *X*.
Measure how well each decision option performs on the criteria.	Conduct geological borings and probabilistic risk assessments, collect statistical data and elicit citizens' responses.
Assess probabilities for each possible outcome.	Option A: health risk = 11; eco-risk = 21; cost = 82. Option B: health risk = 34; eco-risk = 75; cost = 20.
Sum each decision option's utility on each criterion, multiplied by the weight of each value dimension.	Option A = 32; Option B = 45.
Conduct a sensitivity analysis to incorporate changes in the criteria composition, outcome generation, assignment of weights and probability assessments.	Option A (28, 32, 56); Option B (16, 45, 47).

Source: adapted from Jaeger et al, 2001, p51

and preferences, but make the final decisions on the basis of holistic judgements (Hostmann et al, 2005; Renn, 2006b). In this application of decision–analytic procedures, the numerical results (i.e. for each option the sum over the utilities of each dimension multiplied by the weight of each dimension) of the decision process are not used as an expression of the final judgement of the participant, but as a structuring aid to improve the participant's holistic intuitive judgement. By pointing out potential discrepancies between the numerical model and the holistic judgements, the participants are forced to reflect upon their opinions and search for potential hidden motives or values that might explain the discrepancy.

Within the decision–analytic model, input from external knowledge sources is required when assessing the consequences of each decision option and when assigning probabilities to each option. In an ideal world, this task could be performed by experts and then fed into the process. In reality, however, this process is more sophisticated and intertwined (Hyman and Stiftel, 1988). Often, scientific claims are disputed, experts may voice divergent (even contradictory) advice, the legitimate role of other knowledge (experiential, local, common-sense and folklore wisdom) is not clear, or the boundaries between facts and values have become fuzzy (Funtowicz and Ravetz, 1990, 1992; Laudan, 1996, De Marchi and Ravetz, 1999; Koenig and Jasanoff, 2001; Liberatore and Funtowicz, 2003; van der Sluijs et al, 2003; Horlick-Jones et al, 2007). It is essential to acknowledge, in the context of risk, that human knowledge is always incomplete and selective and, thus, contingent upon uncertain assumptions, assertions and predictions (Functowicz and Ravetz, 1992). In this difficult situation, different approaches could be used: the classic approach would be to consult highly esteemed scientific journals and conduct peer reviews from scientists outside the government agency. These checks may help managers or organizers of deliberative processes to determine the evidence considered acceptable. Another more innovative approach is the joint fact-finding mission in which experts and the participants of the deliberation (stakeholders and representatives, not the public) try to sort out the knowledge claims and define what is relevant and valid for the case in question (Adler et al, 2000, pp21f; Meister and Oldenburg, 2008, p38). A third approach is to conduct a workshop with experts representing the entire range of opinions and assessments regarding the risk in question, and to ask them to classify the systematic knowledge in terms of validity, accuracy, authenticity and reliability (Adler et al, 2000, p18). A fourth possibility would be to involve the experts in a separate consensus-building process such as Delphi or a group Delphi and feed the results to the deliberating body (Webler et al, 1991; Renn et al, 1993).[20]

Another point of consideration is the issue of presenting scientific results to the deliberative body. Participants without scientific training may feel at a disadvantage when the information is being presented to them in scientific terminology, and by extensive use of models, mathematics and statistics. The point here is not that one should simplify in order to be comprehensible to a lay audience (which may be important for communication with stakeholders, but not for a political decision-making process on risk issues which uses mathematical logic as an appropriate means of dealing with great scientific complexity). The main argument is, rather, that the assumptions and conditions that may constrain the validity and applicability of the models should not remain hidden behind the image of exact figures and algorithms (Klein, 1997). These assumptions and conditions should be made explicit and be subject to questioning and challenging by the participants. It may be advisable for those responsible for the deliberative process to work closely with scientists and analysts so that information is made available in a format that guarantees that all assumptions, underlying values and norms, and scientific conventions (such as using the 95th percentile for significance testing) become transparent and are open to criticism. The empirical analysis by Beierle and Cayford (2002) underlines that the quality of the process is enhanced if there is a major effort to make the expertise available to all participants in a form that does not compromise its accuracy but is comprehensible for a non-expert in the field. It is less advantageous to have each stakeholder select his or her own expert and then have the experts conduct a fight against each other in front of the deliberating body (US EPA/SAB, 2001, p9).

Most decision analysts agree that applying the concepts from decision analysis requires specific tools that help participants to use the decision–analytic framework most productively. This is true for both eliciting values on the consequences and for organizing information on issues of complexity, uncertainty and ambiguity in predicting the consequences for the various options under consideration (Keeney, 1988, 1992). The tools needed on the informational aspects involve a set of quality criteria (US EPA/SAB, 2001, p6):

- Have all evidence claims been fairly and accurately tested against commonly agreed standards of validation (methodological rigour)?
- Has all the relevant evidence in accordance with the state-of-the-art knowledge been collected and processed (comprehensiveness and representativeness)?
- Were systematic, experiential and local knowledge and expertise adequately included and processed (incorporation of all relevant knowledge claims)?
- Have all conflicts about evidence been resolved or addressed using accepted means of validation, testing and methodology approved of by the respective scientific or knowledge communities?
- Were all normative judgements inherent in evidence claims made explicit and thoroughly explained? Were normative statements deduced from accepted ethical principles, legally prescribed norms or accepted conventions within the knowledge community?

Every type of knowledge has standards of quality that can be examined, debated and tested. Thus, the issues of what is to be examined, how it is to be examined, who is to examine it, and when it is to be examined are negotiable during the course of the deliberation (Adler et al, 2000, p18). Yet, the methods and procedures of examination need to be taken from the accepted arsenal of validation and reliability testing methods. After carefully considering the evidence, the US Environmental Protection Agency/Science Advisory Board report on *Improved Science-based Environmental Stakeholder Processes* came to the conclusion that:

> *... an adequate treatment of science is possible in stakeholder processes, but typically only if substantial financial resources, adequate time and high-quality staff are available from the outset to allow the necessary deliberation and provide the necessary support on an iterative basis throughout ongoing interaction with the stakeholders.* (US EPA/SAB, 2001, p8)

The second aspect of introducing deliberative methods into the analytic part of the process is equally important. The 1996 US National Research Council report (Stern and Fineberg, 1996) on characterizing risk postulated the importance of getting the *right* science and getting the science *right*. Experts need to acknowledge that they act on the basis of professional conventions, sometimes doubtful assumptions, incomplete or conflicting data and simplified models. This self-reflection about the preconditions of scientific enquiry is a good starting point for a deliberation among experts and later between experts and non-experts (Liberatore and Funtowicz, 2003; Jasanoff, 2004). The more the respective expert communities learn to use deliberative techniques for sorting out knowledge claims, the more effective is the transfer of results of these discussions to non-expert communities.

Process requirements for deliberative processes

The discussion so far has focused on the potential of analytic–deliberative processes, their advantages and disadvantages, and the interface between the analytic and the deliberative process. This section deals with the internal structure of deliberation. There is a need for an internal structure that facilitates common understanding, rational problem-solving and fair and balanced treatment of arguments. The success or failure of a discourse depends upon many factors. Among the most influential are the following (Renn and Webler, 1998, pp57ff):

- *A clear mandate for the participants of the deliberation.* Models of deliberative democracy require a clear and unambiguous mandate of what the deliberation process should produce or deliver (Armour, 1995; Shindler and Neburka, 1997; US EPA, 2001; Banthien et al, 2003). Since deliberations are most often informal instruments, there should be a clear understanding that the results of such a process cannot claim any legally binding validity (unless it is part of a legal process, such as arbitration). All the participants, however, should begin the process with a clear statement that specifies their obligations or promises of voluntary compliance once an agreement has been reached.
- *Openness regarding results.* A deliberative process will never accomplish its goal if the decision has been made (officially or secretly), and the purpose of the communication effort is to 'sell' this decision to the other parties. Individuals have a good sense of whether a decision-maker is really interested in their point of view or if the process is meant to pacify potential protesters (Fiorino, 1989b).
- *A clear understanding of the options and permissible outcomes of such a process.* The world cannot be reinvented by a single involvement process, nor can historically made decisions be deliberately reversed. All participants should be clearly informed of the ranges and limits of the decision options that are open for discussion and implementation (Yosie and Herbst, 1998b; Leach, 2005, p47). If, for example, the technology is already in existence, the discourse can focus only on issues such as emission control, monitoring, emergency management or compensation. But the range of permissible options should be wide enough to provide a real choice situation to the participants (Kasperson, 1986).
- *A predefined timetable.* It is necessary to allocate sufficient time for all the deliberations; but a clear schedule, including deadlines, is required to make the process effective and product oriented (US EPA/SAB, 2001).
- *A well-developed methodology for eliciting values, preferences and priorities.* The need for efficiency in risk governance demands a logically sound and economical way of summarizing individual preferences and integrating them within a group

decision (either agreement on dissent, majority and minority positions, tolerated consensus, true consensus or compromise). Formal procedures, such as multi-objective or multi-attribute utility analysis, could serve as tools for reaching agreements (Edwards, 1954; von Winterfeldt and Edwards, 1986; Chen and Mathes, 1989; Bojorquez-Tapia et al, 1994; Maguire and Boiney, 1994; McDaniels, 1996; Hostmann et al, 2005). Our research team has used multi-attribute utility procedures (MAU) in most of our deliberative processes (Renn, 2006b).

- *Equal position of all parties.* A deliberative process needs the climate of a 'powerless' environment (Habermas, 1971, 1991b; Webler, 1995). This does not mean that every party has the same right to intervene or claim a legal obligation to be involved in the political decision-making process. However, the internal discourse rules have to be strictly egalitarian; every participant must have the same status in the group and the same rights to speak, make proposals or evaluate options (Kemp, 1985). Two requirements must be met. First, the decision about the procedure and the agenda must rely on consensus; every party needs to agree. Second, the rules adopted for the discourse are binding for all members, and no party is allowed to claim any privileged status or decision power. The external validity of the discourse results is, however, subject to all legal and political rules that are in effect for the topic in question.
- *Neutrality of the facilitator.* The person who facilitates such a process should be neutral in his/her position on the risk issue, and respected and authorized by all participants (Bacow and Wheeler, 1984; Moore, 1986; Baughman, 1995). Any attempt to restrict the manoeuvrability of the facilitator, moderator or mediator should be strictly avoided.
- *A mutual understanding of how the results of the process will be integrated within the decision-making process of the regulatory agency.* As a pre-decisional tool, the recommendations cannot, in most cases, serve as binding decisions. They should be rather regarded as a consultative report similar to the technical recommendations provided by scientific consultants to the legitimate public authorities (Dienel and Renn, 1995). Official decision-makers must acknowledge and process the reports by the deliberative bodies; but they are not obliged to follow their advice. However, the process will fail its purpose if deviations from the recommendations are neither explained nor justified to the panellists.

There is a second set of internal requirements relating to the behaviour of the participants which is necessary for facilitating agreement or at least a productive discussion. Among these requirements are the following:

- *Willingness to learn.* All parties have to be ready to learn from each other. This does not necessarily imply that they have to be willing to change their preferences or attitudes (Webler et al, 1995b; Daniels and Walker, 1996; Pidgeon, 1997). Conflicts can be reconciled on the basis that parties accept others' position as a legitimate claim without giving up their own point of view. Learning in this sense entails:
  – recognition of various forms of rationality in decision-making (Perrow, 1984; Habermas, 1989);

- recognition of different forms of knowledge, whether it is systematic, experiential, local or folklore wisdom (Habermas, 1971);
- willingness to subject oneself to the rules of argumentative disputes (i.e. provide factual evidence for claims); obey the rules of logic for drawing inferences; disclose one's own values and preferences vis-à-vis potential outcomes of decision options, etc. (Webler 1995).

- *Resolution of allegedly irrational responses.* Reflective and participatory discourses frequently demonstrate a conflict between two contrasting modes of evidence: the public refers to anecdotal and personal evidence, mixed with emotional reactions, whereas the professionals play out their systematic and generalized evidence based on abstract knowledge (Lynn, 1986; Dietz and Rycroft, 1987; Adler et al, 2000, p18). A dialogue between these two modes of collecting evidence is rarely accomplished because experts regard the personal evidence as a typical response of irrationality. The public representatives often perceive the experts as uncompassionate technocrats who know all the statistics, but couldn't care less about a single life lost. This conflict can only be resolved if both parties are willing to accept the rationale of the other party's position and to understand, and maybe even empathize with, the other party's view (Tuler, 1996). If, over the duration of the discourse, some familiarity with the process and mutual trust among the participants have been established, role-playing can facilitate that understanding. Resolving alleged irrationalities means discovering the hidden rationality in the argument of the other party.
- *Demoralization of positions and parties.* The individuals involved in a deliberative process should agree in advance to refrain from moralizing (Bacow and Wheeler, 1984). Moral judgements on positions or persons impede compromise. Something cannot be 30 per cent good and 70 per cent bad; either it is good, bad or indifferent. As soon as parties start to moralize, they cannot make trade-offs between their allegedly moral position and the other parties' 'immoral' position without losing face (Scheuch, 1980). A second undesired result of moralizing is the violation of the equality principle. Nobody can assign equal status to a party which is allegedly morally inferior. Finally, moralizing masks deficits of knowledge and arguments. Even if somebody knows nothing about a subject or has only weak arguments to support his or her position, assigning blame to other actors and making it a moral issue can help win points. The absence of moralizing does not mean refraining from using ethical arguments, such as 'this solution does not seem fair to future generations' or 'we should conserve this ecosystem for its own sake'. Ethical arguments are essential for resolving environmental disputes.

Evaluation of deliberative models

Evaluation criteria for deliberative processes

Evaluation of participatory processes is essential for improving analytic–deliberative processes and making them more effective with regard to the stated objectives. Furthermore, evaluation can help to improve the design of the process, test different tools and techniques, and find the most suitable matches between purpose, instrument and structure. The importance of evaluation contrasts, however, with the state of the art in evaluation research in terms of deliberative participation applications. There is a lack of clear and unambiguous criteria, there is no consensus in the research community of how to measure success or failure, and there is also no agreement about the choice of appropriate research methods. As Rowe and others (2004, p90) have pointed out, this unsatisfactory situation is caused by four reasons:

1 The choice of normative criteria depends upon the values of the researchers.
2 Definition of success or failure often defies objective assessments and rests on subjective impressions.
3 The methods for judging success or failure vary considerably between different researchers.
4 Empirical tools and procedures are often unreliable in the statistical sense (particularly in case studies).

Blackstock et al (2007, p733) reviewed over 50 evaluation studies and ended up with a list of 22 criteria applied in these studies. Many of the listed evaluative criteria refer to the subjective satisfaction of the actors involved in the process;[21] others refer to context and outcome. Rowe and Frewer (2000) reviewed more than 20 evaluation studies and reduced the large number of criteria they encountered to a manageable number of 10. In spite of the detailed justification that the two authors gave for their choice of criteria, the selection still appears eclectic.

With respect to evaluation studies focusing on deliberative processes, several attempts at defining and delineating evaluation criteria have been made. Ray Kemp used Habermas's definition of the ideal speech situation as a measure against which to compare the discourse that occurred in the public enquiry process regarding the British uranium reprocessing facility (Kemp, 1985). Daniel Fiorino developed performance criteria from the theory of participatory democracy and evaluated several generic models of participation (Fiorino, 1989a, 1990). Frank Laird has supplemented Fiorino's criteria with another set from the theory of pluralist democracy and evaluated the same models (Laird, 1993). Although not developed for the purpose of evaluation, the competing values theory by Quinn and Rohrbaugh (1981) provide another set of interesting criteria for measuring the success or failure of deliberative processes. These criteria are related to four potential organizing principles: flexibility and control on the one hand, and internal versus external focus on the other. These conflicting principles are associated with corresponding criteria: legitimacy, participatory quality, accountability and efficiency. Similar criteria were suggested by Renn (2004b, p236): these criteria refer to fairness, competence, legitimacy and efficiency. Those criteria were used in a series of Pan-European evaluation studies (Goldschmidt and Renn, 2006; Goldschmidt et al, 2008, in press; Sellke et al, 2007). Webler et al (2001) pointed out that the criteria must reflect both the subjective expectations of the participants and objective yardsticks from a theoretical perspective. A recent study of a deliberative process by Rowe et al (2004) used two sets of criteria: one with acceptance criteria (representativeness, independence, early involvement, influence and transparency) and the other with process criteria (resource accessibility, task definition, structured decision-making and cost effectiveness). This diversity of criteria and approaches clearly demonstrates how fragmented the field is.

The main problem with almost all of the evaluation schemes is the lack of attention paid to the different concepts of involvement that were described earlier. For example, the evaluation criterion of representativeness is meaningless for a participation process based on anthropological or emancipatory concepts. Criteria such as accountability or legitimacy make little sense in the context of post-modern discourse procedures. In a purely functional context, the criterion of empowerment or capacity-building is irrelevant. So the first major insight into evaluation is that the evaluation criteria should match the concept of the underlying process.

On a meta-theoretical level one can (and should) also criticize the concept itself; but this would imply a set of meta-criteria that are even more difficult to reach an agreement on within the respective evaluation community, because this task is highly normative and value driven. Within each concept, however, one could delineate some criteria that could be used in evaluation studies. For this purpose it is helpful to use a classification scheme that distinguishes between normative, substantive and procedural criteria (similar in: Blackstock et al, 2007, p727). Table 8.3 illustrates a composition of normative, substantive and procedural criteria for each participation context. Several criteria show up in more than one concept (e.g. internal fairness); but there is none that is relevant for all concepts.

With respect to analytic–deliberative processes, the entries in Table 8.3 suggest adopting the criteria for deliberative concepts and, depending upon the type of analytic input, the criteria from the functional concept. This would imply three normative criteria, seven substantive criteria and six procedural criteria. If other goals were also envisioned, such as displaying diversity or empowering the participants, more criteria would be added to the list. Such a long list of criteria is difficult to handle and even more difficult to measure using empirical methods and tools. Yet, from the long list of criteria one could make a selection by looking into the purpose of the deliberation and the type of risk problem in terms of complexity, uncertainty and ambiguity. Therefore, this essay proposes using the longer list as the starting point and then making a case-based selection.

Empirical results of evaluations

Notwithstanding the fact that there is no agreement on evaluation criteria and methods to measure success or failure, there is an increasing amount of literature on empirical results of comparative investigations with regard to the actual performance of stakeholder and public involvement processes (reviews in Talbot, 1983; Bingham, 1984; Susskind and Ozawa, 1985; Buckle and Thomas-Buckle, 1986; Frey and Oberholzer-Gee, 1996; Moore, 1996; Steelman and Ascher, 1997; Creighton et al, 1998; Rowe and Frewer, 2000; Webler et al, 2001; Rowe et al, 2004; Bradbury, 2005; Rauschmayer and Wittmer, 2006; Burgess and Clark, 2006; Blackstock et al, 2007). Each of these studies, however, use different criteria for evaluating participatory processes, which makes it extremely difficult to compare the results.

The most comprehensive empirical analysis so far has been performed by Beierle and Cayford (2002) using the criteria of output (result of the process) and outcome (effect on political decision or on the target policy field, such as siting a facility or improving the environmental quality) as the two dependent variables, and several internal factors (such as intensity, inclusiveness, commitment of agency, staff and participants) and external factors (such as external pressure, commitment to implementing results or responsiveness of agencies) as dependent variables. The main result of the study was that the responsiveness and involvement of the agency, sufficient resources and skilful structuring, as well as participants' motivation, were the best predictors for output. There were no direct relationships between the dependent variables and outcome, partially because the empirical data did not cover outcome or there were too many confounding factors that made a correlation analysis meaningless. In terms of output, however, there were many interesting findings. For example, intensity and communication quality were also positively correlated with quality of the output, yet negatively correlated with representativeness and transparency. The report also highlights the importance of the social and political climate in which the process takes place:

> *In some cases, what fosters or hinders implementation is not participation per se but the larger regulatory programme in which participation and implementation operate. Programme budgets, regulatory power and staff are usually the principal drivers behind implementation, and public participation is simply one piece of a decision-making process along the way.* (Beierle and Cayford, 2002, p62)

Rowe and Frewer (2000) made an attempt to evaluate different procedures and instruments of stakeholder and public involvement. This evaluation was not based on empirical data, but rather on the underlying concept that they associated with each of these instruments (a similar approach to what is suggested above). The results of this evaluation are illustrated in Table 8.4.

Over the last few years, there have been more specific evaluation studies based on case analyses or smaller samples for assessing the success or failure of deliberative approaches to environmental decision-making. Many of these relate to special topics, such as forestry management (Shindler and Neburka, 1997; Leach, 2005) or water basin management (Godschalk and Stiftle, 1981; Delli Priscoli, 1989; Creighton et al, 1998). Others refer to special models of involvement, such as mediation (Talbot, 1983; Bingham, 1984; Susskind and Ozawa, 1985; Buckle and Thomas-Buckle, 1986; Rose-Ackerman, 1994; Moore, 1996) or consensus conferencing (Joss, 1995, 1997; Einsiedel and Eastlick, 2000). Finally, several studies address prospects and limitations of specific techniques or instruments, such as decision–analytic tools (Gregory, 2004; Rauschmayer and Wittmer, 2006).

Of special relevance for analytic–deliberative processes are the evaluation summaries by Yosie and Herbst (1998b); Rowe and Frewer (2000); Delli Carpini et al (2004); Rowe et al (2004) and Bradbury (2005). Although each of these studies operates on different evaluation criteria, some common lessons can be drawn:

- Stakeholder involvement processes are often poorly managed (Wondolleck, 1985; Yosie and Herbst, 1998b). While this development can be partially

Table 8.3 *Overview of evaluation criteria associated with different participation concepts*

Concept	Normative	Substantive	Procedural
Functionalist	Quality of decision output	*Integration* (results reflect different knowledge claims) *Adequacy* (of results with problem at hand) *Impacts* (of results on policy-making) *Expertise* (results reflect the knowledge of the participants)	*Diversity* (in selecting representatives of different knowledge communities) *Resource accessibility* (all information available) *Internal fairness* (all arguments should have equal weight)
Neo-liberal	*Quality of informed consent or judgement* (producing a mirror image of public preferences under the condition of best available knowledge)	*Competence* (results are based on informed choices) *Internal transparency* (participants know how results were articulated and how the process is structured) *Efficiency* (cost-effective balance between results and means of reaching these results)	*Internal fairness* (all arguments should have equal weight) *Representativeness* (process should deliver a true picture of participants' preferences and interests) *Professionalism* (of moderators and staff)
Deliberative	Contribution to the common good	*Competence* (results are based on informed choices) *Accountability* (results reflect commitment to moral standards) *Capacity-building* (results reflect the potential of the participants and promote their voices in the policy arena) *External transparency* (outsiders know how results were articulated and how the process has been conducted)	*Internal fairness* (all arguments should have equal weight) *External fairness* (every relevant argument should be represented at least once) *Independence* (of the process and the deliberations from external powers) *Learning* (process encourages participants to gain more insights)

Anthropological	Same as deliberative	*Competence* (results are based on informed choices) *Accountability* (results reflect commitment to moral standards) *External transparency* (outsiders know how results were articulated and how the process has been conducted)	*Internal fairness* (all arguments should have equal weight) *Diversity* (in selecting representatives of different social backgrounds) *Independence* (of the process and the deliberations from external powers)
Emancipatory	*Empowerment* of less privileged groups and individuals	*Capacity-building* (results reflect the potentials of the participants and promote their voices in the policy arena) *Accountability* (results reflect commitment to moral standards)	*Independence* (of the process and the deliberations from external powers) *Compensatory selection* (participation is by self-selection or by conscious over-representation of the less privileged) *Emancipation* (process encourages self-efficacy)
Post-modern	Influence on public debate	*Plurality* (results mirror the diversity of possible opinions) *Capacity-building* (results reflect the potential of the participants and promote their voices in the policy arena)	*Independence* (of the process and the deliberations from external powers) *Diversity* (in selecting representatives of different social backgrounds) *Emancipation* (process encourages self-efficacy)

Source: Ortwin Renn

attributed to the difficulties inherent in resolving certain environmental problems, it is also associated with the lack of understanding of the type of process design which achieves best results for certain types of problems.

- Stakeholder involvement processes produce better output if the organizing agency is fully committed to the process and provides adequate resources to the participants (Tuler and Webler, 1995; Harter et al, 1998; US EPA/SAB, 2001).

Table 8.4 *Evaluation of different models of participation*

	Referenda	**Public hearings**	**Public opinion survey**	**Negotiated rule-making**	**Consensus conference**	**Citizens' jury/panel**	**Citizen advisory committee**	**Focus groups**
Acceptance criteria								
Representativeness of participants	High (assuming full turn-out at poll)	Low	Generally high	Low	Moderate (limited by small sample)	Moderate (limited by small sample)	Moderate to low	Moderate (limited by small sample)
True independence of participants	High	Generally low	High	Moderate	High	High	Moderate (often relation to sponsor)	High
Early involvement?	Variable	Variable	Potentially high	Variable	Potentially high	Potentially high	Variable but may be high	Potentially high
Influence on final policy	High	Moderate	Indirect and difficult to determine	High	Variable but not guaranteed	Variable but not guaranteed	Variable but not guaranteed	Liable to be indirect
Transparency of process to the public	High	Moderate	Moderate	Low	High	Moderate	Variable but often low	Low

Process criteria								
Resource accessibility	Low	Low to moderate	Low	High	High	High	Variable	Low
Task definition	High	Generally high	Low	High	Generally high	Generally high	Variable but may be high	Variable but may be high
Structured decision-making	Low	Low	Low	Moderate	Moderate (influence of facilitator)	Potentially high	Variable (influence of facilitator)	Low
Cost effectiveness	Variable/low	Low	Potentially high	Potentially high	Moderate to high	Moderate to high	Variable	Potentially high

Source: adapted from Rowe and Frewer, 2000

- Stakeholder involvement processes work better if the mandate and the structure of the process are clear and transparent to all participants (Rowe et al, 2004; Bradbury, 2005; Leach, 2005), However, such clarity should not be traded off against the need for flexibility in process management.
- Stakeholder involvement can influence policy outcome only if the results are available at the time that a political decision has to be made and if the decision-makers have committed themselves ahead of time that they will seriously consider the results (Rowe et al, 2004; Hagendijk and Irvin, 2006; Abels, 2007).
- Stakeholder involvement leads to more subjective satisfaction of all participants if the process is perceived as adaptive to participants' needs, sensitive to group processes, and balanced in moderation and facilitation (Checkoway and van Til, 1978; Creighton, 1991; Moore, 1996; Wondolleck et al, 1996; Shindler and Neburka, 1997; Leach, 2005). There is no clear evidence, however, that the quality of the output is directly related to the quality of the communication skills.
- Many facilitators and participants in stakeholder processes continue to confuse whether they are a means to decision-making or an end. This lack of clarity contributes to the prolonged nature of some processes, as well as confusion over the key elements of a problem that can be solved through a stakeholder process (Yosie and Herbst, 1998b).
- Participation processes lead to better-quality results if all the relevant stakeholders are included; yet the probability of not reaching a conclusion increases with the number of participants (Shindler and Neburka, 1997). In addition, if participants are able to make a firm commitment for the full duration of the process and have a clear mandate from their constituencies, the probability of success increases (Armour, 1995; Leach, 2005).
- Many deliberative processes fail because they promise that participants will gain influence on the policy-making process or overemphasize the importance of the involvement process for the respective political arena (Buckle and Thomas-Buckle, 1986; Bora and Hausendorf, 2006; Abels, 2007). Once participants notice the marginal influence of their input, they either withdraw or play along without major personal involvement.

On the European side, Goldschmidt, Sellke and Renn (in press) evaluated three pan-European participation efforts involving more than 1800 citizens from up to 24 European countries, working on regulations of brain sciences, the future of rural areas and the top priorities for the European Union, one of the priorities being sustainability and energy. The criteria used in these evaluations were perceived fairness, competence, efficiency and transparency. The main result was that a fair and balanced deliberation was often in conflict with the goal of efficiency and external transparency. In addition, the more enthusiasm participants felt about the subject, as a result of the information input and the deliberation, the more they demanded that time and resources be increased in order to develop a common judgement. In all three cases, the groups were not obliged to reach a consensus; in due course, a majority vote was taken. The evaluators were rather sceptical about this procedure as voting in a deliberative body is difficult to legitimize. All three projects achieved their stated objectives and resulted in substantive outputs. The question of outcome in terms of influence on the European policy process is too early to raise as the projects were completed in 2006 and 2007.

To our knowledge, there has been no systematic evaluation performed on an analytic–deliberative process that combines analytic procedures with deliberative discourse. A paper by Sweeney (2004) addresses some of the main issues connected with such hybrid processes, but does not provide an empirical evaluation. Webler et al (2001) postulated criteria for judging success or failure of analytic–deliberative processes, but did not perform an empirical evaluation. The main reason for this may simply be that only few participation projects qualify as analytic–deliberative processes. The lack of data and experience make it, hence, impossible to conduct a comprehensive evaluation. However, there are several case study evaluations that highlight potential merits and problems (Rymann, 1993; Buser, 1995; Tuler and Webler, 1995; Vorwerk and Kämper, 1997; Roch, 1997; Löfstedt, 1999; Rippe and Schaber, 1999; van de Kerkhoff, 2004; Rowe et al, 2004, Blackstock et al, 2007).

Even considering the fragmentation of the field and the lack of statistical reliability in many studies, the main impression from these evaluation studies is rather clear: if you get the structure of the deliberative process right and if the organizers, as well as the participants, are committed to their tasks, then the likelihood of success in terms of output and process is rather high. Moreover, the often neglected comparison between deliberative and non-deliberative modes of decision-making reveals a relative superiority of deliberative models over any other alternative for all risk decisions involving high degrees of uncertainty and ambiguity. The final verdict on these models is still out; but there is sufficient reason for cautious optimism.

CONCLUSIONS

The objective of this essay was to address and discuss the need and potential for integrating analysis and deliberation, to introduce different concepts of stakeholder and public involvement, and to characterize the main features of, and conditions for, a successful implementation of an analytic–deliberative process.[22] Organizing and structuring such a process goes beyond the well-meant intention of having the public involved in risk decision-making. The mere desire to initiate a two-way communication process and the willingness to listen to public concerns are not sufficient (Hadden, 1989; Lynn, 1990). Discursive processes need a structure that ensures the integration of technical expertise, regulatory requirements and public values. Decisions on risk must reflect effective regulation, efficient use of resources, legitimate means of action and social acceptability.

These inputs can be provided by the different systems of society: efficiency by economic markets; knowledge on effectiveness by scientists and experts; legitimacy by the political institutions; and reflection of values and preferences by including social actors. The objective is to find an organizational structure so that each system contributes to the deliberation process the type of expertise and knowledge which claim legitimacy within a rational decision-making procedure (von Schomberg, 1995; Renn, 2004b). It does not make sense to replace technical expertise with vague public perceptions, nor is it justified to have the experts insert their own value judgements into what ought to be a democratic process.

For evaluating the potential impact of deliberative processes on policy-making, it was useful to distinguish six different concepts for including stakeholders and the public in the decision-making process. These concepts were labelled as functional, neo-liberal, deliberative, anthropological, emancipatory and post-modern. Each of these concepts has a specific philosophical foundation and expresses a different point of view with respect to what democracy means and what role participation can play in this context. Furthermore, these concepts are related to the four major societal functions (efficiency, effectiveness, legitimacy, and reflection of values and preferences) and contribute variously to these functions. These concepts also suggest corresponding instruments and techniques for structuring and organizing participatory processes. Finally, they can serve as heuristic tools to develop evaluation criteria. Two of the concepts, the functional and the deliberative, lend themselves to forming what the 1996 National Research Council report on characterizing risks has coined an analytic–deliberative process (Stern and Fineberg, 1996). This combination promises to be particularly well suited to dealing with risk problems as they demand scientific expertise, structured thinking and excellent deliberative skills.

Recently, there has been much concern in the professional risk community that opening the risk management arena to public input would lead to a dismissal of factual knowledge and to an inefficient spending of public money (Cross, 1992; Rossi, 1997; Okrent, 1998). In my opinion, these concerns are not warranted if one looks at actual experiences with discursive models of participation. There are only few voices that wish to restrict scientific input to risk governance. The role of scientific analysis in risk governance should not be weakened but rather strengthened. Profound scientific knowledge is required in risk governance, especially with regard to dealing with complexity, uncertainty and ambiguity. This knowledge has to be assessed and collected by scientists and risk professionals who are recognized as competent authorities in the respective risk field. The systematic search for the 'state of the art' in risk assessment leads to a knowledge base that provides the data for deliberation (Yankelovich, 1991). At the same time, however, the style of deliberation should also transform the scientific discourse and lead the discussion towards classifying knowledge claims, characterizing uncertainties, exploring the range of alternative explanations and acknowledging the limits of systematic knowledge in many risk arenas (Meister and Oldenburg, 2008).

Placing emphasis on the analytic part of the process does not contradict the deliberative character of the whole decision-making process. Although systematic evaluations of analytic–deliberative processes are largely missing, and empirical data about the success or failure of such processes are still not conclusive, most reviewers agree that ignorance and misperceptions are not the major problems in participatory settings (Bingham, 1984; Creighton, 1991; Sherington, 1997; Beierle, 2000, Beierle and Cayford, 2002; Rowe et al, 2004; Goldschmidt and Renn, 2006). On the contrary, even participants from the lay public were not only willing to accept but actually demanded that the best technical estimate of the risks under discussion should be employed for the decision-making process (Burns and Überhorst, 1988; Renn, 1998). These participants also insisted, however, that other dimensions apart from expected values should enter the deliberation process. Once the potential contributions of the expert communities, the stakeholder groups and members of the affected public had been recognized and acknowledged in such settings, a process of mutual understanding and constructive decision-making started to unfold. Such a discursive process may not always lead to the desired results but the experiences so far justify a fairly optimistic outlook. The main lesson from these experiences has been that scientific expertise, rational decision-making and public values can be reconciled if there is a serious attempt to integrate them. The transformation of the risk arena into a cooperative risk discourse seems to be an essential and, ultimately, inevitable step in improving risk policies and risk management.

Essay 10 *Expert, Stakeholder and Public Participation: A Review of Instruments for an Integrated Model of Analytic–Deliberative Decision-making*[23]

Introduction

Inviting stakeholders, experts and the public to take part in decision-making about management options to deal with environmental and health risks has been a major objective in many countries of the world. The popularity associated with public participation, however, obscures the challenge of how to put this noble goal into practice and how to ensure that risk management reflects the main goals of effectiveness, efficiency and fair burden-sharing (see Essay 9 in this volume). How can and should risk managers include the best available knowledge in the field, incorporate public preferences, integrate public input into the management process, and assign the appropriate roles to technical experts, stakeholders[24] and members of the public? Who represents the public: the elected politicians, administrators, stakeholders, or all individuals who will be affected by the decision? There is a large amount of individual variance when laypersons are asked to set environmental priorities (Dake, 1991; Drottz-Sjöberg, 1991; Boholm, 1998).

This essay provides a review of the various instruments that have been used in expert, stakeholder or public participation in the field of risk governance (including framing, assessment, evaluation and management). For this purpose, a classification scheme is developed that corresponds with the three major challenges of risk: complexity, uncertainty and ambiguity. In addition, the paper describes an integrative model of participation which includes several instruments to combine input from expertise, stakeholder interests and public values. This model of participation, called the *model of cooperative discourse*, attempts to meet two major objectives: first, to enhance competence in the decision-making process and, second, to assign a fair share of responsibility for managing environmental or health affairs to those who are, or will be, affected by the potential consequences. Special emphasis is given to the link between participation and formal models of decision-making.

The need for integration: The analytic–deliberative approach

Risk managers and regulators are faced with a difficult dilemma: on the one hand, technical expertise is a necessary, but not sufficient, condition to make prudent decisions. On the other hand, risk decisions impact upon human values, preferences and lifestyles. We live in a pluralist society with different value systems and world views. There is a need to integrate these often-conflicting values within the decision-making process (Horlick-Jones et al, 2007). This can best be accomplished through a process called deliberation.

The term deliberation refers to the style and procedure of decision-making without specifying the participants who are invited to deliberate (Stern and Fineberg, 1996; Corrigan and Joyce, 1997; Sweeney, 2004). For a discussion to be called deliberative, it is essential that it relies on a mutual exchange of arguments and reflections, rather than decision-making based on the status of the participants, sublime strategies of persuasion or socio-political pressure. Deliberative processes should include a debate about the relative weight of each argument and a transparent procedure for balancing arguments (Tuler and Webler, 1999). Many advantages and accomplishments are associated with deliberation (Chess et al, 1998). Depending upon the structure of the discourse and the underlying concept, deliberative processes can (Fiorino, 1990):

- enhance understanding;
- generate new options;
- attenuate hostility and aggressive attitudes among the participants;
- explore new problem framing;
- enlighten legal policy-makers;
- produce competent, fair and optimized solution packages; and
- facilitate consensus, tolerated consensus and compromise.

Deliberative elements in risk governance are necessary and vital for gaining legitimacy due to the nature of risk decisions as being knowledge and value driven.

The same is true for the second component: analysis. Decisions on risk must reflect the best knowledge about potential impacts of events, technologies and human activities. After all, humans may suffer or even die and the environment may be damaged when decisions about risks turn out to be flawed or based on incomplete or unreliable knowledge (van den Daele, 1992). All complex risk decisions demand the input of the most accurate and trustworthy expertise. The necessary knowledge demanded for prudent risk management decisions includes, first of all, *systematic* and scientific insights, particularly expertise about dose–effect relationships, exposure and impacts upon human health and the environment. In addition, *experiential* (based on long-term familiarity with the risk cause, the risk agent or the risk-absorbing system), *local* (referring to one's own experience with the local conditions) and *folklore wisdom* (using common sense or personal experience) can also contribute to exploring the potential impacts associated with a given risk (Wynne, 1989, 1992a; Jasanoff, 1991, 1996, 2004; see Essay 9).

The combination of knowledge processing and deliberation in a single participatory process has been called an analytic–deliberative approach to participation. The concept was made popular by a US National Research Council report on characterizing risks (Stern and Fineberg, 1996): the analytical element includes not only technical expertise, but also experiential, local and folklore knowledge. The deliberative element refers to the input of stakeholders and social groups; but it is also the overarching principle guiding the integration of expertise, stakeholder interests and public concerns. The concept of analytic–deliberative processes is one of the promising attempts to develop an integrative approach to risk governance based on the inclusion of experts, stakeholders and the general public (Chess et al, 1998; Tuler and Webler, 1999; Renn, 1999a, 2004b; Charnley, 2000; Sweeney, 2004).

What are the possibilities, the procedures and techniques for implementing the idea of an analytic–deliberative process? Since the process should at least have two components – inclusion of analytic expertise and deliberation over interpretations and evaluation – a single type of discourse is usually not sufficient. Analytic–deliberative processes demand a combination of several integrated components. Before introducing such an integrated concept, it is important to review the choices risk managers have available in terms of procedures and instruments[25] from which a combined model can be formed.

THE SPECIAL REQUIREMENTS OF THE RISK ARENA

Decision-making on risk shares many features with other political arenas in which collective decisions demand compliance, even from those who did not participate in the decision-making process or agree with its outcome (see Essay 9). In addition, risk decision-making encounters three specific challenges that need addressing by any type of analytic–deliberative process – complexity, uncertainty and ambiguity (Klinke and Renn, 2002; IRGC, 2005, pp29f; see also Chapters 3, 6 and 8):

1 *Complexity*. Complexity is introduced when the causal relationship forms a multifaceted web of causal relationships, where many intervening factors may interact to affect the outcome of an event or an activity (WBGU, 2000, pp194ff). Complexity requires sophisticated modelling, which often defies common-sense or intuitive reasoning. Yet, if resolved, it produces a high degree of confidence in the results.
2 *Uncertainty*. The less well known and understood this causal web is, the more uncertainty is introduced into the system. Uncertainty reduces the strength of confidence in the estimated cause-and-effect chain (Stirling, 1998; van Asselt, 2000). Risk-based decisions must consider more carefully the uncertainties which characterize both the benefits and the risks.
3 *Ambiguity*. Ambiguity arises when differences exist in how individual actors or stakeholders value some input or outcome of the system (IRGC, 2005, p30). It is based on the question of what our knowledge about risks means for understanding the effects of the risk agent on human health and the environment (interpretative ambiguity), and what kind of decisions or actions are justified once the risks and uncertainties are characterized (normative ambiguity). In risk governance, ambiguity plays an important role because plural knowledge and value input are difficult to reconcile and overarching arguments which might lead to a consensus are hard to find or to get approved by all parties (Luhmann, 1990; Harrison and Hoberg, 1994, pp6, 168ff; Horlick-Jones, 1998; Jasanoff, 1998).

Different evaluation and management strategies follow from the analysis of these three challenges. If the problem is complexity, a risk manager is well advised to gather the best expertise and to regulate on the basis of state-of-the-art knowledge in risk assessment (see also van den Daele, 1992; Charnley, 2000, pp16ff). It does not make much sense to incorporate public concerns, perceptions or any other social aspects within the function of resolving (cognitive) complexity, unless specific knowledge of these groups helps to untangle complexity. Complex phenomena demand almost equally complex methods of assessment.

If the problem is uncertainty, however, knowledge is either not available or unattainable due to the nature of the hazard. Under these circumstances, risk managers have to rely on resilience as the guiding principle for action (Wynne, 1992a; Collingridge, 1996; WBGU, 2000, pp176ff). Decisions based on uncertainty management require, therefore, more than input from risk specialists. They must include stakeholder concerns, economic budgeting and social evaluations. The focal point here is to find the adequate and fair balance between the costs of being overcautious versus the costs of being not cautious enough (van den Daele, 2000, p215; IRGC, 2005, p52).

Trade-offs are even more complex when it comes to resolving ambiguity. Although scientific expertise is essential for understanding ambiguities, it cannot prescribe the value trade-offs to resolve them (Charnley and Elliot, 2000; van Asselt, 2000, pp165ff; Renn, 2004b; van den Hove, 2007). In addition, ambiguities cannot be resolved by increased efficiency since the outcome in itself is controversial, not just the distribution of costs. Genetically modified organisms for agricultural purposes may serve as an example. Our own surveys on the subject demonstrate that people associate high concerns with the application of gene technology for social and moral reasons (Hampel and Renn, 2000). Whether the benefits to the economy balance the cost to society in terms of increased health risks was not a major concern of the polled public. People disagreed about the social need for genetically modified food in Western economies where conventional food grows in abundance, about the loss of personal agency when selecting and preparing food, about the long-term impacts of industrialized agriculture, and about the moral implications of tampering with nature (see also Thompson, 1988; Sjöberg, 1999a). These concerns cannot be addressed by either scientific risk assessments or by finding the right balance between overprotection and underprotection. The risk issues in this debate focus on differences between visions of the future, basic values and convictions, and the degree of confidence in the human ability to control and direct its own technological destiny. This is the place where participatory processes are required from a social-analytical, as well as normative, viewpoint (Bohman, 1997, 1998; Cohen, 1997).

The distinction in complexity, uncertainty and ambiguity can serve as a guide for classifying different instruments for expert, stakeholder and public participation. Risks with a high degree of complexity, but little uncertainty and ambiguity, demand deliberative processes that are focused on knowledge and expertise. High uncertainty in risk estimates calls for deliberative processes that emphasize reflection about fairness and equity in benefit- and burden-sharing. Risk which triggers off major ambiguities and controversies necessitates deliberations about future visions, basic values and aspirations. For each of these three risk formations there is a pool of

Table 8.5 *Pool of instruments for risk management challenges*

	Challenge	Objective	Function	Instruments
Pool 1	Complexity	Inclusion of best available knowledge	Agreement on causal relations and effective measures	Expert panels, expert hearings, meta-analysis, Delphi method, etc.
Pool 2	Uncertainty	Fair and acceptable arrangement for benefit- and burden-sharing	Balancing costs of underprotection with costs of overprotection facing uncertain outcomes	Negotiated rule-making, mediation, roundtables, stakeholder meetings, etc.
Pool 3	Ambiguity	Congruency with social and cultural values	Resolving value conflicts and ensuring fair treatment of concerns and visions	Citizen advisory committees, citizen panels, citizen jury, consensus conferences, public meetings, etc.
	Combination	Meeting more than one challenge	Meaningful and effective integration of functions	Selection from each of the three pools

Source: Ortwin Renn

deliberative instruments to choose from. If a risk is associated with two or all three characteristics (high complexity, uncertainty and ambiguity), one is well advised to combine the respective instruments from each pool. Table 8.5 provides an overview of the three pools of instruments and their functions for risk management. The following section briefly introduces the diversity of procedures and instruments using the distinction between the three pools of instruments.[26]

Review of participatory instruments

Pool 1: Instruments for reducing complexity

Resolving complexity requires deliberation among knowledge carriers. The instruments listed in this category provide opportunities for experts (not necessarily scientists) to argue over the factual assessment with respect to the main characteristics of the risk under investigation. The objective of a discourse in each of these instruments is the most adequate description or explanation of a phenomenon (e.g. the question: which physical impacts are to be expected due to the emission of specific substances?). Instruments that promise to meet these requirements are expert hearings, expert workshops, science workshops, expert panels or advisory committees, or consensus conferences as practised in the medical field (Coppock, 1985; McGlynn et al, 1990; Jones and Hunter, 1995; Renn et al, 1995; Roqueplo, 1995; Koenig and Jasanoff, 2001). If anecdotal knowledge is needed, one can refer to focus groups, panels of volunteers and simple surveys (Milbrath, 1981; Dürrenberger et al, 1999). More sophisticated methods of reducing complexity for difficult risk issues include Delphi methods, group Delphi, meta-analytical workshops and scoping exercises (Pill, 1971; Webler et al, 1991; Sutton et al, 2000). The most frequently used instruments of the first pool are described below (OECD, 2002):

- *Expert hearing.* This is the most popular form for resolving differences among experts (Renn et al, 1995; Boehmer-Christiansen, 1997; OECD, 2002). Experts with different positions are asked to testify before the representatives of the organizing institution (most often a regulatory agency) or the deliberative panel. The organizers ask each expert a specific question and let them develop their line of arguments. Occasionally, hearings allow for open discussions among the experts; but the final judgement is left to the organizing committee or the deliberative panel. Hearings are excellent and fairly inexpensive settings, if the objective is to get a clearer picture of the variability of expert judgements and to become aware of the arguments supporting each position. Hearings do not provide consensus and may not resolve any conflict. However, they may clarify the basis of the conflict or the different points of view in a contested risk issue.
- *Expert committees.* Expert committees, advisory boards, think tanks and scientific commissions are also very popular forms for involving external knowledge carriers within the risk management process (Primack and von Hippel, 1974; Renn, 1995; Rich, 2004; Rakel, 2004). They have the advantage that experts interact freely with each other, have more time to learn from each other and are able to consult other experts if deemed necessary. They work independently of the agency or deliberative body to which they report. The main disadvantage is that expert committees may not arrive at a consensus, may take too much time to reach a conclusion, may not respond to the urgent needs of the deliberative body and may 'live a life of their own'. In addition, many expert committees can only come to an agreement if the members have similar backgrounds and positions. Thus, biased results may result.
- *Expert consensus conference.* Particularly in the medical field, experts are gathered in a workshop to discuss treatment options and to decide on a general standard to be applied in comparable cases throughout the world (McGlynn et al, 1990; Jones and Hunter, 1995). The workshop is organized in group sessions in order to prepare common standards and in plenary sessions to reach a common agreement. One could envision consensus conferences in the risk area for the purpose of setting and articulating common conventions for risk assessment and evaluation.
- *Delphi exercises.* A Delphi process is aimed at obtaining a wide range of opinions among a group of experts (Turoff, 1970; Pill, 1971; Linstone and Turoff, 2002). The process is organized in four steps. In step 1, a questionnaire asks a group of distinguished scientists to assess the severity or the scope of a risk. The scientists provide their best estimate and assign a confidence interval to their answers. In step 2, the organizing team feeds back to each participant the scores of the whole group, including medians, standard deviation and aggregated confidence intervals. Each individual is then asked to perform the same task again, but now

with the knowledge of the responses of all other participants. In step 3, this procedure is repeated until individuals do not change their assessment any more. In step 4, the organizer summarizes the results and articulates the conclusions. A variation of the classic Delphi method is the group Delphi (Webler et al, 1991). During a group Delphi all participants meet face to face and make the assessments in randomly assigned small groups of three and four. The groups whose average scores deviate most from the median of all other groups are requested to defend their position in a plenary session. Then the small groups are reshuffled and perform the same task again. This process can be iterated three or four times until no further significant changes are made. At the end of a Delphi process, one receives either a normal distribution of assessments around a common median, a two- or three-peak distribution (signalling a majority and one or more minority votes) or a flat curve (which means that knowledge is insufficient to make any reliable assessment). The advantage of Delphi is that a serious effort has been invested in finding the common ground among the experts and in finding the reasons and arguments that cause differences in assessments. The disadvantage is that Delphis depend upon the quality and completeness of the expertise and information brought into the process. In general, we have had mostly positive experiences with Delphi processes, particularly group Delphi.

Pool 2: Instruments for dealing with uncertainty

The next pool of instruments refers to the second level of the debate which deals with uncertainty and its impact upon balancing the pros and cons of different risk reduction methods. Scientific input is also needed in order to compile the relevant data and the various arguments for the positions of the different science camps. Procedures such as the 'pedigree scheme' by Funtowicz and Ravetz (1990) might be helpful in organizing the existing knowledge. Furthermore, information about the different types of uncertainties has to be collected and brought into a deliberative arena. The central objective is, however, to deliberate about the most prudent handling of unresolved uncertainty. For this purpose, representatives of affected stakeholders and public interest groups must be identified, invited and informed about the issue in question (Yosie and Herbst, 1998a, pp644ff). The objective of the deliberation is to find the right balance between too little and too much precaution. There is no scientific answer to this question, and even economic balancing procedures are of limited value since the stakes are uncertain. Major instruments for reflective discourses are roundtables, negotiated rule-making, mediation, arbitration and stakeholder dialogues. Again, the most popular instruments for conducting a reflective discourse within a deliberative setting are the following (OECD, 2002):

- *Stakeholder hearings.* Most regulatory regimes of the world require hearings with stakeholders or directly affected citizens under specific circumstances (Checkoway, 1981; Kemp, 1985; Renn et al, 1995). Such hearings can serve a useful purpose if they are meant to give external stakeholders the opportunity to voice their opinion and arguments. Hearings also provide opportunities for stakeholders to understand the position of the regulatory agencies or other direct players (such as industry). But hearings have proven very ineffective for resolving conflicts or pacifying heated debates. On the contrary, hearings normally aggravate the tone of the conflict and lead to polarizations. Other than for the purpose of investigating the concerns and objections of organized groups, stakeholder hearings should be avoided.

- *Roundtables (advisory committees, stakeholder dialogues and negotiated rule-making).* Roundtables are very popular settings for stakeholder involvement (Brooks, 1984; English et al, 1993; Rose-Ackerman, 1994; Hadden, 1995; Renn et al, 1995; Wondelleck et al, 1996; Yosie and Herbst, 1998b; US EPA/SAB, 2001; Stoll-Kleemann and Welp, 2006). Normally, the participants represent the major social groups, such as employers, unions, professional associations, and others. The advantage is that the ritual window-dressing activities (typical for classic hearings) can be overcome through the continuity of the process and a strict working atmosphere. The major disadvantage is that groups outside the roundtable and representatives of the general public are left out. They can only trust the process to be effective and fair. If the debate is heated and adversarial elements govern the political climate, roundtables will face severe difficulties to legitimize their agreements. For many regulatory issues and risk management decisions, however, such roundtables have been very effective and also cost efficient in incorporating the perspective of organized groups and in suggesting adequate management options. There are also good techniques available (such as value tree analysis, multi-attribute decision-structuring and meta-planning exercises) to make these heterogeneous group meetings more productive (Rauschmayer and Wittmer, 2006). Essential for organizing a successful roundtable is the involvement of a professional moderator. Moderation should be performed by a neutral institution rather than the organizer.
- *Mediation (arbitration and alternative dispute resolution methods).* If conflicts are already clearly visible and unavoidable, the procedures of alternative dispute resolution are effective and less costly instruments compared to legal litigation (Cormick, 1980; Mernitz, 1980; Amy, 1983; Bingham, 1984; Folberg and Taylor, 1984; Edwards, 1986; Moore, 1986, 1996; Baughman, 1995; Fiorino, 1995; Hadden, 1995; US EPA, 1995; Susskind and Fields, 1996; Wondelleck et al, 1996). Mediation and similar procedures rest on the assumption that stakeholders can find a common solution if they do not insist on positions, but try to meet their crucial interests and underlying values. Under these circumstances, win–win solutions may be available that will please all parties. Mediation requires the involvement of a skilled and professional mediator. Similar to roundtables, such mediators should be recruited from neutral professional services. It is advisable that mediators have sufficient knowledge about the issue, that they can understand and evaluate all participants' statements, but that they do not have a clear commitment to one or the other side. The advantage of mediation is that conflicts among participants can be reconciled before they reach the legal arena. The disadvantage is that, depending upon the composition of the group, interests which are not represented or emphasized at the roundtable will not be considered. Most alternative dispute-resolution methods work well under the condition of adversarial and corporatist styles; they may be seen as unnecessary in more trustful environments where conflicts are rare and stakeholders less agitated.

Pool 3: Instruments for coping with ambiguity

The last group of instruments addressed in this subsection deals with ambiguity. Ambiguity can be encountered at all stages of the risk assessment as well as risk management process. Most often, ambiguities arise over the issue of social or moral justification of a risky activity, of distributional inequities and environmental justice, and the selection of the right management options, including the decision of who is to be responsible and accountable. Before investing in resolving ambiguity, it is essential to investigate the cause of the ambiguity and to find the right spot where the involvement procedure would best fit in the decision-making process. Preferred instruments here are citizen panels or juries (randomly selected), citizen advisory committees or councils, public consensus conferences, citizen action groups and other participatory techniques. The main instruments belonging to this category are as follows (OECD, 2002):

- *Public hearings.* Public hearings are required in many regulatory regimes all over the world (Kemp, 1985; Renn et al, 1995). The idea is that people who feel affected by a decision should be given an opportunity to make their concerns known to the authorities and, vice versa, to give the authorities the opportunity to explain their viewpoint to the public (Hartmann, 1983). Although public hearings are fairly inexpensive and easy to organize, their effectiveness is rated as poor in most of the scientific investigations on the subject. Hearings tend to stereotype the issue and the actors involved, to aggravate emotions, to emphasize dissent rather than consensus and to amplify distrust rather than generate trust. Unless the issue is only slightly controversial and the climate is characterized by an overall consensual mood, I would not recommend public hearings as a setting for resolving ambiguity.
- *Surveys and focus groups.* Surveys of the general public or special groups are excellent settings in which to explore the concerns and worries of the addressed audience (Milbrath, 1981; Dürrenberger et al, 1999). If they are performed professionally, the results are usually valid and reliable. The results of surveys, however, provide only a temporary snapshot of public opinion, they do not produce solutions for conflict resolution or predict the fate of positions once they have entered the public arena. Surveys describe the starting position before a conflict may unfold. Focus groups go one step further by exposing arguments to counter-arguments in a small group discussion setting (Krueger and Casey, 2000). The moderator introduces a stimulus (e.g. statements about the risk) and lets members of the group react to the stimulus and to each other's statements. Focus groups provide more than data about people's positions and concerns; they also measure the strength and social resonance of each argument vis-à-vis counter-arguments. The major disadvantage of surveys and focus groups is the lack of real interaction among participants. Therefore, both instruments are advisable as preliminary steps in understanding the context and the expectations; but they do not assist risk managers in resolving a pressing issue. In addition, both instruments are fairly expensive.
- *Citizen advisory committees (ombudsman, neighbourhood associations, citizen boards).* The instrument of citizen advisory committees is particularly popular in

local and regional contexts, but there are also examples of advisory committees on a national level (Laksmanan, 1990; Lynn and Kartez, 1995; Vari, 1995; Applegate, 1998). The chemical industry has been experimenting with citizen advisory committees for a long time in the framework of its responsible care programme (Prakash, 2000). This programme is directed towards people in the vicinity of chemical installations. Such an approach is also feasible with consumers if companies or agencies would like to involve their ultimate clients in the risk management process. The problem here is selection: either one invites representatives of stakeholder groups (such as the consumer associations) or one tries to find a sample of 'representative' citizens. Both approaches have their merits and drawbacks. Stakeholder groups are often quite distanced from the members they are supposed to represent. This is particularly true for consumer associations since consumers form a very heterogeneous group, and the majority of them do not belong to consumers associations. At the same time, a representative sample of consumers is difficult to obtain and it is questionable whether such a sample can speak in the interest of all consumers. In spite of these difficulties, such advisory committees can be very effective in detecting potential conflicts (early warning function) and getting the concerns of the consumers heard and reflected in the respective organizing institutions. In addition, the organization of citizen advisory committees is fairly inexpensive and easy to do.

- *Citizen consensus conferences.* The Danish Board of Technology introduced a new form of citizen involvement, which it called 'consensus conferencing'. This instrument is strongly based on the belief that a group of non-committed and independent citizens is best to judge the acceptability or tolerability of technological risks (Joss, 1995, 1997, 1998; Sclove, 1995; Andersen and Jaeger, 1999). Six to ten citizens are invited to study a risk issue in detail and to provide the legal decision-maker, or an agency, with a recommendation at the end of the process. The citizens are usually recruited by self-selection. The organizers put an advertisement in the newspaper asking for volunteers. If too many people volunteer for the consensus conference, the organizers follow specific rules for ensuring equal representation. An equal number of women and men are required, as well as a cross-section of the population in terms of age, social class and political preferences. The participants receive a substantial amount of material before they convene for the first time. They study this material during two consecutive weekends. The consensus conference itself lasts three days. During the first day, the participants share their reflections with a body of regulators or decision-makers (often members of parliament). They also raise their questions and listen to the answers given by politicians and experts. On the second day in the morning the hearing continues; but this time it is open to the wider public. In the afternoon, the participants meet behind closed doors and articulate their recommendations. These are then presented to the decision-makers on the following day. The decision-makers have the opportunity to give further comments. Finally, the participants write the final draft of the recommendations and present them to the media at the end of the third day. The advantage of consensus conferencing is the transposition of a major conflict to a small group of laypeople who are being educated about the subject and are asked to make recommendations based on their knowledge and personal values. The main disadvantage is the small number of people who are assigned such an important task. The restricted number of six to ten participants has been the thrust of criticism in the literature (Einsiedel and Eastlick, 2000). Consensus conferences seem to yield a compelling legitimacy effect within countries that are small and emphasize consensus over conflict. Most successful trials are reported in Denmark, Norway and Switzerland. The experiences in more adversarial countries such as the UK, France and Germany are less encouraging (Joss, 1997). The results of the deliberations were not widely published in the media; decision-makers were not willing to submit sufficient time to small groups of laypeople; and administrators paid only lip-service to the conference statements.

- *Citizen panels, planning cells or citizen juries.* Planning cells or citizen panels (juries) are groups of randomly selected citizens who are asked to compose a set of policy recommendations on a specific issue (Crosby et al, 1986; Dienel, 1989; Stewart et al, 1994; Armour, 1995; Crosby, 1995). The objective is to provide citizens with the opportunity of learning about the technical and political facets of the risk management options and enabling them to discuss and evaluate these options and their likely consequences according to their own set of values and preferences. The participants are informed about the potential options and their consequences before they are asked to evaluate these options. Since the process requires time for the educational programme and the evaluation of options, the panels are conducted in seminar form over three to five consecutive days. All participants are exposed to a standardized programme of information, including hearings, lectures, panel discussions, videotapes and field tours. Since participants are selected by random procedures, every individual in the affected population has an equal opportunity to participate in the process. In reality, however, only 5 to 40 per cent of the randomly selected citizens decide to become active participants. In contrast to consensus conferences, however, the number of people who can participate is limited only by available resources and time. Several hundred citizens can be involved in one exercise. All participants are grouped in panels of 20 to 25, with an identical educational programme and evaluative tasks. If most of the panels come up with similar conclusions, one can be sure that this is (or would be) the will of the informed public. Planning cells require a large investment of time and money and are not suitable for all types of problems and all contexts. If the problem is highly technical, it may be impossible to bring citizens up to the necessary level of understanding. Furthermore, if the decision options are too narrowly restricted and there is not enough room to allow trade-offs on decision criteria, then the process will fail. Citizen panels may also face the problem of being accepted as legitimate consultants to policy-makers in an adversarial climate.

Synthesis of components

The three pools of instruments provide a sufficient number of choices for matching the instrument with the risk problem at hand. It is more difficult, however, to find the right and appropriate combination if instruments from several pools must be combined. For example, if risks are characterized by high complexity, uncertainty and ambiguity, one needs an integrated process that includes a sequential chain consisting of at least one instrument from each pool. Or if the risk is highly complex and uncertain but raises little controversy, only instruments from pools 1 or 2 have to be selected. The pools provide tool boxes and, depending upon the nature of the risk problems and what risk managers know about them, the selection has to be made from one or more of the three pools.

The selection of a specific sequence and the choice of instruments depend upon the risk issue, the context and the regulatory structure and culture of the country or state in which such a process is planned. Different countries have developed diverse traditions and different preferences when it comes to deliberative processes (O'Riordan and Wynne, 1987; Löfstedt and Vogel, 2001). The selection of instruments from the three pools, therefore, needs to reflect the risk nature, the regulatory system and the respective political culture.

One possibility for a risk management agency selecting one instrument from each pool might be, for example, to organize an expert hearing to understand the knowledge claims that are relevant for the issue. Afterwards, the agency might initiate a roundtable for negotiated rule-making in order to find the appropriate trade-offs between the costs of over-regulation and under-regulation in the face of major uncertainties. The agency could then convene several citizen advisory committees to explore the potential conflicts and dissenting interpretations of the situation and the proposed policy options. Each component builds upon the results of the previous component.

However, the requirements of an analytic–deliberative process are not met by running three or more different components in parallel and feeding the output of each component as input into the next component (Renn, 2004b). Each type of discourse has to be embedded in an integrated procedural concept. In addition, there is a need for continuity and consistency throughout the whole process. Several participants may be asked to take part in all three instruments, and an oversight committee may be necessary to provide the mandated links. One example for such an integrated hybrid model is the 'cooperative discourse' approach which several colleagues and I have developed and tested during the last three decades (Renn et al, 1993; Renn and Webler, 1998; Renn, 1999a). The following section describes this model in more detail.

An example of an integrated process: The cooperative discourse

Model description

The model of 'cooperative discourse' meets the three risk challenges by assigning specific tasks to different groups in society. These groups represent three forms of knowledge and values:

1 knowledge based on technical expertise (epistemic discourse);

2 knowledge and values derived from social interests and advocacy (reflective discourse);
3 knowledge and values based on common sense, folklore wisdom and personal experience (participatory discourse).

These three forms of knowledge and values are integrated into a sequential procedure of three consecutive steps (Renn et al, 1993). The *first step* refers to the identification of objectives or goals that the process should reflect (Gregory, 2004). The identification of concerns and objectives is best accomplished by asking all relevant stakeholder groups (i.e. socially organized groups that are, or perceive themselves as being, affected by the decision) to reveal their values and criteria for judging different options (reflective discourse). This can be done by a process called value tree analysis (Keeney et al, 1987; von Winterfeldt, 1987), which is explained later. The evaluative criteria derived from the value trees are then transformed into indicators by the research team or an external expert group.

With different policy options and criteria available, the *second step* involves the actors with special knowledge and evidence on the subject. Experts representing multiple disciplines and plural viewpoints about the issue in question are asked to judge the performance of each option on each indicator (epistemic discourse). For this purpose, we have developed a special method called group Delphi (Webler et al, 1991; see description on pp335f).

The *third and last step* is the evaluation of each option profile by one group or several groups of randomly selected citizens, in a participatory discourse. We refer to these panels as citizen panels for policy evaluation and recommendation (Renn and Webler, 1992; Renn et al, 1993). The objective is to provide citizens with the opportunity of learning about the technical and political facets of policy options and enabling them to discuss and evaluate these options and their likely consequences according to their own set of values and preferences. The idea is to conduct a process loosely, analogous to a jury trial, with experts and stakeholders as witnesses, and advisers on procedure as 'professional' judges (Crosby, 1995, Stewart et al, 1994). For meaningful and productive discourse, the number of participants is limited to about 25. Discourse proceeds in citizen panels with the research team as discussion leaders who guide the group through structured sessions of information, personal self-reflection, and consensus-building.

The whole process is supervised by a group of official policy-makers, major stakeholders and moral agents (such as representatives of churches). Their task is to oversee the process, test and examine the material handed out to the panellists, review the decision frames and questions, and write a final interpretation of the results. This oversight committee represents a major component of the model. It provides the integrative envelope over the different sequential elements and creates the necessary link to the legitimate decision-makers. It cannot, and should not, change the recommendations of the panels, but should put them into the right frame for processing by the political institutions that manage or regulate risks.

Finally, the research team has the primary task of providing first drafts of the three products. The functions and procedure of our policy model are illustrated in Figure 8.3. The figure shows that all actors involved (the experts, the stakeholder groups, the citizens, the sponsor, the oversight committee, and the research team) play a role in

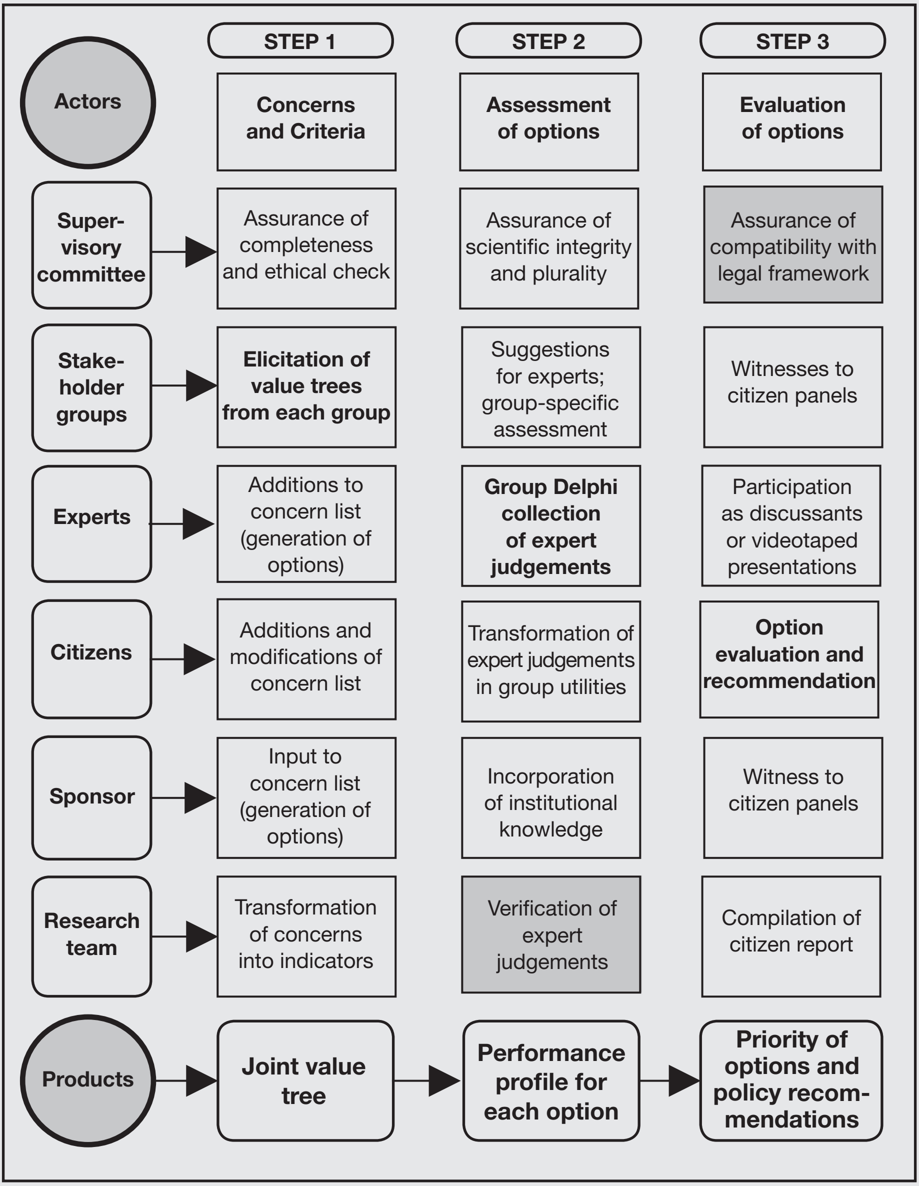

Figure 8.3 *Basic concepts and elements of the cooperative discourse model*

Source: adapted from Renn, 1998

each step; but their influence is directed towards the type of knowledge and rationality that they are most qualified to offer best (these are highlighted in bold face in Figure 8.3). The stakeholders are asked to join a roundtable or dialogue forum (pool 2). Their deliberations lead to the end product of a value tree, which the citizen panels or the experts may augment during a later stage. A group of experts from different disciplines and backgrounds is asked to engage in a group Delphi process (investment taken from pool 1): they are principally responsible for constructing performance profiles for each option, taking into consideration the institutional knowledge of the sponsor and the specific knowledge of the various stakeholder groups. The major task of the citizen panels (an instrument taken from pool 3) is to evaluate options and generate or modify policies, assisted by expert and stakeholder witnesses. The role of the sponsoring risk management agency is limited to making suggestions about options, to providing testimony to the citizen panels and to participating in the oversight committee. The oversight committee has the task of exercising external control over the whole process, providing the necessary links between the three steps and ensuring the compatibility of the results with the political institutional frames in which the results are going to be processed. Finally, the research team has the primary task of providing first drafts of the three products (joint value tree, performance profiles and citizen report) in order to gain approval for these products from the respective actors, and to feed them back into the process. This division of labour introduces checks and balances into the process and constitutes a structural order that is logical and transparent.

Formal tools used in the cooperative discourse model

The three-step procedure uses three specific decision-making tools. During the first step of the process, value tree analysis is applied to produce a consistent, coherent and transparent set of evaluation criteria. During the second step the formal techniques of the group Delphi process are employed. During the third step, multi-attribute utility (MAU) techniques are applied to guide citizens through the process of handling conflicting values and objectives, and to integrate knowledge and values (McDaniels, 1996; Horstmann et al, 2005; Rauschmayer and Wittmer, 2006). The group Delphi process has been described on pp335f. The two remaining procedures are described as follows.

Value tree analysis. A value tree identifies and organizes the values of an individual or group with respect to possible decision options (Keeney et al, 1984; Keeney et al, 1987). In the process of structuring a value tree, representatives of different stakeholder groups are asked to identify their criteria and objectives for evaluating different options. Values in this context are abstractions that help organize and guide preferences (von Winterfeldt, 1987).

A value tree structures the elicited values, criteria and corresponding attributes in a hierarchy, with general values and concerns at the top, and specific criteria and features at the bottom. Depending upon the political context and the nature of the decision to be made, the values of the various stakeholder groups may vary considerably. By giving each group the right to assign a weight of zero to each criterion they regard irrelevant, it is possible to construct a joint or combined value tree that accounts for all viewpoints and that can be verified by all participants (von Winterfeldt and Edwards, 1986; Keeney et al, 1987).

In opposition to many users of the value tree technique (i.e. von Winterfeldt, 1987), I perceive little benefit in having the stakeholder groups do either the performance measurement of each option on each criterion or the assignments of trade-offs between the various independent criteria. Both tasks are extremely prone to strategic game playing and would probably end in a process by which each group would rationalize its latent preference for one of the decision options available (Renn, 1999d). I prefer to have the participating groups leave the actual measurement to a group of independent experts (in step 2) and the weighting to unbiased panels of uncommitted citizens (in step 3). However, stakeholder groups may inform the experts about potential impacts they expect as a result of any one option, and they can contribute their evaluation of these options to the citizen panel in their testimony.

Multi-attribute utility analysis. The second major component for using formal decision-making tools refers to the elicitation of values, criteria and attributes, and the assignment of relative weights to the different value dimensions. The procedures used for this purpose are derived from multi-attribute utility theory (Edwards, 1954, 1977; Humphreys, 1977; von Winterfeldt and Edwards, 1986; Arvai et al, 2001; Rauschmayer and Wittmer, 2006). The respondents are first asked to use the criteria of the joint value tree to rate each decision option on each criterion. The participants are free to add new values to the tree; but they may not delete any of the criteria elicited from the stakeholder groups. They can also modify the presented option or add a new option to the list. The rating of each option then proceeds on the basis of the profiles that the experts generated during a workshop organized according to the Delphi process. Finally, each criterion is weighted against the other, resulting in a matrix of relative weights and utility measures for each option and each criterion. Both tasks, the transformation of the expert data in utilities and the assignment of trade-offs, are performed individually and in small groups.

Deviating from the established MAU procedure, the numerical results (i.e. for each option the sum of the utilities of each dimension multiplied by the weight of each dimension) of the decision process are not used as an expression of the final judgement of the participants, but as a structuring aid to improve the participants' holistic, intuitive judgement (Renn, 1999a, 2006b; similar procedure in Hostmann et al, 2005). By pointing out potential discrepancies between the numerical model and the holistic judgements, the participants are forced to reflect upon their opinions and to search for potential hidden motives or values that might explain the discrepancy. The final recommendations are always based on a holistic judgement by individuals or groups.

This revised version of the MAU model has enjoyed successful application in German, US and Swiss citizen panels; see the following section. The major advantage of the MAU model – to decompose a complex problem and to structure a productive discussion – is utilized to its full extent without accepting the rigid rule of amalgamating the scaled results within a single dimension.

Experiences with the cooperative discourse model

Applications of the cooperative discourse model in Germany, Switzerland and the US emerged from the early experiences with citizen panels in urban planning in various German cities and communities (Dienel, 1989). Based on these experiences, several researchers experimented with the cooperative discourse method, first in Germany and later in other countries. This section describes several large-scale applications in three countries:

- The most comprehensive study dealt with the evaluation of national energy policies in Germany. In August 1982, the German Ministry of Research and Technology initiated a large research project to investigate the preferences of the German population with respect to four energy policy options developed by a parliamentary commission in 1979 (Renn et al, 1985; Renn, 1986). The government was interested in eliciting reliable information on the energy scenario which was the most appealing to the population and on the basis which citizens would evaluate the policy options laid out in each scenario. A research team, directed by the author, conducted a three-year study to collect data on public preferences and to analyse the motivations and underlying reasons for the judgement process of evaluating the predefined energy scenarios. The study operated with 24 citizen panels (each including approximately 25 participants) drawn from seven communities in different parts of West Germany. The panels unanimously rejected a high reliance on energy supply and opted for an energy policy that emphasized energy conservation and efficient use of energy. Nuclear energy was perceived as an undesirable but (at least for an intermediate time period) necessary energy source. The panellists recommended stricter environmental regulation for fossil fuels even if this meant higher energy prices. They developed a priority list for policies and drafted recommendations for implementing high-priority policies (Renn et al, 1985).
- A regional study was conducted from 1994 to 1996 in the northern part of the black forest (southern Germany). The objective was to have stakeholders and citizens take part in planning a waste management programme (Schneider et al, 1998; Renn, 1999a). A stakeholder dialogue based on the model of roundtables was organized in 1994 to develop waste reduction policies and to assess the potential recycling potential of the area (using the method of value trees). The same group was also asked to find the most suitable technical solution for waste processing before final disposal. After these decisions were made, 200 randomly selected citizens from potential host communities were asked to find the most appropriate site for the types of facilities that had been previously chosen by the representatives of the roundtable. The most outstanding result was that panellists were even willing to approve a siting decision that would affect their own community. All ten citizen panels reached a unanimous decision based on tolerated consensus, which involved the recommendation to construct a small state-of-the-art incinerator in the centre of the most populated town within the region. The reason for this surprising recommendation was that citizens wanted to present a visual reminder to their fellow citizens. They were not to forget the need to reduce waste, to burden those who contribute most to the problem and to put the incinerator near the political power centre as a 'clever' means of ensuring compliance with environmental standards: 'Since the mayor resides right next door to the facility, he will make sure that nothing harmful will happen.' The decision was given to the regional planning board, which approved the recommendations with some minor modifications. The responsible county parliaments and the city council of the largest city within the region, however, refused to accept the recommendations and took the 'easy way out' and exported the waste to another region.

- In 1992, the Building Department (*Baudepartement*) of the canton Aargau (northern part of Switzerland) requested Thomas Webler and myself (at that time affiliated with the Swiss Federal Institute of Technology) to organize a cooperative discourse for siting one or several landfills in the eastern part of the canton. The mandate of the research team was to organize a cooperative discourse with four citizen panels. These panels had the task: first, to develop criteria for comparing the different sites; second, to evaluate the geological data that were collected during that period; third, to eliminate the sites that were not to be further considered; and, fourth, to prioritize the remaining sites with respect to their suitability to host a landfill (Renn and Webler, 1998; Renn, 1999a). Four citizen panels were formed, each consisting of two representatives from each potential site community. With the exception of one community, every town sent eight people to the panels. Not one of them dropped out during the process. Between January and June 1993, the panels met seven to nine times before they attended a workshop of two days to come up with the final decision. All participants rated each site on the basis of their self-selected evaluative criteria, their personal impressions, the written and oral information, and the results of a workshop with experts on the basis of a group Delphi. All four panels composed a list of prioritized sites for the landfill. The most remarkable outcome was that each panel reached a unanimous decision based on tolerated consensus. In December 1993, the result of the participation process was made public. The canton government approved the results and entered the next phase of the licensing procedure. Currently, the selected site still stands; but the creation of a landfill has been postponed since the amount of waste has sharply decreased over the last few years.
- There has been one major attempt to implement the original version of the cooperative discourse in the US. Using randomly selected citizens for policy-making and evaluation is not alien to the US. The Jefferson Center in Minneapolis has conducted numerous projects with citizen juries (Crosby et al, 1986; Crosby, 1995). Several community planners have experimented with the model of citizen panels, which were composed to reflect a representative sample of the population (same model as in Kathlene and Martin, 1991). In our case study, the Department of Environmental Protection of New Jersey asked Thomas Webler and myself in 1988 to apply the cooperative discourse model to sewage sludge management problems (Renn et al, 1989). The objective of the project was to give citizens of Hunterdon County, New Jersey, the opportunity of designing the regulatory provisions for an experimental sludge application project on a Rutgers University research farm located in Franklin Township, New Jersey. Although much smaller in scale, the project provided many new insights and experiences that partially confirmed the European observations and partially documented the need for adjustments to the US political culture. The citizen panels were conducted on two consecutive weekends. The desired goal was to elicit recommendations for regulatory provisions that were to be included in the permit for the land application of sewage sludge on the site in question. The factual issues were discussed in a group Delphi with eight sludge experts (Webler et al, 1991). The results of the Delphi were fed into the panels' deliberation process. The envisioned programme for the citizen panels was radically altered after the participants, particularly the landowners abutting the site, made it clear that they rejected the project of land

> application and that they felt more comfortable conducting their own meetings without the assistance of a third party. The citizens met several times without the help of a facilitator and formulated recommendations which were forwarded to the sponsor (the New Jersey Department of Environmental Protection). In addition to the policy recommendation to reject the land application proposal, the process provided valuable information about citizens' concerns and values. Whereas most of our consulted experts were convinced that citizens' concerns focused on issues such as odour, traffic and contamination of groundwater, the citizens' value tree analysis revealed that their major concerns were the expected change of community image from an agricultural community to a 'waste dump' and the long-term effects of pollutants on farmland (Webler et al, 1995a).

In summary, the applications of cooperative discourse method provided some evidence and reconfirmation that the theoretical expectations linked to this method can be met on the local, regional and national level. Eliciting the preferences and educated responses of citizens in a rather short time has proved a valid instrument. Evaluation studies by independent scholars confirmed that the objectives of effectiveness, efficiency and social acceptability were largely met in the Swiss, as well as in the German, case studies (Rymann, 1993; Roch, 1997; Vorwerk and Kämper, 1997; Löfstedt, 1999). The US study was not externally reviewed. The evaluators agreed that the main interests and value groups were adequately represented, that the process and the results were cost effective, and that the outcomes of the process were judged as reasonable and competent suggestions by technical experts. However, the evaluators were rather sceptical about the legitimization function of these trials and criticized the lack of trust in these procedures by the political authorities. In all cases, the results of the deliberation were not implemented, at least not to their full extent. The evaluations emphasized the need for a stronger role of the supervisory committee (which was installed in the Swiss case) and the inclusion of the actual decision-makers in these committees as a means of bridging the gap between the deliberative bodies and the political risk management institutions.

Conclusions

A combination of analytic and deliberative instruments (or stakeholders and the public) is instrumental in reducing complexity, necessary for handling uncertainty and mandatory for dealing with ambiguity. Uncertainty and ambiguity cannot be resolved by expertise only, even if the expertise is uncontested. In situations of high uncertainty, economic balancing between overprotection and underprotection requires subjective evaluations of fair benefit-sharing and risk-sharing. Furthermore, the interpretation of ambiguous consequences requires the input of public preferences and values. Neither agency staff nor scientific advisory groups are able or legitimized to represent the full scope of public preferences and values. This is a compelling reason for broadening the basis of decision-making and including those who have to 'pay' in terms of bearing the cost for stricter regulatory requirements or being exposed to an uncertain hazard.

How can and should risk managers collect public preferences, integrate public input within the management process, and assign the appropriate roles to technical experts, stakeholders and members of the public? This essay suggests making use of the distinction between three different pools of participatory instruments. Each of the three pools is predominantly suited to dealing with problems of complexity (pool 1), uncertainty (pool 2) and ambiguity (pool 3). The objective is to design a combination of two or more of the available instruments from each pool depending upon the diagnosed characteristics of the risk. One candidate for such an integrated process is the model of 'cooperative discourse' that has been developed and tested over the last three decades.

Based on our experiences with the model of cooperative discourse in several countries, we have come to the conclusion that the model provides a theoretically ambitious and practically feasible method of putting an analytic–deliberative process into action. It provides an opportunity for addressing all three challenges of risk. It ensures that the state of the art in systematic knowledge is included in the deliberation; it ensures a fair representation of public interests; it emphasizes reflective and normative competence; and it builds upon well-proven techniques of efficient decision-making such as the application of multi-attribute scaling techniques (see review in Rippe and Schaber, 1999).

Many arguments in favour of analytic–deliberative processes and their theoretical foundations provide ample evidence for their potential contribution to improving risk evaluation and management. It is still an open question whether deliberation can deliver what it promises in theory. The empirical account is still open and incomplete. Being active in developing and testing analytic–deliberative processes, this author is confident, however, that over time we will not just prove, theoretically, the merits and potentials, but also the practical feasibility and superiority of analytic–deliberative processes in different political cultures and among a variety of regulatory styles. The time for analytic–deliberative processes is here to come.

9

The Social and Political Context of Risk Governance[1]

The importance of context

Risk governance cannot take place in isolation. Nor is it something that can be applied in a standard way in all locations, political cultures, organizations and risk situations. The entire risk governance process must be open to adaptation in order to reflect the specific context of each risk. When considering the wider environment of risk handling in modern societies, many classes of influential factors come into play. Only a few can be mentioned here. For example, the distinction between horizontal and vertical governance can be helpful in describing and analysing cases of risk handling in different countries and contexts (Zürn, 2000). In addition, the interplay between economic, political, scientific and civil society actors must be addressed when looking beyond just governmental or corporate actions. The different dimensions of context affecting the risk governance process are illustrated in Figure 9.1. These refer to:

- *Organizational capacity.* Organizational capacity is specific to the organization, or group of organizations, responsible for dealing with risks at the level of the individual, the company, the local or national government, or at an international level (e.g. the World Health Organization), or a combination of any or all levels.
- *Political and regulatory culture.* Taking into account the political and regulatory culture of different countries provides a comparison between diverse approaches to handling and regulating risks. Although management styles may become more alike (particularly in industry), there is no common, global approach to risk governance. The same risk may be processed differently and be subject to a different management decision depending upon such factors as national culture, political tradition and social norms. In some environments, a top-down ('vertical governance') approach will dominate; in others, an inclusive 'horizontal governance' approach will be the norm.

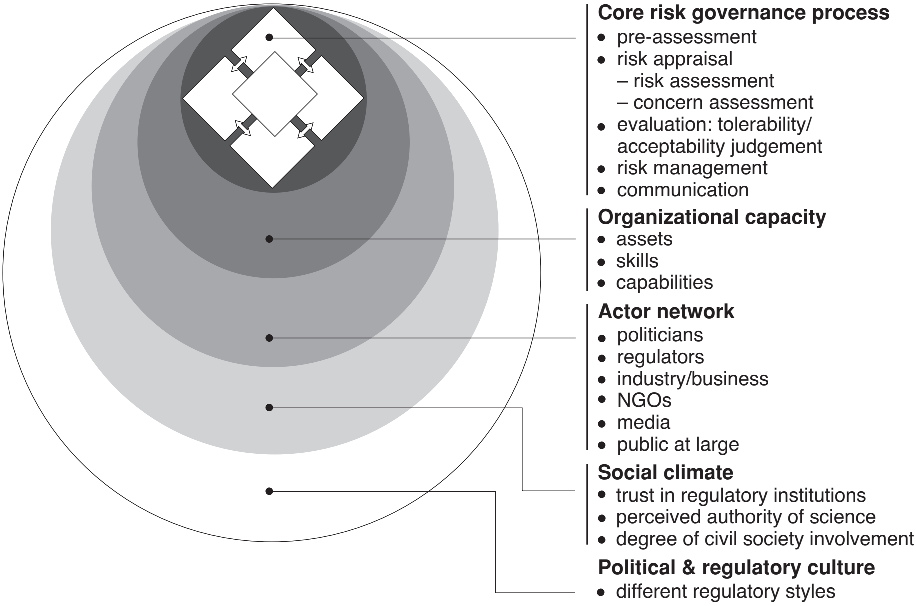

Figure 9.1 *Risk governance goes much further*

Source: adapted from IRGC, 2007, p14

- *Actor network.* The actor network will be different for every risk and for every situation. It comprises all those with a stake in the risk and its possible outcomes – which could involve a large set of actors, such as national, regional and local governments; different sectors of industry; regulators; NGOs; the media; and members of the general public. An understanding of all actors at each governance level is very helpful in framing the risk, making concern assessments, judging acceptability and tolerability, communicating throughout the governance cycle, and taking appropriate risk management decisions.
- *Social climate and risk culture.* Understanding social climate and risk culture can help in judging the level of preparedness for the change that a risk might trigger or, alternatively, the potential acceptability of a risk management decision. Often, the factors that comprise a social climate and corresponding risk culture will have an impact upon perceptions of a decision's fairness, appropriateness and feasibility. In turn, these perceptions will influence compliance with the decisions.

These contextual factors indicate that the risk governance framework that has formed the underlying principle of this volume must be adapted to work differently in different contexts. For example, some societies are more comfortable with high levels of stakeholder involvement than others, and not all political systems use the same degree of inclusive decision-making. As currently developed, the framework is more consistent with public decision-making in a context of advanced democracies with a strong civil society influence. Yet, we can observe a clear development towards more inclusive governance even in those countries that have traditionally been administered by strong central governments with little input from the various social society actors.

The social and political context of risk governance is outside this book's focus. However, it might be of value to the reader to widen our focus at the end and address two of the most important contextual factors: organizational capacity and regulatory style. These two factors are briefly explained in the next two sections.

ORGANIZATIONAL CAPACITY

Examining organizational capacity opens a new set of wider risk governance issues relating to the interplay between the governing actors and their capability of fulfilling their role in the risk governance process. In discussing the different components of risk appraisal and management, it has been implicitly assumed that society has developed the institutional and organizational capability to perform all of the tasks prescribed in each component – preferably in an objective matter-of-fact manner. This is, of course, an ideal picture that masks the realities of the *political* context in which risk governance takes place. In particular, the framing of risk is exposed to many institutional and political forces who may wish to jump on the bandwagon of public dissent or media hype in order to push their own interests (Shubik, 1991). Given the potential of risk perceptions to mobilize public outrage, thus making it impossible for decision-makers not to listen, some actors in society may have an interest in orchestrating 'risk events', whereas others might have a major motivation for concealing risks or downplaying their impacts. Most political systems have responded to this manoeuvring by establishing independent risk assessment and, occasionally, management agencies, expecting that these are less likely to be influenced by public pressure. As the European Commission's White Paper on European governance pointed out, the key ingredients of 'good' governance in this sense are openness, participation, accountability, effectiveness and coherence (European Commission, 2001b, p10). These requirements are important for all countries, particularly many transitional and most developing countries.

For the analysis of institutional capacity, it is useful to distinguish between assets, skills and capabilities (Paquet, 2001; IRGC, 2005, pp57ff). *Assets* form the social capital for risk governance in the form of knowledge bases and structural conditions for effective management. *Skills* refer to the quality of institutional and human performance in exploring, anticipating and dealing with existing and emerging risks. *Capabilities* describe the institutional framework necessary to translate assets and skills into successful policies. These three components constitute the backbone of institutional capacity for risk governance.

The assets include:

- *Rules, norms and regulations:* these establish rights and obligations. In the risk area, the existence of norms, standards, best practice, legal instruments, etc., has always been a major and often contentious issue – hence, the importance of such assets. This is true not only with regard to their prescribing of how to deal with risk, but also for the absence, or the lack of observance, of rules (e.g. with regard to the end use of new technologies), which itself constitutes an increasing factor of risk.
- *Resources:* these are not limited to financial resources, but comprise an appropriate physical infrastructure for managing risk as well as the availability of adequate information, including the means for information gathering and processing.
- *Competence and knowledge*: this involves providing the necessary education and training, and establishing and maintaining a pool of experience and expertise. Education should not only be directed at specialists, but should also reach out to the general public, building up a culture of awareness and prevention.
- *Organizational integration:* this comprises the capacity to access and retrieve, in a combination tailored to individual cases, each of the first three types of assets. Organizational integration is a key element, without which otherwise worthy assets will struggle to achieve much.

Using an analogy from mathematics, the first three assets are additive, while organizational integration is a multiplying factor. A non-existent organizational capability for integration would nullify the efficacy of the other factors.

Skills are related to the capacity of organizations and institutions to deal with evolving, sometimes chaotic, external conditions. Such conditions should not be considered as an eventuality that cannot be dealt with, but should rather be viewed as input parameters to the risk process that require adequate treatment. Skills should enable political, economic and civic actors to use (and enhance the impact of) the available assets effectively. They relate to:

- *Flexibility*: new ways of making sense of a dynamic situation – adapting to change which, in many cases, means fighting against established practices and institutional inertia. An example can be found in the current concern that city planning frequently still follows 19th-century practices, while the increase in magnitude and frequency of extreme climatic events associated with climate change should dictate a new approach.
- *Vision:* bringing new practices into a context which would not naturally generate them – anticipating change. This implies paying more attention to

advanced methodological approaches, such as foresight and scenario planning, and a preparedness to think 'outside the box'.
- *Directivity:* reframing the whole perception of the way of life – driving change that will affect the outside world rather than limiting oneself to preventing or mitigating the effects of external forces. Several environmental policies (e.g. a ban on chlorofluorocarbons, or CFCs) and security policies (e.g. a ban on weapons of mass destruction), adopted at the international level, reflect this approach.

Using the same mathematical analogy, the three factors that comprise the skills are in an incremental relationship with each other. Within that relationship they can exhibit different intensities as a function of the nature of external forces.

Finally, capabilities constitute the framework in which assets enriched by skills can be exploited for developing and implementing successful risk governance policies. Capabilities can be conceptualized as a structure with several successive layers (Wolf, 2005):

- *Relations* link users and sources of knowledge, as well as those carrying the authority and those bearing the risk – in particular civil society. As previously stated, the participation of civil society in risk governance is essential. Relations should thus be based on inclusive decision-making in order to alleviate, at the outset, any circumstances that generate dispute and conflict and, consequently, aggravate risk.
- *Networks* constitute, in terms of structures, a close cooperative structure that goes beyond relations. Half way between self-organization and hierarchy, networks determine close links between and among groups of principally equal actors.
- *Regimes* establish the rules of the game: the framework in which the actors should act. Both relations and networks are essential for forming and sustaining regimes.

Drawing on the mathematical analogy again, the factors that comprise capabilities are intertwined, each having a separate but complementary function in the overall build-up of capabilities.

All three factors – assets, skills and capabilities – are important variables when assessing and investigating risk governance structures in different countries or risk domains; they can also serve as guiding principles for identifying and researching deficiencies and for providing assistance to improve capacity. It may even be possible, based on the above mathematical analogies, to construct an overall performance indicator that may be able to help countries to evaluate their risk governance capacities and to use these elements as pathfinders for establishing new institutional frameworks to achieve improved structures for coping with risk.

The role of regulatory culture

One major aspect of risk governance concerns political culture – that is, *regulatory regimes* or *governmental styles*. Each country and, in many instances, different risk domains within a country pursue diverse pathways for dealing with risk. The multitude of risk classification documents and meta-analyses of risk taxonomies is obvious proof of the plurality of risk-handling processes and conceptual approaches. It may, therefore, be helpful to search for some underlying principles of these approaches and to classify them accordingly.

This exercise of finding common denominators in cultural and national diversity is less of a challenge than one may assume at first glance. Most analysts agree that many of the cognitive factors governing risk perception are similar throughout the world (Renn and Rohrmann, 2000). In addition, risk management styles are also becoming more and more alike as the world becomes more globalized (Löfstedt and Vogel, 2001). In spite of the distinct cultural differences among nations and the variations with respect to educational systems, research organizations and structures of scientific institutions, the assessment and management of risks and concerns have become universal enterprises in which nationality, cultural background or institutional setting play but a minor role. This is particularly due to the role of science in proposing and justifying regulatory standards. Research establishments, as well as universities, have evolved into multinational and cosmopolitan institutions that speak identical or, at least, similar languages and exchange ideas on worldwide communication networks (Howells, 1990).

Risk management depends, however, not only upon scientific input. It rather rests on three components: *systematic knowledge*, *legally prescribed procedures* and *social values* (Renn, 1995). Even if the same knowledge is processed by different risk management authorities, the prescriptions for managing risk may differ in many aspects (e.g. with regard to inclusion and selection rules, interpretative frames, action plans for dealing with evidence, and so on). National culture, political traditions and social norms, furthermore, influence the mechanisms and institutions for integrating knowledge and expertise within the policy arenas. Policy analysts have developed a classification of governmental styles that addresses these aspects and mechanisms. While these styles have been labelled inconsistently in the literature, they refer to common procedures in different settings (these are summarized in Table 9.1) (Brickman et al, 1982; Coppock, 1985, 1986; Jasanoff, 1986, pp79–83; Vogel, 1986; O'Riordan and Wynne, 1987; Löfstedt and Vogel, 2001):

- The *'adversarial'* approach is characterized by an open forum in which different actors compete for social and political influence in the respective policy arena. The actors in such an arena use, and need, scientific evidence to support their position. Policy-makers pay specific attention to formal proofs of evidence because their decisions can be challenged by social groups on the basis of insufficient use or negligence of scientific knowledge. Risk management and communication are essential for risk regulation in an adversarial setting because stakeholders demand to be informed and consulted. Within this socio-political context, stakeholder involvement is mandatory.

- In the *'fiduciary'* approach, the decision-making process is confined to a group of patrons who are obliged to make the 'common good' the guiding principle of their action. Public scrutiny and involvement of the affected public are alien to this approach. The public can provide input to, and arguments for, the patrons, but is not allowed to be part of the negotiation or policy-formulation process. The system relies on producing faith in the competence and the fairness of the patrons involved in the decision-making process. Advisers are selected according to national prestige or personal affiliations. In this political context, stakeholder involvement may even be regarded as a sign of weakness or a diffusion of personal accountability.
- The *'consensual'* approach is based on a closed circle of influential actors who negotiate behind closed doors. Social groups and scientists work together to reach a predefined goal. Controversy is not present and conflicts are reconciled on a one-to-one basis before formal negotiations take place. Risk communication in this context serves two major goals: it is supposed to reassure the public that the 'club' acts in the best interest of the public good, and to convey the feeling that the relevant voices have been heard and adequately considered. Stakeholder participation is only required to the extent that the club needs further insights from the affected groups or that the composition of the club is challenged.
- The *'corporatist'* approach is similar to the consensual approach, but is far more formalized. Well-known experts are invited to join a group of carefully selected policy-makers representing the major forces in society (such as the employers, the unions, the churches, the professional associations and the environmentalists). Similar to the consensual approach, risk communication is mainly addressed to outsiders: they should gain the impression that the club is open to all 'reasonable' public demands, and that it tries to find a fair compromise between public protection and innovation. Often, the groups represented within the club are asked to organize their own risk management and communication programmes as a means of enhancing the credibility of the whole management process.

Although these four styles cannot be found in pure form in any country, they form the backdrop of socio-political context variables against which specific risk governance structures are formed and operated. The US system is oriented towards the adversarial style, while the Japanese system is characterized by a strong consensual mode of using expertise. The policy style of Northern Europe comes closest to the corporatist approach, whereas most Southern European countries exercise a fiduciary approach. All of these systems are in transition, (Löfstedt and Vogel, 2001). Fiduciary systems tend to become more corporatist, and corporatist

Table 9.1 *Characteristics of policy-making styles*

Style	Characteristics	Risk management
1 *Adversarial approach*	• Open to professional and public scrutiny • Need for scientific justification of policy selection • Precise procedural rules • Oriented towards producing informed decisions by plural actors	• Main emphasis is on mutual agreements on scientific evidence and pragmatic knowledge • Integration of adversarial positions through formal rules (due process) • Little emphasis on personal judgement and reflection by risk managers • Stakeholder involvement essential for reaching communication objectives
2 *Fiduciary approach (patronage)*	• Closed circle of 'patrons' • No public control, but public input • Hardly any procedural rules • Oriented towards producing faith in the system	• Main emphasis on enlightenment and background knowledge through experts • Strong reliance on institutional in-house 'expertise' • Emphasis on demonstrating trustworthiness • Communication focused on institutional performance and 'good record'
3 *Consensual approach*	• Open to members of the 'club' • Negotiations behind closed doors • Flexible procedural rules • Oriented towards maintaining solidarity with the club	• Reputation is the most important attribute • Strong reliance on key social actors (also non-scientific experts) • Emphasis on demonstrating social consensus • Communication focused on support by key actors
4 *Corporatist approach*	• Open to interest groups and experts • Limited public control, but high visibility • Strict procedural rules outside of negotiating table • Oriented towards sustaining trust with the decision-making body	• Main emphasis is on expert judgement and demonstrating political prudence • Strong reliance on impartiality of risk information and evaluation • Integration by bargaining within scientifically determined limits • Communication is focused on fair representation of major societal interests

Source: adapted from Renn, 2001 and IRGC, 2005, p63

styles tend to become more adversarial. What is interesting is the fact that the US attempts to incorporate more consensual policies within its adversarial system, while Japan is faced with increasing demands for more public involvement in the policy process (Doniger, 1987; Harter et al, 1998).

The two counteracting movements – the first one in Europe and Japan towards more openness and public participation, the second one in the US and other countries towards increased communitarian orientations – have contributed to the genesis of a new regulatory style, which may be called '*mediative*' (Renn, 2001). This style opens the debate to public input, but requires stringent rules for presenting and proving claims of evidence. In the US, it has taken the form of negotiated or mediated rule-making; in Europe it has evolved as an opening of the corporate clubs to new movements, such as environmental groups. The new 'mediative' style features the following characteristics:

- open negotiations among the consensual, fiduciary or corporatist members of policy-making institutions;
- inclusion of public interest groups (model of mediation);
- early involvement of the public through decentralized and innovative discourse models (using social science in its catalytic role for conflict resolution and planning);
- providing scientific expertise to all participating groups, but avoiding recruiting advocates of special interest groups;
- strengthening the role of interpretative functions that science and, in particular, the social sciences and humanities can offer to the discourse participants.

The mediative style might offer a specific opportunity for promoting inclusive governance without running the risk of paralysis by deliberation. Such a style cannot be created by governmental decree, but may only evolve over time in close interaction with governmental and non-governmental forces. A conciliatory style might be the appropriate response to the urgent need of our modern pluralist society to balance the quest for efficiency and effectiveness with the public's desire for inclusiveness and fairness.

10

Conclusions[1]

The starting point for writing this book was the insight that modern societies are in urgent need for a new inclusive and integrative framework promising to promote good risk governance, establish a more stringent approach to deal with complex, uncertain and ambiguous risks, develop a more suited structure to cope with emerging systemic and global threats and provide a convincing and acceptable format for involving civil society in the decision-making process. Good governance seems to rest on the three components: knowledge, legally prescribed procedures and social values. It has to reflect specific functions, from early warning (radar function), via new assessment and management tools to improved methods of balanced risk evaluation, effective risk communication and deliberative participation. Criteria of good governance have been discussed in many different contexts. They need to be transferred to risk-related issues and put into operation so that best practices can be identified and recommended. Central items to be addressed are sound scientific expertise, adequate inclusion of public concerns, consistency and coherence in making trade-offs between risks and benefits, non-discrimination and proportionality in designing management options, and assurance of thorough monitoring and independent oversight during implementation of management options. In addition, governance structures should reflect criteria such as transparency; effectiveness and efficiency; accountability; strategic focus; sustainability; equity and fairness; respect for the rule of law; and the need for the chosen solution to be politically and legally feasible, as well as ethically and publicly acceptable. Beyond the involvement of organized groups, the required framework needs to include procedures for general public participation, and public dialogue and effective communication about risk issues (see Essay 9). In the modern pluralist world, most risks will need to be subject to such a robust governance approach if they are to be adequately managed.

Together with specialists and practioners from different fields of risk analysis, we have tried to develop such a framework (IRGC, 2005, 2007). Drawing on an analysis of a selection of well-established approaches to what has traditionally been called 'risk analysis' or 'risk management', the new framework I pursued throughout this book has been designed to offer both a comprehensive means of integrating risk identification, assessment, management and communication, and a tool that can compensate the absence of (or weaknesses in) risk governance structures and processes (Bunting et al, 2007, p15). Use of the framework promises to identify the key steps in the risk governance process, and the diagnosis of potential deficits, problems or shortcomings in governance institutions or procedures. In addition, it can assist in facilitating a thorough understanding of risk issues, identifying the stakeholders interested in (and concerned with) the risks and providing guidance for how, and when, to include stakeholders in the process.

What are the innovative features of the framework and how does it differ from those that were analysed in this volume?

The risk *governance* process is understood to include, but also to go beyond, the three conventionally recognized elements of *risk analysis* (risk assessment, risk management and risk communication).[2] *Governance* thus includes matters of institutional design, technical methodology, administrative consultation, legislative procedure and political accountability on the part of public bodies, and social or corporate responsibility on the part of private enterprises. But it also includes more general provision on the part of government and commercial and civil society actors for building and using scientific knowledge, for fostering innovation and technical competences, for developing and refining competitive strategies, and for promoting social and organizational learning.

The framework builds upon the logical structure of four consecutive phases called pre-assessment, appraisal, characterization/evaluation and management. In addition, risk *communication* accompanies all four phases. Within each of the boxes, specific activities are listed that are deemed essential for meeting the requirements of good governance. This simple framework is in line with almost all other competing concepts and ensures the compatibility of the framework with professional codices and risk governance legislation (see Figure 10.1). Moreover, as the representation in Figure 10.1 shows, the framework renders the established linear structure – in common with other contemporary conceptions of risk governance – into an open, cyclical, iterative and interlinked process (see NRC, 1996; RCEP, 1998; Prime Minister's Strategy Unit/UK Cabinet Office, 2002).

As Figure 10.1 illustrates, the four phases correspond to the two major challenges of risk governance: generating and collecting knowledge about the risk and making decisions about how to handle or treat risk. These two challenges are illustrated by the two horizontal activities: appraisal and management. However, there are two additional phases in which knowledge and values are closely intertwined: pre-assessment and characterization/evaluation.

These two phases are located on the vertical axis and constitute interfaces between knowledge and values. During the phase of pre-assessment, the problem is framed and defined, and the terms of reference are specified. This task needs to be governed by societal values (stating the goals, objectives and contextual conditions) and inspired by what we already know about the hazard (suspected impacts, exposure, persistence and others) (Zinn and Taylor-Gooby, 2006b).

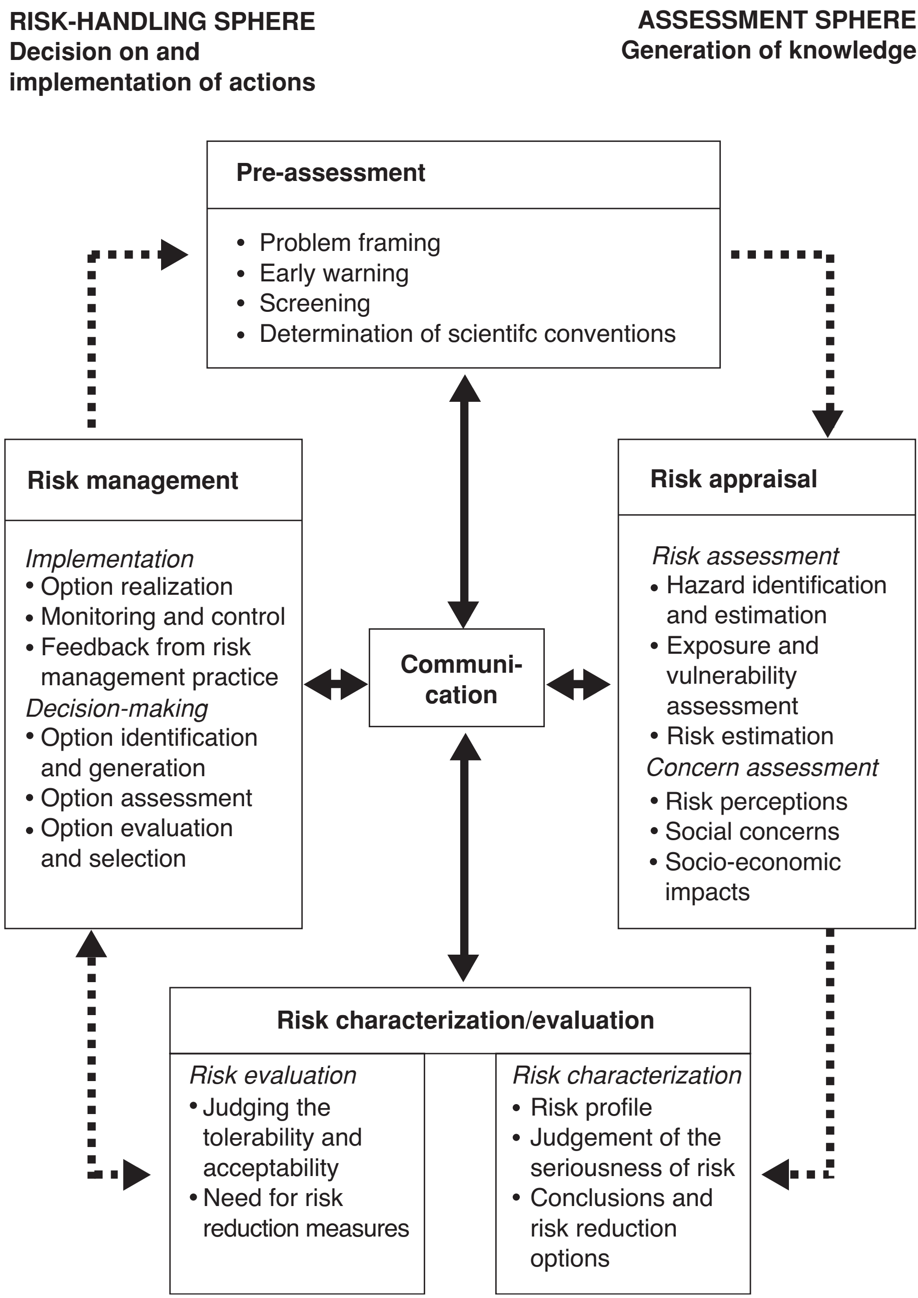

Figure 10.1 *Basic elements of the risk governance framework*

Source: adapted from IRGC, 2007, p6

Similarly, when looking at all of the evidence collected and condensed in the phase of characterization/tolerability judgement, a good understanding of this evidence, as well as a prudent judgement competence for making the necessary trade-offs between risk, benefits and other important impact categories, are essential for an effective governance process. This design of the four phases not only avoids separating values from facts in a naive and decisionistic way, but also escapes the relativism of post-modern philosophy by honouring the analytical distinctions between the factual and the normative world, even if they clearly interact.

The framework offers a truly interdisciplinary and multi-level governance approach. Most notably, it urges risk governance institutions to elicit not only knowledge about the physical impacts of technologies, natural events or human activities, but also knowledge about the concerns that people associate with this cause of risks. This concern assessment should not be confused with eliciting stakeholder feedback or providing platforms for participatory processes. It is, rather, a social science activity aimed at providing sound insights and a comprehensive diagnosis of concerns, expectations and worries that individuals, groups or different cultures may associate with the hazard or the cause of the hazard (Hyman and Stiftel, 1988). This social science analysis should be submitted to the same kind of methodological scrutiny and peer review as any other natural science activity.

Parallel to this concern assessment, the framework provides input on all governance levels from stakeholders either by contributing additional knowledge or by inserting their values, interests and preferences into the evaluation of the risk itself and the selection of the most effective, efficient and fair set of management options. It promotes the idea of inclusive governance, which is seen as a necessary, although insufficient, prerequisite for tackling risks in both a sustainable and acceptable manner and, consequently, imposes an obligation to ensure the early and meaningful involvement of all stakeholders and, in particular, civil society (Jasanoff, 1993). Inclusive governance is based on the assumption that all stakeholders have something to contribute to the process of risk governance and that mutual communication and exchange of ideas, assessments and evaluations improve the final decisions, rather than impede the decision-making process or compromise the quality of scientific input and the legitimacy of legal requirements (see similar arguments in Webler, 1999; Renn, 2004b). As the term governance implies, analysing and managing risk cannot be confined to private companies and regulatory agencies. It rather involves the four central actors in modern plural societies: governments, economic players, scientists and civil society organizations. Figure 10.2 provides an illustration of the interplay between these four major actors for risk governance.

Economic actors provide a means of efficiency and goal attainment to the risk governance process by employing the Pareto principle (or, if third parties are involved, the Kaldor-Hicks criterion). Experts provide evidence on causal relationships and the effectiveness of management options based on methodological rules and peer review. Governments add legitimacy to the procedure that is

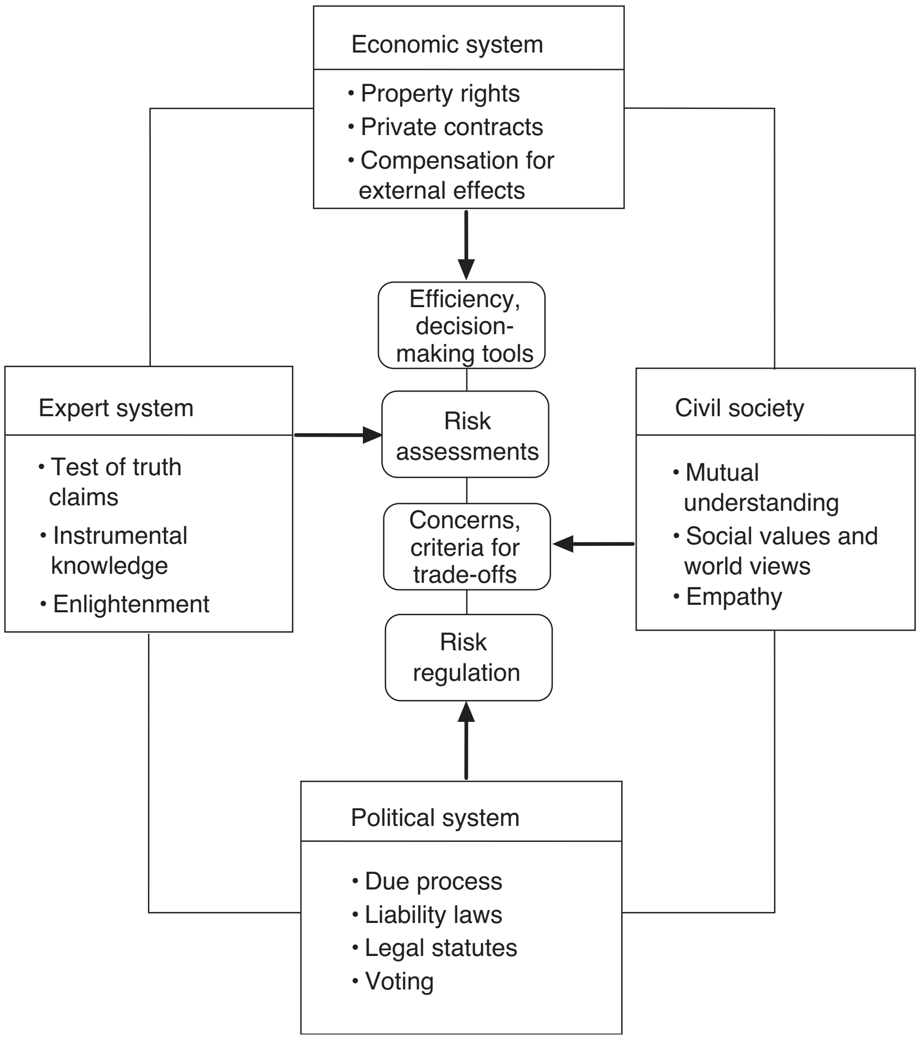

Figure 10.2 *Inclusive risk governance*

Source: adapted from Renn, 2004b, p295

generated by adhering to democratic principles, general law and due process. Finally, players within civil society add their preferences and values to the process based on their personal or collective experience of being affected by either the risk or risk management decisions. All of these actors are, in principle, capable and legitimized to insert these contributions into the governance process.

Last but not least, the framework includes a structuring tool that is designed to assist all risk professionals in selecting the proper risk and concern assessment tools, to inform on trade-offs when evaluating risks, and to design the most appropriate measures when deliberating about risk management options. This structuring tool is the distinction between complexity, uncertainty and ambiguity (Klinke and Renn). These three terms in the framework are attributes that characterize the state of knowledge about the risk in question. Complexity refers to the difficulty of establishing the cause–effect relationship between a risk agent and its potential consequences, uncertainty to the reliability and validity of the causal relationship and ambiguity to the controversy surrounding what a risk actually means for those affected, and the values to be applied when judging whether or not something needs to be done about it. This distinction between simple, complex, uncertain and ambiguous risk problems is useful for designing the appropriate route for assessing, evaluating and managing the respective risks; for selecting the corresponding assessment tools and processes; for employing adequate decision-making aids and procedures when evaluating risks or risk management strategies; and for designing the most suitable management options serving these strategies.

How can the framework be used in the future? First, providing a unified, yet flexible, concept, it can assist risk researchers to conduct comparative analyses among and between different risk types, thus ensuring that resource distribution on risk management across risk sources and technologies follows a consistent and efficient pattern. Second, it may help risk governance institutions to structure their projects in line with the phases and components outlined in this volume. Third, the framework may be a worthwhile basis for diagnosing deficiencies in existing risk governance regimes around the world and may provide suggestions on how to improve them. Lastly, the framework may serve a heuristic function by adding to worldwide efforts to harmonize risk governance approaches and by finding common denominators for risk governance that provide a credible and substantive response to world globalization and to the need for a coherent approach to managing the risks faced by our increasingly interconnected populations.

The promises of new developments and technological breakthroughs need to be balanced against the potential evils that the opening of Pandora's box may entail. This balance is not easy to achieve as opportunities and risks emerge in a cloud of uncertainty and ambiguity. The dual nature of risk as a potential for technological progress and as a threat to nature and society demands a dual strategy for risk governance. Dealing with uncertain and ambiguous risks requires more than technical expertise and excellent decision–analytic skills. Good risk governance rests upon a combination of best available interdisciplinary knowledge, including the awareness of its limitations and uncertainties, and a careful synthesis of public concerns, values and visions. It will be one of the most challenging tasks for all actors involved in risk governance to invest in more effective, efficient and reliable risk assessment, evaluation and management procedures while, at the same time, facilitate the path towards new innovations and improved living conditions. The late Aaron Wildavsky paraphrased this problem by giving one of his seminal articles the provocative title 'No risk is the highest risk of all' (Wildavsky, 1990). The second highest risk, however, is poor and inadequate risk governance. I hope that the thoughts and approaches described in this book can assist all actors involved in risk governance to create innovative ideas, to generate improved knowledge and to develop adequate strategies, instruments and tools that promise a more balanced and humane transition towards a sustainable future.

Glossary

Acceptability: risks are deemed to be acceptable if they are insignificant and adequately controlled. There is no pressure to reduce acceptable risks further unless cost-effective measures become available. In many ways, acceptable risks are equivalent to those everyday risks that people accept in their lives and take little action to avoid (see also **intolerable risks** and **tolerability**).

Agent: in the context of risk, a substance, energy, human activity or psychological belief that can cause harm.

ALARA: as low as reasonably achievable.

ALARP: as low as reasonably practicable. Note: there is little or no difference, in practice, between ALARA and ALARP. 'Reasonably practicable' is defined in some countries through case law, which says that a reduction in risk is 'reasonably practicable' unless the improvement achieved is grossly disproportionate to the cost of achieving that improvement.

Ambiguity: giving rise to several meaningful and legitimate interpretations of accepted risk assessments results. See also **interpretative ambiguity** and **normative ambiguity** ('ambiguity' is one of three major challenges confronting risk assessment; the others are 'complexity' and 'uncertainty').

Buffer capacity: capacity of a system to withstand a risk event (e.g. the failure of a component) through the incorporation of additional protective measures.

Complexity: refers to the difficulty of identifying and quantifying causal links between a multitude of potential causal agents and specific observed effects ('complexity' is one of three major challenges confronting risk assessment; the others are 'uncertainty' and 'ambiguity').

Coping capacity: building measures into systems, society or organizations to reduce the impact of a risk if it occurs – for example, measures to improve the ability of a building to resist earthquakes (see also **resilience**).

Design discourse: a form of deliberation for defining and specifying the most appropriate route for assessing and managing a given risk.

Dose–response relationship: the relationship between the amount of exposure (dose) to a substance (or other hazard) and the resulting changes in health or body function (note: usually applied to human beings, but can be applied more widely in the environment).

Early warning: institutional arrangement for (systematically) looking for indicators of potentially damaging events or their precursors.

Epistemic/epistemological: concerning the nature, origin and scope of knowledge. An 'epistemic discourse' is defined as the scope and quality (validity, reliability and relevance) of the information available and is aimed at finding the best estimates for characterizing risk.

Exposure: contact of a risk target (humans or ecosystems) with a hazard.

Flexibility: one of the skills essential to tackling modern risk situations; the ability to look for new ways of making sense of a dynamic situation – if necessary, to fight against traditional practices and institutional inertia, and to find novel solutions.

Framing: the initial analysis of a risk problem, examining the major actors (e.g. governments, companies, the scientific community and the general public) and what types of problems they label as risk problems. This defines the scope of subsequent work.

Governance: at the national level, the structure and processes for collective decision-making involving governmental and non-governmental actors. At the global level, governance embodies a horizontally organized structure of functional self-regulation encompassing state and non-state actors who bring about collectively binding decisions without superior authority.

Hazard: a source of potential harm or a situation with the potential to cause loss (Australian/ New Zealand risk management standard).

Horizontal governance: this involves all the relevant actors, including government, industry, NGOs and social groups in decision-making processes with a defined geographical or functional segment, such as a community or region.

Indeterminacy: see **stochastic effects**.

Instrumental (discourse): used in the case of 'linear risks'. It is aimed at finding the most cost-effective measures to make the risk acceptable or at least tolerable.

Interpretative ambiguity: different interpretations of an identical assessment result (e.g. as an adverse or non-adverse effect).

Intolerable risks (alternatively **unacceptable risks**)**:** a risk that society deems unacceptable, regardless of the benefits that may arise from the activity that causes the risk.

Justification: the case for undertaking an activity that carries an element of risk – in effect, some kind of risk–benefit analysis that demonstrates the case for the activity.

Latency: concealed or dormant risks; latency refers to those risks where the harm emerges a considerable time after exposure (e.g. to radiation).

Normative ambiguity: different concepts of criteria or yardsticks that help to determine what can be regarded as tolerable, referring, for example, to ethics, quality-of-life parameters, risk–benefit balance, distribution of risks and benefits, etc.

Organizational capacity: the ability of organizations and individuals within organizations to fulfil their role in the risk governance process.

Participative (decision-making/discourse): open to public input; possibly including new forms of deliberation. Examples of participative discourse include citizens' juries, consensus conferences, etc.

Probabilistic risk assessment (PRA): methods for calculating probability–loss functions based on statistical, experimental and/or theoretically derived data (such as event trees or fault trees). PRA is often used in the context of engineered systems.

Reflective (discourse): collective reflection on the course of action to be taken (e.g. balancing possibilities of overprotection and underprotection in the case of large remaining uncertainties about probabilities and/or magnitude of damage). Examples of reflective discourse include roundtables, open space forums and negotiated rule-making.

Resilience: a protective strategy to provide the whole system with defences against the impact of an unknown or highly uncertain risk. Instruments of resilience include strengthening the immune system, designing systems with flexible response options, improving emergency management, etc.

Risk: an uncertain consequence of an event or an activity with regard to something that humans value (definition originally in Kates et al, 1985, p21). Such consequences can be positive or negative, depending upon the values that people associate with them.

Risk analysis: some organizations – for example, Codex Alimentarius – use risk analysis as a collective term to cover risk assessment, risk management and risk communication.

Risk appraisal: the process of gathering all knowledge elements necessary for risk characterization, evaluation and management. This includes not only the results of (scientific) risk assessment, but also information about risk perceptions and the economic and social implications of the consequences of risk.

Risk assessment: the task of identifying and exploring, preferably in quantified terms, the types, intensities and likelihood of the (normally undesired) consequences related to a risk. Risk assessment comprises hazard identification and estimation, exposure, and vulnerability assessment and risk estimation.

Risk characterization: the process of determining the evidence-based elements necessary for making judgements on the tolerability or acceptability of a risk (see also **risk evaluation**).

Risk estimation: the third component of risk assessment, following hazard identification and estimation, and exposure/vulnerability assessment. This can be quantitative (e.g. a probability distribution of adverse effects) or qualitative (e.g. a scenario construction).

Risk evaluation: the process of determining the value-based components of making a judgement on risk. This includes risk–benefit balancing or incorporating quality-of-life implications and may also involve looking at such issues as the potential for social mobilization or at pre-risk issues, such as choice of technology and the social need of a particular operation giving rise to the risk (see **justification**).

Risk governance: includes the totality of actors, rules, conventions, processes and mechanisms concerned with how relevant risk information is collected, analysed and communicated, and how management decisions are taken. Encompassing the combined risk-relevant decisions and actions of both governmental and private actors, risk governance is of particular importance in (but not restricted to) situations where there is no single authority to take a binding risk management decision, but where, instead, the nature of the risk requires cooperation and coordination between a range of different stakeholders. Risk governance, however, not only includes a multifaceted, multi-actor risk process, but also calls for the consideration of contextual factors, such as institutional arrangements (e.g. the regulatory and legal framework that determines the relationship, roles and responsibilities of the actors, and coordination mechanisms such as markets, incentives or self-imposed norms) and political culture, including different perceptions of risk.

Risk management: the creation and evaluation of options for initiating or changing human activities or (natural and artificial) structures with the objective of increasing the net benefit to human society and preventing harm to humans and what they value, as well as the implementation of chosen options and the monitoring of their effectiveness.

Risk mitigation: measures to reduce the impact of a realized risk – for example, design features in a chemical plant to direct any explosive failure in a particular direction away from sensitive parts of the plant.

Risk perception: the outcome of the processing, assimilation and evaluation of personal experiences or information about risk by individuals or groups in society.

Risk prevention: measures to stop a risk from occurring. This often means stopping the activity that gives rise to the risk. Nevertheless, because of the need for substitution, this can often give rise to other risks in the substituted activity.

Risk reduction: measures to reduce the level of risk – for example, by reducing the likelihood of the risk being realized or reducing the impact of the risk.

Risk screening: the process of sifting and selecting information about risk in order to allocate the risk to a particular category or to a particular control regime; the process must be done in a manner that avoids unnecessary compartmentalization of a risk.

Risk trade-offs (or risk–risk trade-offs): the phenomenon that interventions aimed at reducing one risk can increase other risks, or shift risk to a new population.

Risk transfer: passing on some or all of the consequences of a risk to a third party. In some cases, this may be part of legitimate risk management (e.g. to an insurance company); in other cases – for example, where those benefiting from the risk-generating activity are not those who suffer from the risk (e.g. those suffering pollution downstream from a chemical plant) – risk governance needs to ensure that such transfers are dealt with fully and equitably.

Robustness: this primarily concerns the insensitivity (or resistance) of parts of systems to small changes within well-defined ranges of the risk consequences (contrast with **resilience**, which concerns whole systems).

Semantic risk patterns: classes of risk that reflect certain perceptive or psychological approaches to risk. For example, one such class concerns risks posing an immediate threat, such as nuclear energy; another concerns activities where an individual's perception of their vulnerability is underestimated because they believe they are 'in charge' (e.g. when driving a car).

Social amplification of risk: an overestimation or underestimation of the seriousness of a risk caused by public concern about the risk or an activity contributing to the risk.

Social mobilization: social opposition or protest that feeds into collective actions (such as voting behaviour, demonstration or other forms of public protest).

Stakeholder: socially organized groups who are, or will be, affected by the outcome of the event or the activity from which the risk originates and/or by the risk management options taken to counter the risk.

Stochastic effects: effects due to random events.

Systemic risk: systemic risks are at a crossroads between natural events (partially altered and amplified by human action, such as the emission of greenhouse gases), economic, social and technological developments, and policy-driven actions, all at the domestic and the international levels.

Taxonomy: a structure for classifying risks and methods of dealing with risks.

Tolerability: an activity that is seen as worth pursuing (for the benefit that it carries), yet requires additional efforts for risk reduction within reasonable limits (see also **acceptability** and **intolerable risks/unacceptable risks**).

Ubiquity: risk whose impacts are widespread, usually geographically.

Unacceptable risks: see **intolerable risks**.

Uncertainty: a state of knowledge in which (although the factors influencing the issues are identified) the likelihood of any adverse effect, or the effects themselves, cannot be precisely described. Note: this is different from ignorance about the effects or their likelihood. 'Uncertainty' is one of three major challenges confronting risk assessment; the others are 'complexity' and 'ambiguity'.

Vertical governance: this concerns the links between the various segments that may have an interest in an issue (e.g. between local, regional and state levels). **Horizontal governance** concerns the links within those segments.

Vulnerability: the extent to which the target can experience harm or damage as a result of exposure (e.g. immune system of target population, vulnerable groups, structural deficiencies in buildings, etc.).

Notes

1 What Is Risk?

1 This chapter is based on IRGC (2005, pp20ff) with some additions from Renn and Walker (2008, pp338ff).

2 For a philosophical review of the two 'risk camps' see Shrader-Frechette (1991); Bradbury (1989); Clarke and Short (1993, pp379–382); Burningham and Cooper (1999); Horlick-Jones and Sime (2004); Horlick-Jones (2007).

3 I am indebted to Gene Rosa for giving me guidance on keeping a healthy balance between a relativist and realist version of risk in dealing with this difficult conceptual issue. For further reading, refer to Rosa (1998) and Rosa (2008).

4 It is important to distinguish between hazards and risks (Breakwell, 2007, pp12ff). *Hazards* describe the potential for harm or other consequences of interest. These potentials may never even materialize if, for example, people are not exposed to the hazards or if the targets are made resilient against the hazardous effect (such as immunization). In conceptual terms, hazards characterize the *inherent properties of the risk agent and related processes*, whereas risks describe the *potential effects that these hazards are likely to cause to specific targets*, such as buildings, ecosystems or human organisms and their related probabilities.

5 Reviews of the implications of a constructivist versus a realist concept of risk can be found in Bradbury (1989); Renn (1992b); Horlick-Jones (2007). A pronounced constructivist approach can be found in Hilgartner (1992); Wynne (1992b); Luhmann (1993a); Hannigan (1995); Jasanoff (2004). Realist perspectives in the social sciences on risk and environment can be found in Catton and Dunlap (1978); Dunlap (1980); Mayo and Hollander (1991); Dunlap et al (1994); Rosa (1998); Hacking (1999); Campbell and Currie (2006), Rosa (2008).

6 According to Rhodes (1996), there are six separate uses of the term governance: as a minimal state; as corporate governance; as new public management; as good governance; as social-cybernetic systems; and as self-organized networks.

7 The following insights were partially taken from the result of a large European project called Safe Food, in which the basic elements of the IRGC framework were adapted and transferred to the area of food safety. For more information, see Dreyer et al (2007).

8 This essay uses text from Renn (1992b, 1997a, 2008). In addition, several paragraphs on Giddens and Beck were adapted from a recent manuscript by Rosa et al (in press).

2 Pre-assessment

1 The text for this chapter was primarily taken from IRGC (2005, pp23ff).
2 This essay is based on Renn (1997a).
3 Public attitude and risk perception studies before 1986 are summarized in Covello (1983); Slovic (1987); Gould et al (1988); Lee (1998).
4 The German originals are Beck, U. (1986) *Die Risikogesellschaft. Auf dem Weg in eine andere Moderne*, Suhrkamp, Frankfurt/Main; Luhmann, N. (1986) *Ökologische Kommunikation*, Westdeutscher Verlag, Opladen; Luhmann, N. (1989) *Soziologie des Risikos*, De Gruyter, Berlin. The English translations are Beck, U. (1992); Luhmann (1989) and Luhmann (1993a).
5 This line of argument was further pursued by representatives of the sociology of knowledge and the Science Technology and Society movement in the US and Europe. Among their most prominent representatives are S. Jasonoff, B. Wynne, B. Latour and K. P. Japp. A review of this line of thinking can be found in Shrader-Frechette (1995) and Laudan (1996).
6 The proposition of large accidents as normal occurrences of modern technologies was taken from Charles Perrow's (1984) analysis of normal accidents.
7 Early sociological surveys had suggested such a large variance within the public, but this was hardly acknowledged by risk management agencies. See, for example, Renn (1981) or Gould et al (1988). Later studies place more emphasis on the variability of public perceptions. See Dake (1991) and Drottz-Sjöberg (1991, pp163ff).

3 Appraisal

1 This chapter is a modified version of the corresponding chapter in IRGC (2005, pp26ff) and has included some paragraphs from Renn and Walker (2008, pp350ff).
2 The US Nuclear Regulatory Commission (2004) defines vulnerability as 'The condition determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards.'
3 Paté-Cornell (1996) notes that some analysts also refer to this as ambiguity; but we have reserved a different meaning for this term, as discussed in note 6.
4 Since the document was only released in late 2004, reports about practical experiences regarding its implementation are not yet available.
5 A similar decomposition has been proposed by the UK government (Environment Agency, 1998; Pollard et al, 2000).
6 With respect to risk and decision-making, the term ambiguity has been used with various meanings. Some analysts refer to ambiguity as the conflicting goals of participants in the process (Skinner, 1999); others use the term ambiguity when they refer to the inability to estimate the probability of an event occurring (Gosh and Ray, 1997; Ho et al, 2002; Stirling, 2003). In the context of the current framework, ambiguity denotes the variability in interpretation and normative implications with respect to accepted evidence.
7 This essay includes material from Stirling et al, (2006); Renn (2007a); and Elliott and Renn (in press).

4 Risk Perception

1 This introductory text was basically taken from IRGC (2005, pp31ff).
2 The 'drawers' cannot be treated in detail here since this would exceed the scope of this chapter (more information is provided in Streffer et al (2003, pp269ff) and in Essay 4 on risk perception).
3 This essay has adapted paragraphs from Renn (1990); Renn (1997a); Rohrmann and Renn (2000); Jaeger et al (2001); Renn (2004a); and Benighaus and Renn (2007).
4 For a comprehensive review and documentation of this body of research, see overviews provided by Covello (1983); Renn (1990, 2004a); Pidgeon et al (1992); Jungermann and Slovic (1993); Boholm (1998); Rohrmann and Renn (2000). Methodological issues are discussed in Slovic (1992); Rohrmann (1995, 1999).
5 The cultural theory of risk has also been briefly characterized in Essay 2 and will be picked up again when talking about risk communication in Essay 7.

5 Risk Evaluation

1 This text is taken from IRGC (2005, pp36ff), with an added paragraph from Renn and Walker (2008, pp352ff).
2 The traffic light model in this context is an illustrative means of mapping risks according to their tolerability or acceptability. The same metaphor has also been used to map the degree of controversy or normative ambiguity – for example, in the area of siting mobile phone base stations (Kemp, 1998; Kemp and Greulich 2004). The criticism that has been raised against using the traffic light model for addressing opposition to base stations is not relevant to the application of this model in the context of risk characterization and evaluation.
3 This essay is partially adapted from Klinke and Renn (1999, 2002).
4 Figure 5.3 uses the traffic light diagram for classifying risks into three categories: acceptable (green, or light grey in our black and white representation), tolerable (amber/dark grey) and intolerable (red/black). It is the main task of risk evaluation to locate each risk in one of the three arenas (see HSE, 2001; see also Chapter 3).
5 The following descriptions of the six risk classes are taken from Klinke and Renn (2002).
6 The German Advisory Council on Global Change (WBGU) conducted a workshop with external experts to classify 52 risks according to the six risk classes. The examples mentioned here reflect some of the results. Agreement was reached for 41 risks; conflicting views remained on 11 risks. Among them were the risks associated with the medical application of genetic engineering; some well-tested GMOs for food production, obesity and other nutritional risks; social risks such as poverty; and flooding as one of the natural hazards (WBGU, 2000).

6 Risk Management

1 This chapter is a revised version of the original chapter on risk management from IRGC (2005, pp40ff).
2 The terms robustness and resilience have different meanings in different contexts. In most of the *natural hazard literature*, robustness is one of the main components of resilience. In

much of the *cybernetic literature*, however, robustness refers to the insensitivity of numerical results to small changes, while resilience characterizes the insensitivity of the entire system towards surprises. Our suggestion for distinguishing between the two comes close to the cybernetic use of the terms.

3 The link between precaution and irreversibility was also mentioned in the report on risk management by the UK Treasury Department (2004).

4 A more formal treatment of this problem from the perspective of game theory has been published in Kunreuther and Heal (2003).

5 This essay includes material from Renn et al (2003) and Klinke and Renn (2002).

7 Risk Communication

1 This chapter is taken from IRGC (2005, pp54ff).

2 This essay includes material from Renn (1992a, 1998), OECD (2002) and Renn and Levine (1991).

3 According to a new poll conducted by the Yale Center of Environmental Law and Policy's Environmental Attitudes and Behavior Project, 83 per cent of Americans now say global warming is a 'serious' problem, compared to only 70 per cent in 2004. More Americans than ever say they have serious concerns about environmental threats, such as toxic soil and water (92 per cent, up from 85 per cent in 2004), deforestation (89 per cent, up from 78 per cent), air pollution (93 per cent, up from 87 per cent) and the extinction of wildlife (83 per cent, up from 72 per cent in 2005). Most dramatically, the survey of 1000 adults nationwide shows that 63 per cent of Americans agree that the US 'is in as much danger from environmental hazards, such as air pollution and global warming, as it is from terrorists' (http://research.yale.edu/envirocenter/index.php?page=yale-environmental-poll).

4 Essay 8 takes the normative advice aspect even further and elaborates upon a structured scheme of guidance for risk communicators.

5 The influence of trust and credibility on risk perception is covered in Essay 4 on risk perception. Several paragraphs of this essay have been repeated here to provide an overview.

6 This essay includes material from Renn (1992a) and OECD (2002).

8 Risk Participation

1 This chapter is a revised version of IRGC (2005, pp49ff), with additions from Renn and Walker (2008, pp356ff).

2 The labels for the different discourse types suggested below were first introduced by Renn (1999c).

3 For a more detailed analysis of participatory methods for reaching consensus, refer to Essay 9 in this volume (see also Barber, 1984; Webler, 1999; or Renn, 2004b).

4 This review is based on Renn (1992a, 2004b).

5 See reviews in Nelkin and Pollak (1979, 1980); Brooks (1984); Brickman et al (1985); O'Riordan and Wynne (1987); Thomas (1990); Pinkau and Renn (1998); Perry 6 (2000). There is also ample literature on specific approaches to risk regulation, such as muddling through (Lindbloom, 1959, 1965); scientific advisory boards (Dietz and Rycroft, 1987; Wynne, 1992a; Renn, 1995; Harter et al, 1998; Heyvaert, 1999); mediation and negotiated

rule-making (Susskind et al, 1983; Bingham, 1984; Folberg and Taylor, 1984); participatory approaches (Renn et al, 1995; Steelman and Ascher, 1997; Creighton et al, 1998; Yosie and Herbst, 1998a; Rowe and Frewer, 2000; Abels, 2007).

6 This analysis of societal functions and systems is based on the functional school of sociology and political sciences. Early representatives of this school who are relevant for arguments presented here are Parsons, Shils, Easton and Lowi (Parsons and Shils, 1951; Parsons, 1951, 1963, 1967, 1971; Easton, 1965; Lowi, 1964). This school of thought has been heavily criticized for its stationary and equilibrium-based assumptions (see Coser, 1956). Modern functionalists have responded to this criticism by adding a dynamic and change-inducing component to the theoretical framework (Alexander, 1985; Alexander and Colomy, 1990). The approach in this essay has been inspired by the (neo)functional school of Bielefeld in Germany (Luhmann, 1982a; 1984, 1990, 1993a; Münch, 1982, 1996; Willke, 1995). A similar approach for participatory technology assessment was pursued in Joss (2005).

7 For our purpose, we can work with the definition of civil society put forward by J. Alexander: civil society is defined as 'the realm of interaction, institutions and solidarity that sustains public life of societies outside the worlds of economy and state' (Alexander, 1993, p797).

8 In economic theory, the transaction is justified if the sum of the compensation is lower than the surplus that the parties could gain as a result of the planned transaction. However, the compensation does not need to be paid to the third party.

9 See overviews in Burke (1968); Nelkin (1977); Checkoway and van Til (1978); Guild (1979); Nelkin and Pollak (1979); Langton (1981); Daneke et al (1983); Bingham (1984); Brickman et al (1985); Jasanoff (1986); Vogel (1986); Ethridge (1987a); Maguire and Boiney (1994); Renn et al (1995); Applegate (1998); Creighton et al (1998); Harter et al (1998); Rowe and Frewer (2000).

10 Within the tradition of the sociology of science, the interplay between experts and policy-makers has been a popular topic of scholarly work (Primack and von Hippel, 1974; Nelkin, 1977; Knorr-Cetina, 1981; Jasanoff, 1982, 1991; Coppock, 1985; Rip, 1985, 1992; Majone, 1989; Funtowicz and Ravetz, 1990; Shrader-Frechette, 1991; van den Daele, 1992; von Schomberg, 1992; De Marchi and Ravetz, 1999; Weingart, 1999; Nowotny et al, 2001; Jasanoff, 2004). Within the tradition of political science and institutional analysis, the focus has been on new governance processes focusing on the role of stakeholders and organized groups in the risk arena (Kitschelt, 1980, 1986; Olson, 1984; Hillgartner and Bosk, 1988; Eder, 1992; Renn, 1992c; Rose and Miller, 1992; Dahl, 1994; Münch, 1996; Sutter, 2004). Analysts of public participation and involvement have investigated the different approaches of risk managers to have representatives of organized and non-organized interests in society participate in decision-making (Guild, 1979; Kweit and Kweit, 1981, 1987; Fiorino, 1990; Laird, 1993; Renn et al, 1995; Creighton et al, 1998).

11 Reviews of the implications of a constructivist versus realist concept of risk can be found in Bradbury (1989); Shrader-Frechette (1991); Clarke and Short (1993); Burningham and Cooper (1999); Horlick-Jones (2007). A pronounced constructivist approach to risk management can be found in Rayner (1987, 1990); Hillgartner (1992); Luhmann (1993a); Adams (1995); Hannigan (1995); Japp (1996). Realist perspectives in the social sciences on risk and environment can be found in Catton (1980); Dunlap (1980); Rosa (1998); Hacking (1999). Several analysts place themselves in between the two poles – for example, Shrader-Frechette (1991) and Horlick-Jones (2007).

12 There is no agreement in the literature on how to classify concepts of participation. More recent attempts emphasize the two dimensions of participants' selection and intensity of decision-making (ranging from gathering options to co-determination of decisions), yet they lack a clear theoretical foundation (Sherington, 1997; Rowe and Frewer, 2000; Beierle and Cayford, 2002; Bora and Hausendorf, 2006; Hagendijk and Irwin, 2006; Abels, 2007).

13 The social systems school of sociology pursues a similar approach to deliberation (Luhmann, 1989, 1990, 1993b; Markowitz, 1990; Eder, 1992; Japp, 1996). It is based on the assumption that each stakeholder group has a separate reservoir of knowledge claims, values and interpretative frames. Each group-specific reservoir is incompatible with the reservoir of the other groups. Therefore, there is no realistic possibility of reaching consensus; the best one can strive for is a mutually acceptable agreement. This line of argument is also shared by the so-called cultural theory group, who claim that the main four prototypical cultures (see Chapter 4 in this volume) in society cannot overcome their communication barriers (Rayner, 1990; Thompson et al, 1990; Dake, 1991; Adams, 1995).

14 Factual claims refer to statements about reality (descriptive and analytical); expressive claims to promises, emotional statements and appeals (e.g. an operator of a plant promises that she or he will control emissions with special care and diligence); normative claims to evaluative statements ('I prefer naturally grown over conventional food') and moral statements ('A risk of higher than 1:10,000 is not acceptable'). This categorization has been developed by Habermas and used in deliberative settings (Habermas, 1970a, 1987b; Webler 1995).

15 Cary Coglianese mentions six potential 'pathologies' of participation (Coglianese, undated, p22):

1 tractability having priority over public importance;
2 regulatory imprecision;
3 the lowest common denominator problem;
4 increased time and expense;
5 unrealistic expectations;
6 new sources of conflict.

They can be easily grouped in the three categories.

16 The biases and fallacies of laypersons in making risk judgements is discussed in Chapter 4.

17 In a volume edited by Rosenberg (2007), seven empirical evaluations of deliberative participatory processes are juxtaposed with philosophical reflections about the outcomes. One of the results was that strategic manoeuvring could not be avoided in these cases, but could be controlled. Another review by Hagendijk and Irwin (2006) of science-based participation efforts concluded that the empirical evidence of success or failure was too fragmented to allow for a final verdict. Similar to what I have done here, they also suggested distinguishing between different concepts and philosophies of public participation. Beierle and Cayford (2002) could show, however, that a consensus orientation (intensity) of the participatory process correlated strongly with the quality of the outcome. Yet, this does not prove that in such setting biases can be overcome.

18 Authors who favour more direct democracy accept the overall framework of political representation, but would like to either limit the influence of the representational bodies or to enrich their decision-making routines by adding elements of direct democracy (see, in this line of reasoning, Bachrach, 1967; Barber, 1984; Dryzek, 1994; Sclove, 1995).

19 The following text on the potential use of decision analytic tools for deliberative processes is partially based on an unpublished paper by W. North and O. Renn prepared for the Panel on Public Participation in Environmental Assessment and Decision Making of the US National Academy of Sciences (North and Renn, 2005).

20 In several practical applications, we have asked experts in a group Delphi to make a distinction between *certain, probable, possible, unknown and absurd* when judging systematic knowledge claims. This simple classification has been quite successful in catalysing the debate among laypersons involved in a deliberative setting.

21 Subjective satisfaction is certainly an important, but insufficient, criterion for evaluating success or failure of deliberations (Rohrmann, 1992; Webler, 1995; Linder and Vatter, 1996). People will tend to rate processes positively if they are heavily invested in them – emotionally or just by sacrificing their time. In addition, many processes are able to convey a good feeling, but may lead to a very unsatisfactory outcome, and vice versa. There is obviously a need for objective indicators of evaluation which relate to the product and the process independently of the subjective interpretation of the persons involved (Wondolleck, 1985).

22 A procedural model of how to implement such an analytic–deliberative process is described in more detail in Essay 10.

23 This essay is based on Renn (1999a, 2006b).

24 Stakeholders in this essay are defined as socially organized groups who are or perceive themselves as being affected by the decision.

25 In this essay we distinguish between three levels of organizing public participation processes:

1 Concepts describe the basic philosophy and purpose of a participatory process, such as a functional or neo-classical approach (see Essay 9).
2 Instruments describe the procedures or models that are used within a specific concept (i.e. mediation, citizen juries and expert Delphi).
3 Tools refer to specific techniques that moderators or facilitators can use to complete tasks such as the value tree technique or the morphological method (see also Maguire and Boiney, 1994). The emphasis of this essay is on instruments and their combination.

26 Reviews of the pros and cons of each suggested procedure or instrument can be found in the literature. See Pollak (1985); Fiorino (1990); Renn et al (1995); Sherington (1997); Steelman and Ascher (1997); Chess et al (1998); Creighton et al (1998); Rowe and Frewer (2000); Delli Caprini et al (2004).

9 THE SOCIAL AND POLITICAL CONTEXT OF RISK GOVERNANCE

1 This chapter has been adapted from IRGC (2005, pp57ff) and includes paragraphs from Bunting et al (2007, pp13ff) and Renn (2001).

10 Conclusions

1 This chapter includes paragraphs from IRGC (2005, pp64ff) and from Renn and Walker (2008, pp361ff).

2 See NRC (1996); Codex Alimentarius Commission (2005); European Commission, 2002.

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