Chapter 5
Risk and Responsibility

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Abstract When a risk materializes, it is common to ask the question: who is responsible for the risk being taken? Despite this intimate connection between risk and responsibility, remarkably little has been written on the exact relation between the notions of risk and responsibility. This contribution sets out to explore the relation between risk and responsibility on basis of the somewhat dispersed literature on the topic and it sketches directions for future research. It deals with three more specific topics. First we explore the conceptual connections between risk and responsibility by discussing different conceptions of risk and responsibility and their relationships. Second, we discuss responsibility for risk, paying attention to four more specific activities with respect to risks: risk reduction, risk assessment, risk management, and risk communication. Finally, we explore the problem of many hands (PMH), that is, the problem of attributing responsibility when large numbers of people are involved in an activity. We argue that the PMH has especially become prominent today due to the increased collective nature of actions and due to the fact that our actions often do not involve direct harm but rather risks, that is, the possibility of harm. We illustrate the PMH for climate change and discuss three possible ways of dealing with it: (1) responsibility-as-virtue, (2) a procedure for distributing responsibility, and (3) institutional design.

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Introduction

Risk and responsibility are central notions in today's society. When the Deepwater Horizon oil rig exploded in April 2010 killing 11 people and causing a major oil spill in the Gulf of Mexico, questions were asked whether no unacceptable risks had been taken and who was responsible. The popular image in cases like this appears to be that if such severe consequences occur, someone must have, deliberately or not, taken an unacceptable risk and for that reason that person is also responsible for the outcome. One reason why the materialization of risks immediately raises questions about responsibility is our increased control over the environment. Even in cases of what are called natural risks, that is, risks with primarily natural rather than human causes, questions about responsibility seem often appropriate nowadays. When an earthquake strikes a densely populated area and kills thousands of people, it may be improper to hold someone responsible for the mere fact that the earthquake occurred, but it might well be appropriate to hold certain people responsible for the fact that no proper warning system for earthquakes was in place or for the fact that the buildings were not or insufficiently earthquake resistant. In as far as both factors mentioned contributed to the magnitude of the disaster, it might even be appropriate to hold certain people responsible for the fatalities.

The earthquake example shows that the idea that it is by definition impossible to attribute responsibility for natural risks and that such risks are morally less unacceptable is increasingly hard to maintain, especially due to technological developments. This may be considered a positive development in as far it has enabled mankind to drastically reduce the number of fatalities, and other negative consequences, as a result of natural risks. At the same time, technological development and the increasing complexity of society have introduced new risks; the Deepwater Horizon oil rig is just one example. Especially in the industrialized countries, these new risks now seem to be a greater worry than the traditional so-called natural risks. Although these new risks are clearly man-made, they are in practice not always easy to control. It is also often quite difficult to attribute responsibility for them due to the larger number of people involved; this is sometimes referred to as the "problem of many hands" (PMH), which we will describe and analyze in more detail in section Further Research: Organizing Responsibility for Risks. Before we do so, we will first discuss the relation between risk and responsibility on a more abstract, conceptual level by discussing different conceptions of risk and responsibility and their relation, in section Conceptions of Risk and Responsibility. Section Responsibility for Risks focuses on the responsibility for dealing with risk; it primarily focuses on so-called forward-looking moral responsibility and on technological risks.

While risk and responsibility are central notions in today's society and a lot has been written about both, remarkably few authors have explicitly discussed the relation between the two. Moreover, the available literature is somewhat dispersed over various disciplines, like philosophy, sociology, and psychology. As a

consequence, it is impossible to make a neat distinction between the established state of the art and future research in this contribution. Rather the contribution as a whole has a somewhat explorative character. Nevertheless, sections Conceptions of Risk and Responsibility and Responsibility for Risks mainly discuss the existing literature, although they make some connections that cannot be found in the current literature. Section Further Research: Organizing Responsibility for Risks explores the so-called problem of many hands and the need to organize responsibility, which is rather recent and requires future research, although some work has already been done and possible directions for future research can be indicated.

Conceptions of Risk and Responsibility

Both risk and responsibility are complex concepts that are used in a multiplicity of meanings or conceptions as we will call them. Moreover, as we will see below, while some of these conceptions are merely descriptive, others are clearly normative. Before we delve deeper into the relation between risk and responsibility, it is therefore useful to be more precise about both concepts. We will do so by first discussing different conceptions of risk (section Conceptions of Risk) and of responsibility (section Conceptions of Responsibility). We use the term "conception" here to refer to the specific way a certain concept like risk or responsibility is understood. The idea is that while different authors, approaches, or theories may roughly refer to the same concept, the way they understand the concept and the conceptual relations they construe with other concepts is different. After discussing some of the conceptions of risk and responsibility, section Conceptual Relations Between Risk and Responsibility discusses conceptual relations between risk and responsibility.

Conceptions of Risk

The concept of risk is used in different ways (see "The Concepts of Risk and Safety"). Hansson (2009, pp. 1069–1071), for example, mentions the following conceptions:

1. Risk = an *unwanted event* that may or may not occur
2. Risk = the *cause* of an unwanted event that may or may not occur
3. Risk = the *probability* of an unwanted event that may or may not occur
4. Risk = the statistical expectation value of an unwanted event that may or may not occur
5. Risk = the fact that a decision is made under conditions of *known probabilities* ("decision under risk")

The fourth conception has by now become the most common technical conception of risk and this conception is used usually in engineering and in risk assessment. The fifth conception is common in decision theory. In this field, it is common to distinguish decisions under risk from decisions under certainty and decisions under uncertainty. Certainty refers to the situation in which the outcomes (or consequences) of possible actions are certain. Risk refers to the situation in which possible outcomes are known and the probabilities (between 0 and 1) of occurrence of these outcomes are known. Uncertainty refers to situations in which possible outcomes are known but no probabilities can be attached to these outcomes. A situation in which even possible outcomes are unknown may be referred to as ignorance.

The fifth, decision-theoretical conception of risk is congruent with the fourth conception in the sense that both require knowledge of possible outcomes and of the probability of such outcomes to speak meaningfully about a risk. One difference is that whereas the fifth conception does not distinguish between wanted and unwanted outcomes, the fourth explicitly refers to unwanted outcomes. Both the fourth and the fifth conception are different from the way the term "risk" is often used in daily language. In daily language, we commonly refer to an undesirable event as a risk, even if the probability is unknown or the exact consequences are unknown. One way to deal with this ambiguity is to distinguish between hazards (or dangers) and risks. Hazard refers to the mere possibility of an unwanted event (conception 1 above), without necessarily knowing either the consequences or the probability of such an unwanted event. Risk may then be seen as a specification of the notion of hazard. The most common definition of risk in engineering and risk assessment, and more generally in techno-scientific contexts, is that of statistical expectation value, or the product of the consequences of an unwanted event and the probability of the unwanted event occurring (meaning 4 above). But even in techno-scientific contexts other definitions of risk can be found. The International Program on Chemical Safety, for example, in an attempt to harmonize the different meanings of terms used in risk assessment defines risk as: "The probability of an adverse effect in an organism, system, or (sub)population caused under specified circumstances by exposure to an agent" (International Program on Chemical Safety 2004, p. 13). This is closer to the third than the fourth conception mentioned by Hansson. Nevertheless, the International Program on Chemical Safety appears to see risk as a further specification of hazard, which they define as: "Inherent property of an agent or situation having the potential to cause adverse effects when an organism, system, or (sub)population is exposed to that agent" (International Program on Chemical Safety 2004, p. 12).

Conceptions of risk cannot only be found in techno-scientific contexts and in decision theory, but also in social science, in literature on risk perception (psychology), and more recently in moral theory (for a discussion of different conceptions of risk in different academic fields, see (Bradbury 1989; Thompson and Dean 1996; Renn 1992; Shrader-Frechette 1991a). We will below discuss some of the main conceptions of risk found in these bodies of literature. The technical conception of risk assumes, at least implicitly, that the only relevant

aspects of risk are the magnitude of certain unwanted consequences and the probability of these consequences occurring. The conception nevertheless contains a normative element because it refers to *unwanted* consequences (or events). However, apart from this normative element, the conception is meant to be descriptive rather than normative. Moreover, it is intended to be context free, in the sense that it assumes that the only relevant information about a risky activity is the probability and magnitude of consequences (Thompson and Dean 1996). Typically, conceptions of risk in psychology, social science, and moral theory are more contextual. They may refer to such contextual information as by whom the risk is run, whether the risk is imposed or voluntary, whether it is a natural or man-made risk, and so on. What contextual elements are included, and the reason for which contextual elements are included is, however, different for different contextual conceptions of risk.

The psychological literature on risk perception has established that lay people include contextual elements in how they perceive and understand risks (e.g., Slovic 2000). These include, for example, dread, familiarity, exposure, controllability, catastrophic potential, perceived benefits, time delay (future generations), and voluntariness. Sometimes the fact that lay people have a different notion of risk than experts, and therefore estimate the magnitude of risks differently, is seen as a sign of their irrationality. This interpretation assumes that the technical conception of risk is the right one and that lay people should be educated to comply with it. Several authors have, however, pointed out that the contextual elements included by lay people are relevant for the acceptability of risks and for risk management and that in that sense the public's conception of risk is "richer" and in a sense more adequate than that of scientific experts (e.g., Slovic 2000; Roeser 2006, 2007). In the literature on the ethics of risk it is now commonly accepted that the moral acceptability of risks depends on more concerns than just the probability and magnitude of possible negative consequences (see "Ethics and Risk"). Moral concerns that are often mentioned include voluntariness, the balance and distribution of benefits and risks (over different groups and over generations), and the availability of alternatives (Asveld and Roeser 2009; Shrader-Frechette 1991b; Hansson 2009; Harris et al. 2008; Van de Poel and Royakkers 2011).

In the social sciences, a rich variety of conceptions of risk have been proposed (Renn 1992). We will not try to discuss or classify all these conceptions, but will briefly outline two influential social theories of risk, that is, cultural theory (Douglas and Wildavsky 1982) and risk society (Beck 1992). Cultural theory conceives of risks as collective, cultural constructs (see "Cultural Cognition as a Conception of the Cultural Theory of Risk"). Douglas and Wildavsky (1982) distinguish three cultural biases that correspond to and are maintained by three types of social organization: hierarchical, market individualistic, and sectarian. They claim that each bias corresponds to a particular selection of dangers as risks. Danger here refers to what we above called a hazard: the (objective) possibility of something going wrong. According to Douglas and Wildavsky, dangers cannot be known directly. Instead they are culturally constructed as risks. Depending on the cultural bias, certain dangers are preeminently focused on. Hierarchists focus on

risks of human violence (war, terrorism, and crime), market individualists on risks of economic collapse, and sectarians on risks of technology (Douglas and Wildavsky 1982, pp. 187–188).

Like Douglas and Wildavsky, Ulrich Beck in his theory of risk society sees risk as a social construct. But whereas Douglas and Wildavsky focus on the cultural construction of risks and believe that various constructions may exist side by side, Beck places the social construction of risk in historical perspective. Beck defines risk as "a systematic way of dealing with hazards and insecurities induced and introduced by modernization itself" (Beck 1992, p. 21, emphasis in the original). Speaking in terms of risks, Beck claims, is historically a recent phenomenon and it is closely tied to the idea that risks depend on decisions (Beck 1992, p. 183). Typically for what Beck calls the "risk society" is that it has become impossible to attribute hazards to external causes. Rather, all hazards are seen as depending on human choice and, hence, are, according to Beck's definition of these notions, conceived as risks. Consequently, in risk society the central issue is the allocation of risk rather than the allocation of wealth as it was in industrial society.

Some authors have explicitly proposed to extend the technical conception of risk to include some of the mentioned contextual elements. We will briefly outline two examples. Rayner (1992) has proposed the following adaption to the conventional conception of risk:

$$R = (P \times M) + (T \times L \times C)$$

with

R Risk
P Probability of occurrence of the adverse event
M Magnitude of the adverse consequences
T Trustworthiness of the institutions regulating the technology
L Acceptability of the principle used to apportion liabilities for undesired consequences
C Acceptability of the procedure by which collective consent is obtained to those who must run the consequences

Although this conception has a number of technical difficulties, it brings to the fore some of the additional dimensions that are important not just for the perception or cultural construction of risks but also for their regulation and moral acceptability

More recently, Wolff (2006) has proposed to add cause as a primary variable in addition to probability and magnitude to the conception of risk. The rationale for this proposal is that cause is also relevant for the acceptability of risks. Not only may there be a difference between natural and man-made risks, but also different man-made risks may be different in acceptability depending on whether the human cause is based on culpable or non-culpable behavior and the type of culpable behavior (e.g., malice, recklessness, negligence, or incompetence). We might have

good moral reasons to consider risks based on malice (e.g., a terrorist attack) less acceptable than risks based on incompetence even when they are roughly the same in terms of probability and consequences. In addition to cause, Wolff proposes to add such factors as fear (dread), blame, and shame as secondary variables that might affect each of the primary variables. Like in the case of Rayner's conception, the technicalities of the new conception are somewhat unclear, but it is definitely an attempt to broaden the conception of risk to include contextual elements that are important for the (moral) acceptability of risks.

Rayner's and Wolff's proposals raise the question whether all factors which are relevant for decisions about acceptable risk or risk management should be included in a conceptualization of risk. Even if it is reasonable to include moral concerns in our decisions about risks, it may be doubted whether the best way to deal with such additional concerns is to build them into a (formal) conception of risk.

Conceptions of Responsibility

Like the notion of risk, the concept of responsibility can be conceptualized in different ways. One of the first authors to distinguish different conceptions of responsibility was Hart (1968, pp. 210–237) who mentions four main conceptions of responsibility: role responsibility, causal responsibility, liability responsibility, and capacity responsibility. Later authors have distinguished additional conceptions, and the following gives a good impression of the various conceptions that might be distinguished (Van de Poel 2011):

1. Responsibility-as-cause. As in: the earthquake caused the death of 100 people.
2. Responsibility-as-role. As in: the train driver is responsible for driving the train.
3. Responsibility-as-authority. As in: he is responsible for the project, meaning he is in charge of the project. This may also be called responsibility-as-office or responsibility-as-jurisdiction. It refers to a realm in which one has the authority to make decisions or is in charge and for which one can be held accountable.
4. Responsibility-as-capacity. As in: the ability to act in a responsible way. This includes, for example, the ability to reflect on the consequences of one's actions, to form intentions, to deliberately choose an action and act upon it.
5. Responsibility-as-virtue, as the disposition (character trait) to act responsibly. As in: he is a responsible person. (The difference between responsibility-as-capacity and responsibility-as-virtue is that whereas the former only refers to ability, the second refers to a disposition that is also surfacing in actions. So someone who has the capacity for responsibility may be an irresponsible person in the virtue sense).
6. Responsibility-as-obligation to see to it that something is the case. As in: he is responsible for the safety of the passengers, meaning he is responsible to see to it that the passengers are transported safely.
7. Responsibility-as-accountability. As in: the (moral obligation) to account for what you did or what happened (and your role in it happening).

8. Responsibility-as-blameworthiness. As in: he is responsible for the car accident, meaning he can be properly blamed for the car accident happening.
9. Responsibility-as-liability. As in: he is liable to pay damages.

The first four conceptions are more or less descriptive: responsibility-as-cause, role, authority, or capacity describes something that is the case or not. The other five are more normative. The first two normative conceptions—responsibility-as-virtue and responsibility-as-obligation—are primarily forward-looking (prospective) in nature. Responsibility-as-accountability, blameworthiness, and liability are backward-looking (retrospective) in the sense that they usually apply to something that has occurred. Both the forward-looking and the backward-looking normative conception of responsibility are relevant in relation to risks. Backward-looking responsibility is mainly at stake when a risk has materialized and then relates to such questions like: Who is accountable for the occurrence of the risk? Who can be properly blamed for the risk? Who is liable to pay the damage resulting from the risk materializing? Forward-looking responsibility is mainly relevant with respect to the prevention and management of risks. It may refer to different tasks that are relevant for preventing and managing risk like risk assessment, risk reduction, risk management, and risk communication. We will discuss the responsibility for these tasks in section Responsibility for Risks.

Cross-cutting the distinction between the different conceptions of responsibility is a distinction between what might be called different "sorts" of responsibility like organizational responsibility, legal responsibility, and moral responsibility. The main distinction between these sorts is the grounds on which it is determined whether someone is responsible (in one of the senses distinguished above). Organizational responsibility is mainly determined by the rules and roles that exist in an organization, legal responsibility by the law (including jurisprudence), and moral responsibility is based on moral considerations. The two types of distinctions are, however, not completely independent of each other. Organizational responsibility, for example, often refers to responsibility-as-task or responsibility-as-authority and seems unrelated to responsibility-as-cause and responsibility-as-capacity. It might also refer to responsibility-as-accountability, just like legal and moral responsibility. We might thus distinguish between organizational, legal, and moral accountability, where the first is dependent on an organization's rules and roles, the second on the law, and the third on moral considerations.

In this contribution we mainly focus on moral responsibility. Most of the general philosophical literature on responsibility has focused on backward-looking moral responsibility, in particular on blameworthiness. In this literature also, a number of general conditions have been articulated which should be met in order for someone to be held properly or fairly responsible (e.g., Wallace 1994; Fischer and Ravizza 1998). Some of these conditions, especially the freedom and knowledge condition, go back to Aristotle (*The Nicomachean Ethics,* book III, Chaps. 1–5). These conditions include:

1. Moral agency. The agent A is a moral agent, that is, has the capacity to act responsibly (responsibility-as-capacity).

2. Causality. The agent A is somehow causally involved in the action or outcome for which A is held responsible (responsibility-as-cause).
3. Wrongdoing. The agent A did something wrong.
4. Freedom. The agent A was not compelled to act in a certain way or to bring about a certain outcome.
5. Knowledge. The agent A knew, or at least could reasonably have known that a certain action would occur or a certain outcome would result and that this was undesirable.

Although these general conditions can be found in many accounts, there is much debate about at least two issues. One is the exact content and formulation of each of the conditions. For example, does the freedom condition imply that the agent could have acted otherwise (e.g., Frankfurt 1969)? The other is whether these conditions are individually necessary and jointly sufficient in order for an agent to be blameworthy. One way to deal with the latter issue is to conceive of the mentioned conditions as arguments or reasons for holding someone responsible (blameworthy) for something rather than as a strict set of conditions (Davis 2012).

Whereas the general philosophical literature on responsibility has typically focused on backward-looking responsibility, the more specific analyses of moral responsibility in technoscientific contexts, and more specifically as applied to (technological) risks, often focus on forward-looking responsibility. They, for example, discuss the forward-looking responsibility of engineers for preventing or reducing risks (e.g., Davis 1998; Harris et al. 2008; Martin and Schinzinger 2005; Van de Poel and Royakkers 2011). One explanation for this focus may be that in these contexts the main aim is to prevent and manage risks rather than to attribute blame and liability. This is, of course, not to deny that in other contexts, backward-looking responsibility for risks is very relevant. It surfaces, for example, in court cases about who is (legally) liable for certain damage resulting from the materialization of technological risks. It is also very relevant in more general social and political discussions about how the costs of risks should be borne: by the victim, by the one creating the risks, or collectively by society, for example, through social insurance.

Conceptual Relations Between Risk and Responsibility

The conceptual connections between risk and responsibility depend on which conception of risk and which conception of responsibility one adopts. The technical conception of risk, which understands risks as the product of probability and magnitude of certain undesirable consequences, is largely descriptive, but it contains a normative element because it refers to undesirable outcomes. Typically, responsibility also is often used in reference to undesirable outcomes, especially if responsibility is understood as blameworthiness. Yet if the undesirable consequences, to which the technical conception of risk refers, materialize this does not

necessarily imply that someone is blameworthy for these consequences. As we have seen, a number of conditions have to be met in order for someone to fairly be held responsible for such consequences. In cases of risks the knowledge condition will usually be fulfilled because if a risk has been established it is known that certain consequences might occur. It will often be less clear whether the wrongdoing condition is met. Risks normally refer to unintended, but not necessarily unforeseen, consequences of action. Nevertheless, under at least two circumstances, the introduction of a risk amounts to wrongdoing. One is if the actor is reckless, that is, if he knows that a risk is (morally) unacceptable but still exposes others to it. The other is negligence. In the latter case, the actor is unaware of the risk he is taking but should and could have known the risk and exposing others to the risk is unacceptable.

If we focus on forward-looking responsibility rather than backward-looking responsibility, the technical conception of risk might be thought to imply an obligation to avoid risks since most conceptions of risk refer to something undesirable. Again, however, the relation is not straightforward. Some risks, like certain natural risks, may be unavoidable. Other risks may not be unavoidable but worth taking given the advantages of certain risky activities. Nevertheless, there seems to be a forward-looking responsibility to properly deal with risks. In section Responsibility for Risks, we will further break down that responsibility and discuss some of its main components.

In the psychological literature on risk perception, no direct link is made between risk and responsibility. Nevertheless, some of the factors that this literature has shown to influence the perception of risk may be linked to the concept of responsibility. One such factor is controllability (e.g., Slovic 2000). Control is often seen as a precondition for responsibility; it is linked to the conditions of freedom and knowledge we mentioned above. Also voluntariness, another important factor in the perception of risk (e.g., Slovic 2000), is linked to those responsibility conditions. This suggests that risks for which one is not responsible (or cannot take responsibility) but to which one is exposed beyond one's will and/or control are perceived as larger and less acceptable.

In the sociological literature on risk that we discussed in section Conceptions of Risk, a much more direct connection between risk and responsibility is supposed. Mary Douglas (1985) argues that the same institutionally embedded cultural biases that shape the social construction of risks also shape the attribution of responsibility, especially of blameworthiness. Institutions are, according to Douglas, typically characterized by certain recurring patterns of attributing blame, like blaming the victim, or blaming outsiders, or just accepting the materialization of risks as fate or the price to be paid for progress. According to the theory of risk society, both risk and responsibility are connected to control and decisions. This implies a rather direct conceptual connection between risk and responsibility. As Anthony Giddens expresses it:

> The relation between risk and responsibility can be easily stated, at least on an abstract level. Risks only exist when there are decisions to be taken…. The idea of responsibility also presumes decisions. What brings into play the notion of responsibility is that someone takes a decision having discernable consequences (Giddens 1999, p. 8).

The sociological literature seems to refer primarily to organizational responsibility, in the sense that attribution of responsibility primarily depends on social conventions. Nevertheless, as we have seen the idea of control, which is central to risk in the theory of risk society, is also central for moral responsibility.

The redefinitions of risk proposed by Rayner and Wolff, finally, both refer to responsibility as an ingredient in the conception of risk. Rayner includes liability as an aspect of risk. While liability is usually primarily understood as a legal notion, his reference to the *acceptability* of liability procedures also has clear moral connotations. In Wolff's conception of risk, responsibility affects the variable "cause" that he proposes as additional primary variable for risk. As Wolff points out, it matters for the acceptability of risk whether it is caused by malice, recklessness, or negligence. These distinctions also have a direct bearing on the moral responsibility of the agent causing the undesirable consequences; they represent different degrees of wrongdoing. So, on Wolff's conceptualization, whether and to what degree anyone is responsible for a risk has a bearing on the acceptability of that risk.

Although the relation between risk and responsibility depends on the exact conceptualization of both terms and one might discuss how to best conceptualize both terms, the above discussion leads to a number of general conclusions. First, if an undesired outcome is the result of someone taking a risk or exposing others to a risk, it appears natural to talk about responsibility in the backward-looking sense (accountability, blameworthiness, liability) for those consequences and for the risk taken. Second, both risk and responsibility are connected to control and decisions. Even if one does not accept the tight conceptual connection between risk and control that the theory of risk society supposes, it seems clear that risks often are related to decisions and control. As pointed out in the introduction, even so-called natural risks increasingly come under human control. This implies that we cannot only hold people responsible for risks in a backward-looking way, but that people can also take or assume forward-looking responsibility (responsibility-as-virtue or as obligation) for risks. Third, the acceptability of risks appears to depend, at least partly, on whether someone can fairly be held responsible for the risk occurring or materializing.

Responsibility for Risks

In the literature on risk some general frameworks have been developed for thinking about the responsibility for risks and some general tentative answers have been formulated to the question who is responsible for certain risks. In this section, we present a number of these positions and the debates to which they have given rise. We focus on human-induced risks, that is, nonnatural risks, with a prime focus on technological risks. Our focus is also primarily on forward-looking responsibility rather than on backward-looking responsibility (accountability, blameworthiness, and liability) for risks.

Forward-looking responsibility for risks can be subdivided in the following main responsibilities:

1. Responsibility for risk reduction.
2. Responsibility for risk assessment, that is, establishing risks and their magnitude.
3. Responsibility for risk management. Risk management includes decisions about what risks are acceptable and the devising of regulations, procedures, and the like to ensure that risks remain within the limits of what is acceptable.
4. Responsibility for risk communication, that is, the communication of certain risks, in particular to the public.

Section The Responsibility of Engineers will discuss the responsibility for risk reduction. In the case of technological risks, this responsibility is often attributed to engineers. Section Risk Assessment Versus Risk Management will focus on the responsibility for risk assessment versus risk management. The former is often attributed to scientists, while governments and company managers are often held responsible for the latter. It will be examined whether this division of responsibilities is justified. Section Individual Versus Collective Responsibility for Risks will focus on an important issue with respect to risk management: whether decisions concerning acceptable risk are primarily the responsibility of individuals who take and potentially suffer the risk or whether it is a collective responsibility that should be dealt with through regulation by the government. Section Risk Communication will discuss some of the responsibilities of risk communicators and related dilemmas that have been discussed in the literature on risk communication.

The Responsibility of Engineers

Engineers play a key role in the development and design of new technologies. In this role they also influence the creation of technological risks. In the engineering ethics literature, it is commonly argued that engineers have a responsibility for safety (Davis 1998; Harris et al. 2008; Martin and Schinzinger 2005; Van de Poel and Royakkers 2011). In this section, we will consider these arguments and discuss how safety and risk are related and what the engineers' responsibility for safety implies for their responsibility for technological risks.

Most engineering codes of ethics state that engineers have a responsibility for the safety of the public. Thus, the code of the National Society of Professional Engineers in the USA states that: "Engineers, in the fulfillment of their professional duties, shall…. Hold paramount the safety, health, and welfare of the public" (NSPE 2007). Safety is not only stressed as the engineer's responsibility in codes of ethics but also in technical codes and standards. Technical codes are legal requirements that are enforced by a governmental body to protect safety, health, and other relevant values (Hunter 1997). Technical standards are usually

recommendations rather than legal requirements that are written by engineering experts in standardization committees. Standards are usually more detailed than technical codes and may contain detailed provisions about how to design for safety.

Does the fact that safety is a prime concern in engineering codes of ethics and technical codes and standards entail that engineers have a moral responsibility for safety? One can take different stances here. Some authors have argued that codes of ethics entail an implicit contract either between a profession and society or among professionals themselves. Michael Davis, for example, defines a profession as "a number of individuals in the same occupation voluntarily organized to earn a living by openly serving a certain moral ideal in a morally permissible way beyond what law, market, and morality would otherwise require" (Davis 1998, p. 417). This moral idea is laid down in codes of ethics and thus implies, as we have seen, a responsibility for safety. According to Davis, codes are binding because they are an implicit contract between professionals, to which engineers subscribe by joining the engineering profession.

One could also argue that codes of ethics or technical codes and standards as such do not entail responsibilities for engineers but that they *express* responsibilities that are grounded otherwise. In that case, the engineers' responsibility for safety may, for example, be grounded in one of the general ethical theories like consequentialism, deontology, or virtue ethics. But if we believe that engineers have a moral responsibility for safety, does this also entail a responsibility for risks? To answer this question, we need to look a bit deeper into the conceptual relation between safety and risk (see "The Concepts of Risk and Safety"). In engineering, safety has been understood in different ways. One understanding is that safety means absolute safety and, hence, implies the absence of risk. In most contexts, this understanding is not very useful (Hansson 2009, p. 1074). Absolute safety is usually impossible and even if it would be possible it would in most cases be undesirable because eliminating risks usually comes at a cost, not only in monetary terms but also in terms of other design criteria like sustainability or ease of use. It is therefore better to understand safety in terms of "acceptable risk". One might then say that a technological device is safe if its associated risks are acceptable. What is acceptable will depend on what is feasible and what is reasonable. The notion of reasonableness refers here to the fact that reducing risks comes at a cost and that hence not all risk reductions are desirable.

So conceived, engineers may be said to be responsible for reducing risks to an acceptable level. What is acceptable, however, requires a normative judgment. This raises the question whether the engineer's responsibility for reducing risks to an acceptable level includes the responsibility to make a normative judgment on which risks are acceptable and which ones are not or that it is limited to meeting an acceptable risk level that is set in another way, for example, by a governmental regulator. The answer to this question may well depend on whether the engineers are designing a well-established technology for which safety standards have been set that are generally and publicly recognized as legitimate or that they are designing a radically new technology, like nanotechnology, for which existing

safety standards cannot be applied straightforwardly and of which the hazards and risks are more uncertain anyway (for this distinction, see Van de Poel and Van Gorp 2006). In the former case, engineers can rely on established safety standards. In the latter case, such standards are absent. Therefore in the second case engineers and scientists also have some responsibility for judging what risks are acceptable, although they are certainly not the only party that is or should be involved in such judgments.

Risk Assessment Versus Risk Management

In the previous section we have seen that a distinction needs to be made between responsibility for risk reduction and responsibility for decisions about acceptable risks. Engineers have a responsibility for risk reduction but not necessarily or at least to a lesser degree a responsibility for deciding about acceptable risk. In this section we will discuss a somewhat similar issue in the division of responsibility for risk, namely, the responsibility for establishing the magnitude of risks (risk assessment) and decisions about the acceptability and management of risks (risk management). Traditionally risk assessment is seen as a responsibility of scientists, and risk management as a responsibility of governments and (company) managers (National Research Council 1983) (see "Risk Management in Technocracy"). In this section, we will discuss whether this division of labor and responsibility is tenable or not. In particular, we will focus on the question whether adequate risk assessment can be completely value free, as is often supposed, or, as has been argued by a number of authors, that it needs to rely on at least some value judgments.

One reason why risk assessment cannot be entirely value free is that in order to do a risk assessment a decision needs to be made on what risks to focus. Since, on the conventional technical conception of risk (see section Conceptions of Risk), risks are by definition undesirable, classifying something as a risk already involves a value judgment. It might be argued, nevertheless, that decisions about what is undesirable are to be made by risk managers and that risk assessors, as scientists, should then investigate all potential risks. In practice, however, a risk assessment cannot investigate all possible risks; a selection will have to be made and selecting certain risks rather than others implies a value judgment. Again, it can be argued that this judgment is to be made by risk managers. A particular problem here might be that some risks are harder to investigate or establish scientifically than others. Some risks may even be statistically undetectable (Hansson 2009, pp. 1084–1086). From the fact that a risk is hard or even impossible to detect scientifically, of course it does not follow that it is also socially or morally unimportant or irrelevant, as it might have important consequences for society if it manifests itself after all. This already points to a possible tension between selecting risks for investigation from a scientific point of view and from a social or moral point of view.

The science of risk assessment also involves value judgments with respect to a number of methodological decisions that are to be made during risk assessment. Such methodological decisions influence the risk of error. A risk assessment might, due to error, wrongly estimate a certain risk or it might establish a risk where actually none exists. Heather Douglas (2009) argues that scientists in general have a responsibility to consider the consequences of error, just like anybody else. While this may seem common sense, it has important consequences once one takes into account the social ends for which risk assessments are used. Risk assessment is not primarily used to increase the stock of knowledge, but rather as an input for risk management. If a risk assessment wrongly declares something not to be a risk while it actually is a serious risk, or vice versa, this may lead to huge social costs, both in terms of fatalities and economic costs.

Various authors have therefore suggested that, unlike traditional science, risk assessment should primarily avoid what are called type 2 errors rather than type 1 errors (Cranor 1993; Shrader-Frechette 1991b; Hansson 2008; see also Hansson's "A Panorama of the Philosophy of Risk"). A type 1 error or false positive occurs if one establishes an effect (risk) where there is actually none; a type 2 error or false negative occurs if one does not establish an effect (risk) while there is actually an effect. Science traditionally focuses on avoiding type 1 errors to avoid assuming too easily that a certain proposition or hypothesis is true. This methodological choice seems perfectly sound as long as the goal of science is to add to the stock of knowledge, but in contexts in which science is used for practical purposes, as in the case of risk assessment, the choice may be problematic. From a practical or moral point of view it may be worse not to establish a risk while there is one than to wrongly assume a risk. As Cranor (1993) has pointed out the 95 % rule for accepting statistical evidence in science is also based on the assumption that type 1 errors are worse than type 2 errors. Rather than simply applying the 95 % rule, risk assessors might better try to reduce type 2 errors or balance type 1 against type 2 errors (Cranor 1993, pp. 32–29; Douglas 2009, pp. 104–106).

There are also other methodological decisions and assumptions that impact on the outcomes of risk assessment and the possibilities of error. One example is the extrapolation of empirically found dose–effect relations of potentially harmful substances to low doses. Often, no empirical data are available for low doses; therefore the found empirical data has to be extrapolated to the low dose region on the basis of certain assumptions. It might, for example, be assumed that the relation between dose and response is linear in the low dose region, but it is also sometimes supposed that substances have a no effect level, that is, that below a certain threshold dose there is no effect. Such methodological decisions can have a huge impact on what risks are considered acceptable. An example concerns the risks of dioxin. On basis of the same empirical data, but employing different assumptions about the relation between dose and response in the low dose region, Canadian and US authorities came to norms for acceptable levels of dioxin exposure to humans that are different by a factor of 1,000 (Covello and Merkhofer 1993, pp. 177–178).

While it is clear that in risk assessment, a number of value judgments and morally relevant methodological judgments need to be made, the implications for the responsibility of risk assessors, as scientists, are less obvious. One possibility would be to consider such choices to be entirely the responsibility of the risk assessors. This, however, does not seem like a very desirable option; although risk assessors without doubt bear some responsibility, it might be better to involve other groups as well, especially those responsible for risk management, in the value judgments to be made. The other extreme would be to restore the value-free science idea as much as possible. Risk assessors might, for example, pass on the scientific results including assumptions they made and related uncertainties. They might even present different results given different assumptions or different scenarios. While it might be a good idea to allow for different interpretations of scientific results, simply passing on all evidence to risk managers, who then can make up their mind does not seem desirable. Such evidence would probably be quite hard if not impossible to understand for risk managers. Scientists have a proper role to play in the interpretation of scientific data, albeit to avoid that data is deliberately wrongly interpreted for political reasons. Hence, rather than endorsing one of those two extremes, one should opt for a joint responsibility of risk assessors and risk managers for making the relevant value judgments while at the same recognizing their specific and different responsibilities. Among others, this would imply recognizing that risk assessment is a process that involves scientific analysis and deliberation (Stern and Feinberg 1996; Douglas 2009).

Individual Versus Collective Responsibility for Risks

When you get into your car in order to transport your children to school and yourself to an important work meeting, you expose a number of people to the risk of being injured or even killed in an accident. First, you expose yourself to that risk. Second, you expose your children to that risk. Third, you expose other drivers, passengers, pedestrians, and cyclists to that risk. Furthermore, someone made decisions that affected your driving: decisions about driving licenses, street lighting, traffic lights and signs, intersections, roundabouts, and so forth. Who is responsible for these different forms of risk exposure? There is an individual and a collective level at which to answer this question. The underlying philosophical question is that of individual and collective responsibility—to what extent and for which risks is an individual responsible and to what extent and for which risks is society collectively responsible? In the following, we will explain how these issues relate to each other. The analysis of road traffic serves as an example of how aspects of individual and collective responsibility reoccur in most areas of risk management and policy today.

The fact that you expose yourself to the risks associated with driving a car appears to be a primarily individual responsibility. As a driver with a license you are supposed to know what the relevant risks are. Unless you acted under

compulsion or ignorance you are held responsible for your actions, in road traffic as elsewhere. As discussed in section Conceptions of Responsibility, the condition of voluntariness has been discussed by philosophers since Aristotle. When you voluntarily enter your car and know that you risk yours and others' health and life by driving your car, even if those risks are considered fairly small in probability terms, you are responsible in case something bad happens because you accepted the risks associated with driving. This assessment is, of course, complicated by the behavior of other road users. Perhaps someone else made a mistake or even did something intentionally wrong, thereby causing an accident. In that case, you are often considered responsible to some extent, because you were aware of the risks associated with driving and these risks include being exposed to other people's intentional and unintentional bad behavior. However, other road users may bear the greatest share of responsibility in case their part in the causal chain is greater and their wrongdoing is considered more serious. The point is that the individual perspective distributes responsibility between the individuals involved in the causal chain. The key elements are (1) individuals, (2) causation, and (3) wrongdoing. The one/s that caused the accident by doing something wrong is/are responsible for it. (In section Conceptions of Responsibility, we mentioned two further conditions for responsibility, i.e., freedom and knowledge. These are usually met in traffic accidents and therefore we do not mention them separately here, but they may be relevant in specific cases.) When attributing responsibility according to this approach the road transport system is taken for granted the way it is. However, as we noted, someone made decisions concerning the road transport system and the way you and your fellow road users are affected by those decisions.

The collective or systemic perspective, instead, focuses on the road transport system. Were the roads of a reasonable standard, was there enough street lighting, and was the speed limit reasonable in relation to the condition and circumstances of the road? The default is to look at what the individuals did and did not do and to take the road transport system as a given and this is often reflected in law. However, in some countries the policy is changing and moving toward a collective or systemic perspective. In 1997, the Swedish government made a decision which has influenced discussions and policies in other European countries. The so-called Vision Zero was adopted, according to which the ultimate goal of traffic safety policy is that no one is killed or seriously injured in road traffic (Nihlén Fahlquist 2006). This may be seen as obvious to many people, but can be contrasted to the cost-benefit approach according to which the benefit of a certain method should always be seen in relation to its cost. Instead of accepting a certain number of fatalities, it was now stated that it is not ethically justifiable to say that 300 or 200 are acceptable numbers of fatalities. In addition to this idea, a new view of responsibility was introduced. According to that approach, individuals are responsible for their road behavior, but the system designers are ultimately responsible for traffic safety. This policy decision reflected a change in perspective moving from individual responsibility to collective responsibility. Road traffic should no longer be seen purely as a matter of individual responsibility, but instead the designers of the system (road managers, maintainers, and the automotive

industry) have a great role to play and a great share of responsibility for making the roads safer and saving lives in traffic. Instead of merely focusing on individuals, causation, and wrongdoing, the focus should be on (1) collective actors with the (2) resources and abilities to affect the situation in a positive direction. The example of road traffic illustrates how an activity often has a collective as well as an individual dimension. The adoption of Vision Zero shows that our views on who is responsible for a risky activity, with individual and collective dimensions, can be changed.

Furthermore, this example illuminates the difference between (1) backward-looking and (2) forward-looking responsibility. Sometimes when discussing responsibility, we may refer to the need for someone to give an account for what happened or we blame someone for what happened. In other situations we refer to the aim to appoint someone to solve a problem, the need for someone to act responsibly or to see to it that certain results are achieved. There are several distinctions to be made within these two broad categories, but it could be useful to make this broad distinction between backward-looking and forward-looking notions of responsibility (see also section Conceptions of Responsibility).

The issue of collective responsibility is a much discussed topic in contemporary philosophy. Some scholars argue that there is no such thing and that only individuals can rightly be considered responsible. This position was taken, for example, by Lewis (1948) some years after World War II and it is understandable that many people were skeptical to the idea of collective actors and collective guilt at that point in time. The world has changed a lot since then and 65 years after World War II the ideas of collective actors and holding collectives responsible are not as terrifying. On the contrary, against the background of multinational corporations, for example, banks and oil producers, behaving badly and causing harm to individuals it appears more and more crucial to find a way of holding such actors accountable for harm caused by them. Philosophers like Peter French have therefore defended the idea that collective agents, such as corporations or governments, can be morally responsible (e.g., French 1984). Some authors claim that collective responsibility is sometimes irreducible to individual responsibility, that is, a collective can be responsible without any of its members being responsible (French 1984; Gilbert 1989; Pettit 2007; Copp 2007). Others claim that collective responsibility is, in the end, analyzable only in terms of individual responsibility (Miller 2010). The collective responsibility of the government might, for example, be understood as the joint responsibility of the prime minster (as prime minister), other members of the government, members of the Parliament, and maybe civil servants. In section Further Research: Organizing Responsibility for Risks, we will explore possible tensions between individual and collective responsibility, and the so-called problem of many hands.

Scholars are likely to continue discussing whether the notion of collective responsibility makes philosophical sense and if so how it should be conceived. What cannot be denied is that in society we treat some risks as an individual responsibility and others as a collective responsibility. Whereas the risks associated with mountaineering are usually seen as individual responsibility, the risks

stemming from nuclear power are seen as collective. However, it is arguably not always that simple to decide whether an individual or a collective is responsible for a certain risk. It is often the case that there is an individual as well as a collective dimension to risks. Climate risks arising from the emissions of carbon dioxide are good examples of this. Arguably, individuals have a responsibility to do what they can to contribute to the reduction of emissions, but governmental and international action is also crucial. Furthermore, it is also a matter of which notion of responsibility we apply to a specific context. While we sometimes blame individuals for having smoked for 40 years thereby causing their own lung cancer, we may make it a collective responsibility to give them proper care.

There are two general perspectives on the balance between individual and collective responsibility for health risks. First, the libertarian approach views lifestyle risks, for example, smoking, as an individual matter and relates causation to blame and responsibility for the cost of damage. A liberal welfare approach considers causation as one thing and paying for the consequences as another thing so that even if an individual is seen as having caused her own lung cancer, she should perhaps not have to pay for the health care she now needs. Furthermore, according to liberal welfare theories, individuals are always situated in a socio-economic context and, consequently, the fact that a particular individual smokes may not entirely be a matter of free choice. Instead, it may be partly due to the situation she is in, her socioeconomic context, education, and so forth, which entails a different perspective on causation, and hence also on the distribution of responsibility between the individual and the collective. The liberal welfare approach does not pay as much attention to free choice as the libertarian approach, or alternatively does not see choices as free in the same sense as libertarians do. This is because the two perspectives assume different conceptions of liberty. Libertarians focus on so-called negative freedom, that is, being free to do whatever one wants to do as long as one does not infringe on another person's rights. Liberal welfare proponents focus on positive liberty, that is, freedom to act in certain ways and having possibilities to act. The former requires legislation to protect individuals' rights and the latter requires a more expansive institutional setting and taxation to create the circumstances and capabilities (see "The Capability Approach in Risk Analysis") needed for people to make use of those possibilities. Different conceptions of liberty entail different conceptions of responsibility. Those emphasizing negative liberty attribute a greater share of responsibility to individuals and those who prefer positive liberty make governments and societies collectively responsible to a greater extent. (For a classic explanation of the concepts of negative and positive liberty see Isaiah Berlin 1958).

The decision to view a certain risk as an individual or a collective matter entails different strategies for dealing with risk reduction and different strategies for deciding about the acceptability of a risk. If the risk is seen as an individual matter the strategy is likely to emphasize information campaigns at the most. If, for example, road safety is seen as an individual responsibility risk managers who want to reduce the number of fatalities and injuries will inform the public about risky behavior and how to avoid such behavior. "Don't drink and drive"

campaigns is an example of that strategy. Some libertarians would probably argue that even this kind of campaign is unacceptable use of taxpayers' money and that an information campaign should only objectively inform about the risks of drunk driving and not give any advice because individuals should be considered competent enough to make their own decisions about driving. However, a "Don't drink and drive" campaign could also be seen as a way of making sure individuals do not harm each other, that is, do not infringe on other individuals' rights not to be harmed, and for this reason it would probably be acceptable to a moderate libertarian. Surely, libertarians would not agree to anything more intrusive than this, for example, surveillance cameras.

If, instead, road safety is seen as a collective responsibility, risk managers may try to find other ways of reducing the risks of driving. In the case of drunk driving, one such example could be alcohol interlocks, that is, a new technology which makes it impossible to drive under the influence of alcohol. This device measures the driver's blood alcohol concentration (BAC) before the car starts, for example, through an exhalation sample, and because it is connected to the car's ignition it will not start if the measured concentration is above the maximum set. Alcohol interlocks are currently used in some vehicles and some contexts in Sweden and elsewhere. It is possible that the device will be a natural part of all motor vehicles in the future and this would indeed be a way of making drunk driving a collective responsibility, although individuals would still be responsible for not misleading or otherwise circumventing the system.

The collective approach to responsibility for risks is sometimes criticized for being paternalistic. The argument is that people should be free to make their own decisions about which risks are worth taking. One way to assure freedom of choice is to apply the principle of informed consent to decisions about acceptable risk. Informed consent is a principle commonly used in medical experiments and the idea is that those who take part in the experiments are informed about the risks and then decide whether to consent through signing a document. Similarly, individuals are to decide what technological risks they want to take. To this end, they should be informed about the risks of different technologies, and they should be free to decide whether to take a certain risk or not. The approach of informed consent clearly fits in a libertarian approach to risk taking. However, when people make decisions about risks, their choices can be affected through the way information is presented. Thaler and Sunstein (2008) argue that a decision is always made in a context and that "choice architects" design this context. Since choices are always framed in one way or another, you might as well opt for "nudging" people in the "better", healthier for instance, direction. One example of this is a school cafeteria in which different food products are arranged in one way or another and without removing the less healthy options, a "choice architect" could nudge children in the direction of the healthier options. Even a very anti-paternalistic libertarian, they argue, could accept this since no options are removed and the food has to be arranged in one way or another (Thaler and Sunstein 2008).

There are, however, several problems with applying the principle of informed consent to risk taking. One problem is that it might be hard, if not impossible, to

present risks in a neutral and objective way (see also section Risk Communication). Second, risks are sometimes uncertain. Imagine there is research on how radiation from mobile phones affects grown-ups in the time frame of 10 years after you start using the phone, but not how it affects children or how it affects grown-ups in the long-term perspective of say 20–30 years. When you use your mobile phone or you let your child use one and you have been informed about the known risks, have you consented to all risks of radiation stemming from mobile phones? Third, it might be doubted whether all risks are or can be taken voluntarily, take for example, the risks associated with driving in an area lacking public transport. Fourth, in many cases the decision whether to accept or take a certain risk is or cannot be an individual decision because it affects other people. Take for example, the decision whether a certain area of the Netherlands should be additionally protected against the sea given expectations of rising sea levels due to the greenhouse effect. Such measures are likely to be very costly and whereas some individuals will judge that an increased risk should be accepted rather than spending large of amounts of public funds on higher dikes, others are likely to make the opposite assessment.

Decisions about which risks of flooding should be accepted are by their very nature collective decisions. Since such collective decisions are usually based on majority decision making, individual informed consent is not guaranteed. An alternative would be to require consensus, to safeguard informed consent, but that would very likely result in a stalemate and in a perseverance of the status quo. That would in turn lead to the ethical issue of how the status quo is to be understood. For example, in the case of increased likeliness of flooding the question is whether the status quo should be understood in terms of the current risk of flooding, so that maintaining the status quo would mean heightening the dikes, or whether it should be understood in terms of the current height of the dikes and accepting a higher risk of flooding.

Many acts of seemingly individual risk taking have a collective element. Even committing suicide by driving or jumping in front of a train is not an individual act since other road users may come in the way and get hurt and there is probably psychological damage to the train driver and others who see it happen. By driving your car you inevitably risk the lives of others when you risk your own life. Your own risk taking is then intertwined with the risk exposure of others.

The upshot of the above discussion is not that all decisions about risk are or should be, at least partially, collective decisions, but rather that we should distinguish different kinds of risks, some more individual and others more collective. Consider, for example, the alleged health risks of radiation from mobile phones. The risk that is generated by using a mobile phone, and thereby exposing oneself to radiation, is an individual risk; the radiation only affects the user of the phone. Radiation from base stations, on the other hand, is a collective risk. This is why it has been suggested that the former is managed through informed consent whereas the latter should be subject to public participation and democratic decision making (IEGMP 2000).

However, even if we decide that the risks associated with using a mobile phone is sometimes an individual responsibility, it should be noted that a seemingly individual risk carries with it aspects of collective decision making and responsibility since the government and international agencies may have to set a minimal risk level (MRL) stating what is acceptable radiation and what is not. Many contemporary risks are complex and collective. As democratic societies we have to make choices about what risks to allow. There is a procedural dimension to this, but also a normative dimension. As noted by Ferretti (2010), scholars have been discussing how to make sure that the procedure by which decisions about risks are made become more democratic and fair, but that we also have to discuss the normative and substantive issues of what risks are acceptable and what the decisions are about.

Risk Communication

As we have seen the tasks of risk assessment, risk management and risk reduction involve different groups, such as engineers, scientists, the government, company managers, and the public, with different responsibilities. Since each group has its specific expertise and fulfilling one's specific responsibility often requires information from others, communication between the groups is of essential importance. Risk communication is therefore crucial for the entire system of dealing with risks in order to work.

In the literature, risk communication is often understood as communication between the government and the public (e.g., Covello et al. 1989) (see "Tools for Risk Communication" and "Emotion, Warnings, and the Ethics of Risk Communication"). Although as indicated it might be advisable to understand the notion of risk communication broader, we will here follow this convention and understand risk communication as the communication between the government (or a company) and the public. The goals of such risk communication depend to an important extent on whether one conceives of risk management as an individual or collective responsibility as discussed in the previous section. As we saw there, whether risk management is seen as an individual or collective responsibility partly depends on one's philosophical or political stance. However, it also depends on the kind of risks focused on. Moreover, as we argued, risks are often both an individual and collective responsibility. Therefore, the distinction between individual and collective responsibility does not exactly match comparable distinctions between consequentialist and deontological approaches or between liberal and paternalistic approaches.

If one conceives of risk management, and especially of decisions about acceptable risk, as the individual responsibility of the one taking or undergoing the risk, the responsibility of the government as risk communicator is to inform the public as completely and as accurately as possible. However, it seems that the government should refrain from attempts to convince the public of the seriousness

or acceptability of risks. In this frame, the goal of risk communication is to enable informed consent and the responsibility of the risk communicator is basically to provide reliable and relevant information to enable informed consent.

However, if one conceives of decisions about acceptable risk and risk management as a collective responsibility, trying to convince the public of the acceptability or seriousness of certain risks or trying to get their cooperation for certain risk management measures is not necessarily or always morally problematic, especially if the risk communicator is open about his or her goals (cf. Morgan and Lave 1990; Johnson 1999; Thaler and Sunstein 2008). In a liberal society, it might in general be improper for the government to deliberately misinform the public or to enforce certain risk measures, but convincing the public is not necessarily morally problematic. Moreover, in some extreme situations even misinformation and enforcement might be considered acceptable. It is, for example, generally accepted that violence may sometimes be used by the police to reduce the risks of criminality and terrorism. With respect to risk communication, one might wonder whether it would be acceptable to be silent about the risk of burglary if people have to leave their homes as quickly as possible because of the safety risk as a result of a coming hurricane. Misinformation about risks may in some cases be deemed acceptable if the consequences, or risks, of proper information are larger than the risks communicated. In such cases, consequentialist considerations may be considered more relevant than deontological considerations. In general, if one conceives of risk management as collective rather than as a purely individual responsibility, the consequences of risk communication may be relevant to the responsibilities of the risk communicator and these responsibilities can thus extend beyond informing in the public as well as possible. However, it seems that if one accepts that some risk management decisions are a collective responsibility, one can still either take a more consequentialist or a more deontological view on risk communication.

It might seem that the question concerning what information to provide to the public only arises if risk management is (partly) seen as a collective responsibility. If risk management is an individual responsibility and the aim of risk communication is to enable informed consent, the risk communicator should simply pass on all information to the public. However, not all information is equally relevant for informed consent, and so a certain choice of filtering of information seems appropriate. In addition to the question of what information should be provided, ethical questions may arise in relation to the question of how the information is to be framed (Jungermann 1996).

Tversky and Kahneman (1981) have famously shown that the same statistical information framed differently leads to contradictory decisions about what risks are accepted, for example, depending on whether risk information is framed in terms of survival or death. There are many others factors that are relevant for how risks are presented. One issue is the risk measure used. It makes a difference whether you express the maximum dosage of dioxin per day in picograms, milligrams, or kilograms. The latter presentation—maybe unintentionally—gives the impression that the risk is far smaller than in the first case. Another important issue

in risk communication is how uncertainty should be dealt with. Should the risk communicator just communicate the outcome of a risk assessment or also include uncertainty margins? Should the risk communicator explain how the risk assessment was carried out, so that people can check how reliable it is? Should the methodological assumptions and choices made in the risk assessment (section Conceptions of Responsibility) be explained to the public?

Further Research: Organizing Responsibility for Risks

A major philosophical challenge today is to conceptualize responsibility in relation to collective agency. While the increased control over the environment seems to increase the total amount of responsibility, this responsibility is also increasingly dispersed over many different individuals and organizations. The somewhat paradoxical result is that it sometimes appears to be increasingly difficult to hold someone responsible for certain collective effects like climate change. Partly this may result from the fact that today's society is so obsessed with holding people responsible (blameworthy) that many individuals and organizations try to avoid responsibility rather than to assume it. Ulrich Beck (1992) has described this phenomenon as "organized irresponsibility".

We have identified five important topics for further research that we will discuss in the following sections. In section The Problem of Many Hands (PMH), we discuss what has been called the problem of many hands (PMH).

In section Climate Change as an Example, we will discuss the risk of climate change as an example of the PMH. We are all contributing to climate change. However, if and how this observation of (marginal) causal responsibility has implications for moral responsibility is not at all clear and this issue needs considerable attention.

Section Responsibility as a Virtue will discuss the idea that rather than understanding responsibility in a formal way, we should appeal to individuals who should take up responsibility proactively. To that purpose, we suggest to turn to virtue ethics and care ethics. We explore the possibilities of an account of responsibility as the virtue of care, as a way to deal with the PMH.

Another example is the discussion in section Responsibility for Risks about the related responsibilities for risk assessment, risk management, risk reduction, and risk communication. We have seen that there are some problems with the traditional allocation of responsibilities in which, for example, scientists are only responsible for risk assessment and have no role to play in risk management. These examples illustrate the need to discuss the distribution of responsibility (section The Procedure of Responsibility Distribution) among the actors involved as well as the question of who is responsible for the entire system, which involves the notion of institutional design (section Institutional Design).

The Problem of Many Hands

Although Dennis Thompson (1980) already coined the term "problem of many hands" in 1980, relatively little research has been done in this area. For this reason, we will summarize briefly what already has been done, but large parts of the discussion relate to directions and suggestions for further research.

Thompson describes the PMH as "the difficulty even in principle to identify who is responsible for… outcomes" (Thompson 1980, p. 905). Many different individuals act in different ways and the joint effect of those actions is an undesired state-of-affairs X, but none of the individuals (1) directly caused X or (2) wanted or intended X. In such cases, it is either difficult to discern how each actor contributed to X or it is unclear what implications the joint causal responsibility should have for the moral responsibility of the individuals whose combined actions caused X. As we have seen, there is backward-looking and forward-looking responsibility. The PMH can be seen as a problem of forward-looking responsibility, but it has primarily been discussed as a problem of backward-looking responsibility. Typically, the PMH occurs when something has happened and although there may not have been any wrongdoing legally speaking, the public may have a feeling that something has been done for which someone is morally responsible. The question is just who should be considered responsible, since the traditional conditions of responsibility are extremely hard to apply.

Two features of contemporary society make the PMH salient today. First, human activities are to an increasing extent carried out by groups of people instead of by individuals. Second, we are increasingly able to control risks and hazards, which also seem to increase our responsibilities. We will briefly discuss these features in turn.

Traditionally, philosophers theorize about morality in relation to individuals and how they act. However, in contemporary societies, a substantial part of the daily lives of individuals are intertwined with collective entities like the state, multinational corporations, nongovernmental organizations, and voluntary associations. Collective agency has become frequent. We talk about nations going to war, companies drilling for oil, governments deciding to build a new hospital, a local Lions club organizing a book fair. As discussed in section Individual Versus Collective Responsibility for Risks, the concept of collective moral responsibility is a much debated topic in philosophy. A risky activity can be seen as an individual or a collective responsibility, but most risks have aspects of both.

Collectively caused harm complicates ethical analysis. This is so partly for epistemic reasons, that is, because we do not know how the actions of different individuals combine to cause bad things. Furthermore, did each and every individual in that particular collective know what they took part in? However, it is not merely for epistemic reasons that we have problems ascribing responsibility in such cases. Collective harm may also arise due to a tragedy of the commons (Hardin 1968). In a tragedy of the commons, the commons—a shared resource—are exhausted because for each individual it is rational to use the commons as

much as possible without limitation. The aggregate result of these individual rational actions, the exhaustion of the common resource so that no individual can continue to use it, is undesirable and in a sense irrational. Many environmental problems can be understood as a tragedy of the commons. Johnson (2003) has argued that in a tragedy of the commons individuals are not morally required to restrict their use of the common resource as long as no collective agreement has been reached, hence no individual can properly be held responsible for the exhaustion of the commons (for a contra argument, see Braham and van Hees 2010).

Similarly, Pettit (2007) has argued that sometimes no individual can properly be held morally responsible for undesirable collective outcomes (for support of Pettit's argument see, e.g., Copp (2007), for criticism, see Braham and van Hees (2010), Hindriks (2009), and Miller (2007). The type of situations he refers to are known as voting paradoxes or discursive dilemmas. Pettit gives the following example (Table 5.1). Suppose that three employees (A, B, and C) of a company need to decide together whether a certain safety device should be installed and suppose that they agree that this should only be done if (1) there is a serious danger (p), (2) the device is effective with respect to the danger (q), and (3) the costs are bearable (r). If and only if all three conditions are met ($\hat{p}$ $\hat{q}$ r) the device is to be installed implying a pay sacrifice (s) for all three employees. Now suppose that the judgments of the three individuals on p, q, r, and s are as indicated in the table below. Also suppose that the collective decision is made by majority decision on the individual issues p, q, and r and then deducing s from ($\hat{p}$ $\hat{q}$ r). The result would be that the device is installed and that they all have to accept a pay sacrifice. But who is responsible for this outcome? According to Pettit neither A, B, or C can be properly be held responsible for the decision because each of them believed that the safety device was not worth the pay sacrifice and voted accordingly as can be seen from the table (based on the matrix in Pettit 2007, p. 197). Pettit believes that in cases like this the collective can be held responsible even if no individual can properly be held responsible. Like in the case of the tragedy of the commons, this suggests that the collective agency may make it impossible to hold individuals responsible for collective harmful effects.

In addition to the salience of collective agency today, in today's society negative consequences often result from risk rather than being certain beforehand. Whereas moral theories traditionally deal with situations in which the outcome is knowable and well determined, societies today spend a considerable amount of time and money managing risks, that is, situations in which there is a probability of harm. If it is difficult to decide whether killing is always wrong when done by and to individuals, it is even more difficult to decide whether it is acceptable to expose another human being to the risk of, say 1 in 18,000, of being killed in a road crash. Or, on the societal level, are the risks associated with nuclear power ethically acceptable? Would a difference in probabilities matter to the ethical acceptability and if so, where should the line be drawn between acceptable and unacceptable probability? It is difficult to know how to begin to answer these questions within the traditional ethical frameworks (Hansson 2009). The questions concerning the

Table 5.1 The discursive dilemma (based on Pettit 1997)

	Serious danger? (p)	Effective measure? (q)	Bearable costs? (r)	Pay sacrifice s(p̂ q̂ r)
A	No	Yes	Yes	No
B	Yes	No	Yes	No
C	Yes	Yes	No	No
Majority	Yes	Yes	Yes	(Yes) no

ethical acceptability of risks clearly have implications for responsibility. If A kills B, A is reasonably held responsible for it and the consequences of that vary according to norms and context. If A exposes B to the risk of 1 in 18,000 of being killed in a road crash, in what way is A responsible for that risk exposure? Interestingly, while it appears more intricate to decide how someone is responsible for exposing another person to the risk of dying than it is to decide whether someone is responsible for killing that person, the very concept of risk appears to imply some sense of responsibility. A risk is often seen as something we can or ought to be able to manage and control (cf. section Conceptual Relations Between Risk and Responsibility).

Thus, contemporary society is confronted by more collective agency and possibly more risks. These two features put the so-called problem of many hands (PMH) to the fore. A lot may be at stake: people's lives, the environment, and public health. Furthermore, in addition to cases where the probability is relatively well known, technological research and development entail substantial uncertainty about future hazards about which we do not have any knowledge today.

Climate Change as an Example

Climate change is an illustrative example of a substantial risk (or cluster of risks) for which it is extremely difficult to ascribe and distribute responsibility and which is caused by more or less all human beings, private companies, and governments. It is therefore a possible example of the PMH.

In debates about climate change, various notions of responsibility are at play (cf. section Conceptions of Responsibility) as is reflected in the different principles of responsibility that have been proposed. First, there is the polluter pays principle (PPP) stating that the polluting actor, that is, the one who caused the pollution, is the actor who ought to pay the cost (United Nations 1992; Caney 2005; Shue 1999). This principle applies a backward-looking notion of responsibility since it focuses on the causal link, but it also associates backward–and forward-looking responsibility in the claim that the one who caused the damage is also the one who should rectify the situation.

Second, there is a principle referred to as common, but differentiated responsibilities (CDR), which states that although all countries share responsibility for climate change, the developed nations have a greater share of responsibility to do

something about it (forward-looking responsibility) because their past and current causal contribution is greater (backward-looking responsibility) (United Nations 1998). Thus, both the PPP and the CDR assume that the agent who caused climate change is also the one who is responsible to improve the situation. We often think about responsibility in these terms, but it is possible to conceive of responsibility for climate change differently. The ability to pay principle represents a different approach (Caney 2010). Originally, this principle is associated with a progressive tax system to justify why wealthy people should pay a greater share of their incomes in taxes than poor people in order to maintain a social welfare system. It is possible to design a principle of responsibility for climate change in a similar vein. A central principle in ethics is "'ought' implies 'can'" essentially meaning that it does not make sense to demand that people do X if they are unable to do X. It has also been argued that sometimes "'can' implies 'ought'" (Garvey 2008). This means that it may be reasonable to attribute a greater share of responsibility for climate change to developed nations not only because they contributed more to the causal chain, but because they simply have more resources to do something about it. This would of course not be reasonable for all risks, but considering the scope and potentially devastating consequences of this particular cluster of risks, it may be a reasonable principle in this case.

We have seen that there are different ways of approaching the distribution of responsibility for climate change between collective actors. In addition, there is the question about how to distribute responsibility between individuals versus collective agents, for example, governments and private companies. To what extent are individuals responsible? Furthermore, in what ways and for which parts are they responsible? Some philosophers argue that individuals are responsible, in the sense of accountability and blameworthiness (backward-looking responsibility) (e.g., Braham and van Hees 2010). Others argue that individuals are not responsible, but that governments are (e.g., Sinnott-Armstrong 2005), and still others argue that individuals are responsible in a forward-looking way, but that they are not to blame for how climate change and environmental problems came about (e.g., Nihlén Fahlquist 2009).

By talking about risks instead of direct harm, we have changed the perspective of time. A risk that something negative could happen is something for which someone can take responsibility and do something about. This is different from cases in which harm has already been done. When the risk has materialized, we want to find someone to blame or give an account of what happened. We need a backward-looking notion since harm will be done and we will want to blame someone to compensate victims. However we also need responsible engineering, research, and risk management, that is, people who act responsibly in order to minimize the risks to society, people, and the environment.

The typical PMH situation occurs when something undesirable has happened as a consequence of collective acting. The PMH can be described by the question: "Who did that?!" which is the epistemic problem of knowing who actually did something to cause the undesired event, but the PMH can also point to the normative problem that we cannot find anyone whom it would be fair to hold

responsible for the undesired event. The responsibility notion assumed in this question appears to be individualistic and backward looking. Although this notion of responsibility is common and in some ways necessary, there are other notions which may complement it. After all, if we are interested in solving the PMH we probably have to look not only for ways to attribute blame when a risk has materialized, but also for ways in which risks can be reduced or managed in a responsible way to prevent them from materializing. Presumably, what we want is to prevent the PMH from occurring. In the following sections, we will look into three ways to, if not replace, supplement the "Who did that?!"-approach to responsibility: responsibility as a virtue (Responsibility as a Virtue), responsibility distributions (The Procedure of Responsibility Distribution), and institutional design (Institutional Design).

Responsibility as a Virtue

Responsibility is an unusually rich concept. Whereas many notions of responsibility focus on attributing blame for undesired events, there is also a notion that focuses on character traits and personality. To be responsible can be more than having caused X, being blameworthy for causing X, or even having particular obligations to do something about X. Responsibility can also be a virtue and a responsible person can be seen as a virtuous person, that is, having the character traits of a responsible person (see section Conceptions of Responsibility). We will now take a closer look at this virtue-ethical notion of responsibility.

By researching, developing, and using technology, opportunities are created. In this process, risks are created as well. In essence, technology creates opportunities and threats. It is, in this sense, a double-edged sword. For example, we want oil for energy, which means that we have to deal with risk of leakage as well as the actual leakage when it happens. Although we live with risks every day, it becomes clear to most people only when the risk actually materializes. Intuitively many people probably think that activities providing us with opportunities, but also risks, imply an increased sense of responsibility and that such activities should be carried out responsibly.

To associate the concept of responsibility with character traits and a "sense of responsibility" means having a closer look at virtue ethics (see "Risk and Virtue Ethics"). Virtue ethics is often mentioned as the third main branch of ethical theories (next to consequentialism and deontology). Virtue ethicists attempt to find answers to questions of what an agent should do by considering the agent's character and the morally relevant features of the situation (Van Hooft 2006, p. 21). Seeing responsibility as a virtue would entail a focus on how to develop and cultivate people's character with the aim to establish a willingness to actively take responsibility. A willingness to take responsibility involves emotions such as feeling personal involvement, commitment, and not leaving it to others, a feeling that it is up to me and a willingness to sacrifice something (Van Hooft 2006, p. 144,

see "Moral Emotions as Guide to Acceptable Risk"). It is not the same as a willingness to accept blame for things an agent has done wrong (backward looking) although that may be one part (Van Hooft 2006, p. 141). The main focus is on forward-looking responsibility.

One important aspect of responsibility as a virtue is the recognition that being a responsible person is about carefully balancing different moral demands (Williams 2008, p. 459). Against the background of the different kinds of moral demands human beings face today, it may be difficult to point to one action which is the only right one. Instead a virtuous-responsible person uses her judgment and finds a way to respond and optimize, perhaps, the various demands. Against this background, it could be argued that in order to avoid PMH, we need virtuous-responsible people who use their judgment to form a balanced response to conflicting demands. This could be one way of counteracting the organized irresponsibility of contemporary society. The question is of course how such a society or organization can be achieved. Virtue ethicists discuss upbringing, education, and training as ways of making people more virtuous (Hursthouse 2000; Aristotle 2000).

As mentioned in section The Problem of Many Hands (PMH), there are two features of contemporary society which combine to put the PMH to the fore. First, collective agency is increasing. Second, the number of risks has increased, or at least our desire to control risks has grown stronger. A virtue approach to responsibility may counteract the problem of many hands in two ways, both related to the second feature. First, focusing on responsible people may prevent risks from materializing instead of distributing responsibility when it has already materialized (see "Risk and Virtue Ethics"). Responsible people are concerned about risks to human health and the environment because they care and they use their judgment to prevent such risks from materializing. Second, when risks do materialize responsible people will not do everything to avoid being blamed, but will take ownership of what happened and make sure the negative consequences are minimized. Whether the virtue notion of responsibility could also meet the challenge of increasing collective agency is less straightforward. It could be argued that the very tendency to have more collective agency counteracts responsibility as a virtue since people can hide behind collective agents. However, the collectivization could also be seen as making it ever more important to develop a sense of responsibility. Such a development would probably start with moral education and training of young children, something which virtue ethicists often suggest as a way to cultivate virtue. It would also require organizations that foster virtues and a sense of responsibility (see also section Institutional Design).

The Procedure of Responsibility Distribution

As mentioned earlier, the concept of responsibility is extraordinarily rich and refers to not one but many different notions. In addition to the difference between legal and moral responsibility, there are many different notions of moral responsibility. It is

not surprising that people have different notions in mind and what may appear as conflicts about who is responsible for a certain state-of-affairs may sometimes primarily be misunderstandings due to lack of conceptual clarity. However, it is not merely conceptual lack of clarity which causes differences. People disagree about the normative issues involved, that is, how responsibility should be understood and distributed. This is true for people in general and surely holds for professionals as well. According to Doorn (2010, 2011), the prevalence of differences in views on responsibility may cause the PMH. One way of attempting to resolve these differences may be to focus on the procedural setting instead of the substantive conception of responsibility. In order to do this, it is important that we agree that there are disagreements. The solution is not to find and apply the right one, but rather to achieve respect for differences, consensus concerning the procedural setting (this may of course be hard to achieve), and possibly agreement on concrete cases of responsibility distributions.

In political philosophy, John Rawls famously showed that what is needed in pluralist societies is a consensus on the basic structure of society among different religious, moral, and other "comprehensive doctrines" (Rawls 1999 [1971], 1993). He argues that we cannot expect that all citizens in a pluralist society agree on politics, but there are some basic principles to which most reasonable people regardless of which doctrine they adhere to would agree, not the least because those very principles would grant them the right to hold those different doctrines. In order for people with different comprehensive doctrines to agree to a basic structure as being fair they justify it through working back and forth between different layers of considerations, that is, their (1) considered moral judgments about particular cases, (2) moral principles, and (3) descriptive and normative background theories. When coherence is achieved between these different layers, we have achieved a wide reflective equilibrium (WRE). In spite of differing judgments on particular cases, different moral principles, and background theories, people can justify the basic structure of society. When many people agree on the basic principles of fairness through different WRE we have an overlapping consensus. Therefore, even if the ways in which we justify it may differ substantially everyone agrees on something, that is, the basic structure of society.

Doorn applies Rawls' theory to the setting of R&D networks (see also Van de Poel and Zwart 2010). The aim is to develop a model which shows how engineers do not have to agree on a specific conception of responsibility as long as they agree on fair terms of cooperation. R&D networks are non-hierarchical and often lack a clear task distribution, which leaves the question of responsibility open. Doorn shows how a focus on the procedure for responsibility distribution instead of a substantive conception of responsibility makes it possible for engineers to agree on a specific distribution of responsibility. They can agree to it because the procedure was morally justified and fair, even if they disagree about a specific notion of responsibility. This way responsibility is distributed, that is, the PMH is avoided, but the professionals do not have to compromise their different views on responsibility. Without reaching a consensus on a responsibility notion or a responsibility distribution, consensus is reached on a procedure yielding legitimate

responsibility distributions. In addition to Rawls' procedural theory there are others theories, for example, based on deliberative democracy that are set out by authors like Habermas, Cohen, and Elster which can be used in order to help focus on the procedure of distributing responsibility instead of the substantive notions (see, e.g., Habermas 1990; Bohman and Rehg 1997; Elster 1998).

Institutional Design

We have discussed responsibility as a virtue (Responsibility as a Virtue) and the procedure by which responsibility may be distributed (The Procedure of Responsibility Distribution) as two ways of counteracting the problem of many hands. We will now look at the importance of institutions. In particular, we will look at what has been called institutional design, the purposeful design of institutions (see, e.g., Weimer 1995). Since institutions generally already exist and cannot be designed from scratch, institutional design usually amounts to modulating or changing existing institutions. Institutional design may contribute to solving the PMH in two different ways: (1) it might create the appropriate institutional environment for people to exercise responsibility-as-virtue and (2) it might help to avoid unintended collective consequences of individual actions. We will discuss both possibilities briefly below.

Institutions may facilitate virtuous or vicious behavior. As argued by Hanna Arendt (1965), Eichmann was an ordinary person who, when he found himself in the context of Nazi-Germany, started to behave like an evil person. Institutions may socialize people into evil doing. Although most cases are not as dramatic and tragic as Eichmann's case, the institutions within and through which we act affect to what extent we act as responsible people. Larry May (1996) has developed a theory of responsibility that connects ideas about responsibility as a virtue to institutions. Institutions can facilitate and encourage or obstruct virtuous behavior. May discusses the ways in which our individual beliefs may change at the group level. The community has an important role in shaping the beliefs of individuals. Relationships between people require a certain collective consciousness with common beliefs. The important point about May's theory is that to foster a sense of responsibility-as-virtue among individuals in a group or organization requires an appropriate institutional environment. As we have argued before (Responsibility as a Virtue) fostering responsibility-as-virtue may contribute to solving the PMH. The additional point is that doing so not only requires attention for individuals and their education but also for their institutional environment.

The other way that institutional design can contribute to solving the PMH is by devising institutions that minimize unintended collective consequences of individual actions. As we have seen in The Problem of Many Hands (PMH), the PMH partly arises because the actions of individuals may in the aggregate result in consequences that were not intended by any of the individuals. The tragedy of the commons and the discursive dilemma were given as examples of such situations.

The phenomenon of unintended consequences is, however, much more general. The sociologist Raymond Boudon (1981) has distinguished between two types of systems of interaction. In what he calls functional systems, the behavior of individuals is constrained by roles. A role is defined by "the group of norms to which the holder of the role is supposed to subscribe" (Boudon 1981, p. 40). In interdependent systems, roles are absent but the actors are dependent on each other for the achievement of their goals. An ideal-typical example of an interdependent system is the free economic market. The tragedy of the commons in its classical form also supposes an interdependent system of interaction and the absence of roles, since the actors are not bound by any institutional norms.

According to Boudon, emergent, that is, collective, aggregate effects are much more common in interdependent systems than in functional systems. Reducing emergent effects can therefore often be achieved by organizing an interdependent system into a functional system. This can be done, for example, by the creation of special roles. The "invention" of the role of the government is one example. In cases of technological risks, one may also think of such roles as a safety officer or safety department within a company or directorate, or an inspectorate for safety within the government. Another approach might be to introduce more general norms as constraints on action. This is in fact often seen as the appropriate way to avoid a tragedy of the commons. In both cases new role responsibilities are created. Such role responsibilities are obviously organizational in origin, but they may entail genuine moral responsibilities under specific conditions, like, for example, that the role obligations are morally allowed and they contribute to morally relevant issues (see also Miller 2010).

Conclusion

There are many different conceptions of risk and psychologists and philosophers have pointed out the need to include more aspects than probabilities and consequences, or costs and benefits when making decisions about the moral acceptability of risks. It remains to be seen whether these additional considerations also need to be built into the very concept of risk.

In addition there are many different notions of responsibility, and the exact relation between risk and responsibility depends on how exactly both notions are understood. Still in general, both risk and responsibility often refer to undesirable consequences and both seem to presuppose the possibility of some degree of control and of making decisions that make a difference.

We started this chapter by mentioning the Deepwater Horizon oil spill in 2010. People were outraged when it occurred and, it seems, rightly so. It raised the issue of responsibility-as- blameworthiness because it appeared as though there had been wrongdoing involved. However, it also raised the issue of responsibility-as-virtue since a lot of people joined the work to relieve the negative consequences of

the oil spill and to demand political action to counteract companies from exploiting nature and human beings.

As this example shows, there is not only backward-looking responsibility for risk but also forward-looking responsibility. We discussed in some details relevant forward-looking responsibilities that might be attributed to engineers, risk assessors, risk communicators, and risk managers. We also discussed that risks may be more or less seen as individual or collective responsibility.

We ended with discussing the problem of many hands (PMH), which seems a possible obstacle to taking responsibility for the risks in our modern society. We also suggested three possible ways for dealing with the PMH: responsibility-as-virtue, a procedural approach to responsibility, and institutional design. What is needed is probably a combination of these three approaches, but the discussion suggests that there is also hope in that people are able to unite and release a collective sense of responsibility.

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