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# Risk and Technology Assessment

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# Risk and Technology Assessment

*Rinie van Est, Bart Walhout, Frans W.A. Brom*

## Abstract

This chapter provides an overview of the changing relationship between risk, technology assessment (TA), and risk assessment (RA). It does so by comparing the development of the practice of parliamentary TA and RA, the way risk is interpreted in these practices, and the political role these practices play in dealing with risks. The basic argument is that originally RA and TA presented politically separate practices. Over the last decade the conceptual gap between these two practices has been bridged to a large extent. We start with describing the classical approaches to TA and RA, which developed in 1960s in the United States and where guided by the belief that scientific methods would improve decision making around the risks involved in science and technology. Classical parliamentary TA and RA present very distinct scientific and political practices, with different conceptions of risk and political roles. The classical approach to risk operated with a narrow mathematical definition of risk. Classical TA defined risk in a much broader fashion; risk referred to a broad set of (potential) negative social effects of science and technology. RA was thought to help the government in managing risk, by depoliticizing risk management. In contrast, parliamentary TA aimed to enable a political debate within Congress, and thereby strengthening the position of Congress vis-à-vis the executive branch. Throughout the years both practice and scientific literature have revealed basic shortcomings of the classical approach to TA and risk. Driven by the concept of uncertainty the role of RA and TA, and their interpretation of risk, have changed. Modern risk approaches are expected to deal with both calculable and uncertain risk. TA is encouraged to look beyond effects, to also analyze current visions and values that drive science and technology. Based on the concept of uncertainty, attempts have been made to characterize risk or problem situations in order to clarify the limitations of the classical RA and TA approaches. The claim is that in case of scientific and regulatory uncertainties, and value dissent more participatory approaches to RA and TA are required, which seek to represent public controversy. The IRGC risk governance framework can be seen as exemplary for the new risk approach. From a risk governance perspective RA and parliamentary TA have become complementary practices. The case of risk governance on nanotechnology in the Netherlands proves this point. However, parliamentary TA's role within risk governance presents a remarkable blind spot on the current research agenda.

## 1. Introduction

This chapter aims to discuss the relationship between risk and technology assessment, in particular parliamentary technology assessment. Technology assessment (TA) is driven by an awareness about potential positive and negative effects of technological change and the hope that one can anticipate these effects. Since it deals with the interplay between technological change and (potential) social problems TA has a clear political side to it (Van Est & Brom forthcoming). This counts in particular for parliamentary TA, which this chapter will focus on. Although risk and TA clearly touch each other in all kinds of ways, such an exercise – to our knowledge – has never been undertaken before. This is quite surprising since on first sight the relationship between risk and TA seems to be a close and obvious one. Take for example this quote by Grunwald (2009, p. 1131): “One of the main reasons for the emergence of TA was because of the risks directly or indirectly caused by technology and its use. ... TA should and does contribute to the early signaling of risks and how they should be dealt with.” Discussing the above relationship, however, is a rather complex, but still worthwhile task, because it is of particular interest for current debates on risk politics and governance.

### *No straightforward connection*

Discussing the relationship between TA and risk is not a straightforward task. Take for example, the fact TA is not built around a precisely defined concept of risk. At least the classical risk approach provides a clear technical definition of risk, even a formula to calculate risk. Namely risk is generally defined as the product of the magnitude of the possible adverse consequence(s), and the probability of occurrence of each consequence. In contrast, ‘risk’ within the current TA practice tends to refer to a “colloquial meaning of the term risk” (Maassen and Merz 2006, p. 25), in the sense that risk in TA equates with (negative) social impacts of science and technology in general. There are at least three other reasons why the connection between risk and TA is not obvious.

First, no unambiguous and selective definition of TA exists (Grunwald 2009). This is because TA is neither a separate field of scientific research nor a well-defined, clear-cut practice. Disciplines ranging from policy and political sciences to ethics, science and technology studies, communication sciences, and social and cultural studies, have all influenced the way TA is understood, performed and institutionalized. TA is being employed in wide variety of institutional settings, covering many functions, goals, methods and target groups. TA can be found in industry to help product development, close to politics to provide information and stimulate the parliamentary and public debate. TA is also employed as an instrument to guide scientific research from a societal perspective. For example, studies on ethical, legal and social aspects (ELSA) of science and technology have been increasingly integrated in large research programs in order to integrate societal considerations in research choices.

Second, risk assessment (RA) is about assessing (technical) risks. RA provides scientific input into the risk management process, that is, the political decision making process about how to deal with risk. Parliamentary TA is not primarily about assessing (technical) risks. Its

main political role is to help the democratic system to deal with (potential) public controversies on science and technology. These public controversies might be driven by concerns on safety, but also wider public concerns. Public controversies come into play because various groups may have different interests or different views on what the problem is, and what kind of solutions should be strived for. Democratic politics is a way to deal with public controversies that includes free and open deliberation and also exercising power. Political practice is about connecting these two poles (cf. Jaspers 1965), and TA is supposed to play a positive and constructive role in achieving that.

Finally, the practice of parliamentary TA and the practice of assessing and politically managing risk are not static ones, but constantly developing. Both the classical approach to TA and risk were first developed and institutionalized in the United States during the 1960s and 1970s. Since then both practices have spread around the world. Throughout the years both practice and academic literature as well as encountering new political cultures have changed the practice of parliamentary TA. Also the classical risk approach has received a lot of criticism. In particular, the political value of the technical definition of risk has been hotly debated over the years.

### *Complementary political roles*

The fact that analyzing the relationship between risk and TA is dynamic and complex does not imply that it is impossible or not useful to do so. We believe that it can be fruitful to clarify in a systematic way how parliamentary TA interprets risk and how this practice touches the practice of risk assessment. Both TA and RA provide scientific input into the political decision making process on how society handles risks. One might say that TA relates to the parliamentary debate in the same way as RA relates to the political process of governing risks. Lynn's (1981) game metaphor of the political decision making process gives us a second impression of how the practice of TA and RA relate to each other. Lawrence E. Lynn distinguishes three games within the political decision making, corresponding to three levels within the political system. The high game involves deciding on whether there is a role for the government. It focuses on deciding the right thing to do and identifying the social values that are explicitly at stake. The middle game is more concretely about what the role of the government is going to be, about the effectiveness and efficiency of policy interventions. The low game is about the formulation of the precise design of the related policy instruments. Roughly speaking, parliamentary debate and TA are situated in the high and middle political game, while risk assessment and management are situated more in the middle and low game. The roles and practices of TA and RA thus seem to be complementary, and partially overlapping. From this line of argument follows the central aim of this paper: to analyze to what extent the political practice of (parliamentary) TA and risk assessment may inspire and complement each other in a constructive manner. For this, we will describe and compare the political role TA and RA play within the political decision making process on risks, in connection to the way they interpret the notion of risk.

## *Contents*

Section Classical Risk Approach and TA compares the classical approach to RA and TA. Both practices arrived in the 1960s and were politically legitimized in similar ways. Both approaches were based on the assumption that science-based expertise would rationalize the political decision making process on technology related risks and controversies. Nevertheless, their political roles and their conception of risk differed strongly. While RA was meant to rationalize the political debate on technological risks, parliamentary TA's role was to strengthen the position of the parliament vis-à-vis the government. Besides, while RA had a narrow probabilistic definition of risk, TA used a common sense notion of risk, referring to a broad set of (potential) social effects of science and technology. The classical forms of RA and TA became severely challenged by two fundamental and interrelated forms of critique: the issue of problem framing and representation. The next three sections deal with, two aspects of problem framing.

Section Interpretation of Risk with RA and TA analyzes various shifts in the interpretation of risk within TA and RA. TA has broadened its scope from focusing on (potential) effects of technology towards the current visions and values that shape science and technology. RA has broadened its perspective from risks that are calculable based on past experience towards (future) uncertain risks. Section Risk Characteristics and RA and TA looks at the relationship between characterizing the risk situation and its implications for the appropriate roles and approaches to RA and TA. With respect to characterizing the risk situation the notion of uncertainty has slowly entered the minds of political decision makers during the 1990s. This awareness revealed the boundaries of the classical risk approach, by limiting it to so-called simple risk problems. Moreover, it underpinned the legitimacy of participatory approaches in TA and RA.

Section New (Participatory) Approaches to TA and RA deals with the issue of representation, that is, the question of who is allowed to define the risk problem at stake. The basic complaint is that expert-based classical approaches do not sufficiently represent public concerns on risks. To address this shortcoming new (participatory) approaches to TA and RA have been proposed which aim to involve a broader set of social actors within the political decision making process on technology related risks. In particular, this section investigates the relationship between the risk governance model (see also the contribution by Hermans, Fox and van Asselt on risk governance in the present book) and TA. Our analysis shows that the risk governance model includes various typical TA elements and visions. Exactly this makes a comparison of the practice of politically dealing with risk and parliamentary TA of current interest.

Section An Example: Risk Governance of Nanotechnology in the Netherlands describes the case of risk governance on nanotechnology in the Netherlands. This case shows how parliamentary TA has a fruitful role to play in the governance of risk. The final Section Future Research will make some concluding remarks and describes some themes that require further research.

## 2. Classical risk approach and TA

Risk assessment and technology assessment were first developed in the United States (Bimber and Guston 1997). During the 1960s, the rise of decision theory, operations research and system theory had raised the hope that scientific methods could improve decision making around science and technology (Bereano 1997). This belief rendered political legitimacy and support to the idea of risk assessment and technology assessment in the United States.

For example, to calculate the probability of accidents in the field of nuclear power and aerospace quantitative risk assessment tools were developed. This led to the so-called classical risk approach. In the same period, the scientific community in close interplay with the Congress developed a classical TA approach, which defined TA as “a policy study designed to better understand the consequences across society of the extension of the existing technology or the introduction of a new technology with emphasis on the effects that would normally be unplanned and unanticipated.” (Coates 2001, p. 303) Eventually, this led to setting up a TA institute in the U.S. Congress in the early 1970s. This section gives a short description of both the classical risk approach and classical TA, and compares the way they interpret risk, and their presumed political roles within the decision-making process.

### 2.1. Classical risk approach

#### *Risk as a calculable property*

In the scientific literature many definitions of risk can be found (for an overview cf. Renn 2005, p. 141-142). Most definitions, however, normally consist of two elements. The first element refers to damage, undesired impacts or adverse effects. The second element speaks of chance, likelihood or probability of such harmful consequences. The most prevailing definition combines the chance that a given hazardous effect will occur and the impact this will have. Risk became interpreted as the product of the magnitude of the potential loss or damage and the probability that that loss will occur. This is reflected in the often used (risk) formula: “risk = probability x effect”. The corner stone of the classical approach, thus, is to quantify certain risks.

#### *Separating science and politics*

This formula forms the basis for the classical risk approach which became dominant during the 1960s in the way Western societies politically deal with risks. In this approach basically two stages can be distinguished. In the risk assessment phase, risk experts try to quantify relevant risks (Renn 2005, p. 27). Risk experts first have to identify and, if possible, make an estimation of the hazard. Next, they have to assess the exposure and/or vulnerability to the danger. Finally, they have to make an estimation of the risk based on the former two steps by using the risk formula. In the risk management stage risk managers take measures to deal with or control various unacceptable risks. The classical risk approach is founded on a clear

(institutional) distinction between the risk assessment and management stages, or in other words between the ‘science’ of estimating risks and the ‘politics’ of taking risk measures (National Research Council 1983). It was feared that otherwise political pressure could harm scientific independence, which could lead to over- or underestimating certain dangers.

## **2.2. Classical TA as expert-driven policy analysis**

### *Empowering Congress vis-à-vis government*

Over the 1960s public awareness grew of potential health and environmental risks related to new technologies. It was felt that representative institutions were failing to deal with the negative side-effects of technological change. The need to estimate the environmental impact of a proposed (technological) project became regulated by the National Environmental Policy Act (1970). TA was “in some ways an enlarged version of the awareness that led to the extensive development of environmental impact statements (EIS)” (Coates 2001, p. 303). In 1972 the Technology Assessment Act acknowledged the need to anticipate on a broader spectrum of social effects of technological change, besides health and environmental impacts (U.S. Congress 1972). Its passage in the House led to the creation of the Office of Technology Assessment (OTA) in the U.S. Congress. The foundation of OTA was driven by the U.S. Congress’ desire to assess the political, economic, and social aspects of technological change independently from the executive. Already in the early 1960, the Congress of the United States was confronted with an increasing science and technology budget, related to ambitious projects, like putting a man on the moon. Congress became concerned about its lack of ability to evaluate matters of scientific and technical complexity. Lacking critical, independent information, Members of Congress feared they were becoming “the rubber stamps of the administrative branch of government” (Democrat George Miller (1961) quoted in Kunkle 1995).

### *Policy analysis versus democratization*

Several competing political agendas concerning the function of TA were in play. While some saw OTA primarily as an instrument to strengthen the Congress’s scientific oversight of federal science and technology initiatives, others wanted TA to be an instrument for democratization (Bereano 1997). The 1960s had seen the revival of Jeffersonianism, with its trust in community self-reliance and grassroots democracy. With respect to the practice of TA, Jeffersonian ethics implied a call for more public participation in the political decision-making process concerning new technologies. In 1973 and 1974, a coalition of public interest groups and individuals tried to assure that OTA would develop participatory processes. This, however, did not become common practice within OTA. In the early 1960s, members of Congress realized that the executive branch had close relationship with the National Academy of Sciences, while Congress was lacking such contacts (Kunkle 1995). During the 1960s closer bonds between the National Academy of Sciences and Congress were created. In that process, the scientific community was successful in turning OTA primarily into a scientific instrument. Accordingly, OTA defined its practice of TA primarily as a form of

critical-rational policy analysis. The aim of this expert-driven policy analysis was seen as “speaking truth to power”. Nevertheless, Congress continued to call for inclusion of wider social values and perspectives in TA. This led to the development of a system of controlled consultation with some experts and interest groups.

**2.3. Comparative conclusions**

Both the classical risk approach and classical (parliamentary) TA are guided by the belief that scientific methods can improve political decision making around science and technology. Still, they clearly present very distinct scientific and democratic practices, with different conceptions of risk and different political roles (see Table 1).

Within the classical risk approach risk became mathematically defined through the risk formula. Within TA risk was interpreted in a much broader and more social science oriented fashion. Although RA was part of the TA methods toolbox, ‘risk’ within the TA community referred to everything that forms a danger. This definition reflected the demand from Congress, which was interested in a broad set of (potential) social effects of science and technology.

Related to this, the political roles of RA and TA were quite distinct. Risk assessment was thought to help the government in managing risk. The hope was that the scientific information delivered by RA could depoliticize risk management, and make it into a bureaucratic process. The objective of classical TA was to provide neutral expert advice, which would strengthen the Congress’s position vis-à-vis the executive branch. In other words, its role was to enable and strengthen the political debate about risk. Also the fact that TA was intended to assess a broad set of social effects gave Congress the means to discuss risks related to science and technology from a broad public perspective.

**Table 1.** Comparing the classical risk approach and classical parliamentary TA.

	<b>Classical risk approach</b>	<b>Classical parliamentary TA</b>
<b>Science</b>	Risk assessment	Technology assessment
<b>Interpretation of risk</b>	Risk = Probability x Effect	Broad set of (potential) social effects of science and technology
<b>Political role</b>		
<b>Interface science – policy making</b>	Informing (governmental) risk managers about technical risks	Informing MPs on social effects of S&T
<b>Interface government – parliament</b>	Rationalizing the political decision making process on risk management	Empowering the Congress vis-à-vis the government
<b>Interface society – policy making</b>	--	Rationalizing (preventing) public controversy (by anticipating on social effects)

## **2.4. Two basic shortcomings of the classical risk approach**

Over the last decades both practice and scientific literature have revealed many shortcomings of the classical approach to TA and risk. Basically two closely related categories of critique can be discerned. The first type of concerns relates to problem framing. Section Interpretation of Risk with RA and TA deals with the issue of how to interpret risk, and what this implies for the object of study and role for RA and TA. Section Risk Characteristics and RA and TA looks at the discussion on characterizing risk or TA problem situations. In particular, this debate plays a role in clarifying the limits of the classical approaches and legitimizing new (participatory) approaches to RA and TA.

The second category of critique is about the question of 'who defines', causes or is affected by or is responsible for dealing with the problem. It was described above that from the onset parliamentary TA was confronted with a competing participatory perspective on parliamentary TA. The classical risk approach received similar points of critique. The complexity of assessing risks was thought to give room to experts to bring in their own values in the decision-making process in a way that could not easily be detected by the public. Such an opaque highly expert-driven assessment was found not be in tune with modern democratic principles. Since risks are often problematic complex constructs it is a major democratic challenge to translate these constructs into "debatable risks" (WRR 2008, p. 113) Section New (Participatory) Approaches to TA and RA describes and compares the rationales for new (participatory) approaches to TA and RA.

## **3. Interpretation of risk with RA and TA**

Throughout the years both RA and TA practices have been criticized for having a too narrow focus, and therefore for being scientifically misdirected or politically biased. For example, both TA and RA were accused of focusing too much on bad chances and too little on good chances. Moreover, classical risk assessment was criticized for employing a too narrow definition of risk, i.e. risk as a calculable entity. It was feared that such a narrow conceptualization would preclude a debate about broader public concerns. Classical TA was less vulnerable to such a critique because it employed a common sense definition of risk, encompassing all kinds of social effects of science and technology. Still, classical TA was criticized because of its sole focus on 'social effects', and not on 'social drivers' of technological change.

### **3.1. RA: From calculable to uncertain risks**

The classical risk approach assumes that it is possible to define and assess risks. The assumption that risks can be objectified and calculated has met with a lot of criticism. Notions like complexity and uncertainty to characterize the risk situation have played a central role in clarifying the limits of the classical risk approach.

### *Bad and good chances*

In *Searching for safety*, Wildavsky (1988) argued that “playing it safe” may also present a danger. He argued that besides bad chances, there are also good chances. Risk assessment then should also be able to characterize the good chances.

### *Public perception*

Already in the 1970s, the assumption that risks can be “objectified” and calculated met with a lot of criticism. The classical risk approach was attacked for not being able to take account of human perceptions (cf. Slovic 1978/2000). For example, the risk formula might attribute equal weight to a major disaster having a low probability and a small accident having a high probability. Most people, however, are more fearful of a major disaster with a low probability. This critique challenges risk assessors and risk managers to come up with an approach that takes into account the way people talk about and perceive risks.

### *Complexity*

Moreover, it was argued that in many circumstances, it is not self-evident to define what the hazards, their probabilities and the consequences precisely are (cf. Fischhoff et al. 1981). In particular, the interactions of humans and/or technological subsystems are much more complex than an a priori risk assignment can capture. Perrow (1984) even talked about ‘normal accidents’, arguing that when a technology has become sufficiently complex and tightly coupled, accidents are inevitable and therefore in a sense “normal”. As a consequence the role played by organizational failures are very hard to take into account. This also counts for the human element in the decision-making process around risk.

### *Broader public concerns*

It was also feared that a narrow focus on the assessment of risks, but also ‘risk perception’, would prevent a debate about broader public concerns (Felt 2007). For example, with respect to GM food, the classical risk approach focuses on assessing the related safety risks. In the public debate, however, freedom of consumer choice plays a central role. Another major source of public concern is the inadequacy of the classical approach to deal with risk. The classical risk approach does not provide space for a proper discussion about the institutional incapacity to deal with (often unpredictable) ethical and social impacts of science and technology. As a consequence, the shortcoming of the classical risk approach exactly provokes such a debate.

### *Risk versus uncertainty*

The concept of uncertainty has played an important role in clarifying the limits of the classical risk approach and promoting new approaches and considering wider public concerns. It has been argued for long that not all decision making situations can be characterized as

situations of risk. The economist Knight (1921) made a distinction between situations characterized by risks and uncertainty. In some circumstances entrepreneurs may be able to calculate certain risks based on experience. In other cases decision making is more speculative. In those cases, Knight talked about making decisions under uncertainty. Harremoës et al. (2001, p 192) have emphasized a third type of problem situation: ignorance. According to the authors risk is about 'known' impacts and probabilities, and a situation of uncertainty is characterized by 'known' impacts, but 'unknown' probabilities. One may speak of a situation of ignorance when also the impacts are 'unknown'.

### *Uncertain risks*

Various authors have argued that the above dichotomies – risk versus uncertainty, calculable versus non-calculable and knowing versus non-knowing – are flawed (cf. WRR 2008, Van Asselt et al. 2009). For several reasons they prefer to talk of 'uncertain risks' (Everson and Vos 2009). First of all, such a term better connects to the way society speaks about and deals with risks. In the public debate various types of uncertainty – e.g. scientific uncertainty and regulatory uncertainty (Hood *et al.* 2001) – are attributed to the notion of risk. Here risk broadly refers to 'bad chances', like damage, loss, calamities and disasters. Moreover, despite all the uncertainties involved in waste disposal, genetically modified food or climate change, these developments are subjected to RA and management. Second, risk situations characterized by uncertainty have become increasingly common. This relates to the fact that current risk assessment is mostly future-oriented. The basis for risk assessment, therefore, has shifted from *probability*, based on experience in the past, to *possibility*, based on expectations about the future. Finally, these authors prefer to speak of 'uncertain risks' to imply that risk situations of uncertainty do not make science and expertise irrelevant. Although most risk situations are characterized by uncertainties, they are certainly not characterized by the absence of knowledge. Within the classical risk approach the role of science was "to speak truth to power". Uncertain risks imply a different role. As Van Asselt et al. (2009, p. 363) hold: "In the context of uncertain risks, risk assessment has, or should have, a different meaning: delineating uncertainty information seems an important challenge."

### **3.2. TA: From social effects to drivers**

Classical TA was criticized for focusing too much on the potential negative effects of science and technology. Moreover, ethical and policy analysis have stimulated TA to focus on novel types of side effects and the social visions and values that are shaping the technology.

#### *Bad and good chances*

From the start, some American politicians were hostile to TA, based on the perception that it would automatically imply regulation of technology. In the early 1970s in America, critics of government intervention in the innovation process, therefore, derided the concept as 'technology arrestment' or 'technology harassment' (Kunkle 1995). Developing a

'constructive' view of TA substantially contributed to the growing acceptance of TA in the German Bundestag (Paschen 2000, pp. 102-103). The institutionalization of TA in Germany was driven by a need to rationalize the debate on science and technology. One way to rationalize the debate was to also focus on the positive aspects of technological change and explicitly explore its social, economic, and ecological possibilities. This also politically legitimated German parliamentary TA.

#### *New types of side effects*

Over the last two decades ethical analysis has become more and more integrated in the practice of TA. The ethics view opened up the debate on what risks or aspects should be taken into consideration. Taking deontological perspectives and discussions regarding the good life and the good society into account, broadens the TA agenda. Ferrari and Nordmann (2009, p. 56), for instance, propose to expand the notion of 'risk'. In addition to economic, scientific, or technological benefit / risk analysis they promote a "philosophical hope / risk analysis." Besides, ethical analysis challenges TA to assist society in reflecting upon the possibility that technologies, like augmented reality and brain implants, may have an effect on our morals and ethical vocabulary (Swierstra *et al.* 2009).

#### *Social drivers*

Moreover, the ethical perspective forces TA to take into consideration the (variety of) deep core values of people that are currently at stake in the debate on technology. A similar plea comes from policy analysis. The argumentative turn in policy analysis presents a shift away from a rational decision making model of politics (politics of interest model) towards a more constructivist approach to policy making (Fischer and Forester 1993). Within this so-called politics of meaning model policy makers are guided by their policy belief systems and political decision making is examined in terms of interacting belief systems. The argumentative turn in policy analysis has stimulated the development of new TA methods, notably interactive TA (Grin *et al.* 1997) and vision assessment (Grin and Grunwald 2000). Starting from an analysis of the background theories of the various involved actors, the main challenge is to develop joint constructions and, ultimately, lines of action.

#### *The boundaries of TA*

Finally, classical TA is founded on the belief that one can anticipate on the various effects technology has on society. Ethical analysis questions this central assumption behind TA that one can influence science and technology. It, thus, forces the practice of TA to be very reflective on its own role, methods and impacts.

### **3.3. Comparative conclusions**

Throughout the years, various scholars have pleaded for RA and TA to embrace a broader perspective on risk and/or their object of study (see Table 2). Both RA and TA are advised to

look at both bad and good chances. It is suggested that risk assessment should include a broader set of social issues, just like classical TA. Moreover, classical risk approach assumed that risks were calculable based on past experience. Modern risk approaches are increasingly oriented towards the future and should be able to deal with both calculable risks and uncertain (potential) risks. Interestingly TA is encouraged to broaden its view in the other direction; by mapping not only (potential) effects, but also analyzing current visions and values that drive science and technology. The various shortcomings of RA and TA also constantly provoke discussions about the (in)capacity of government and political institutions to steer technological change from a societal point of view.

**Table 2.** Comparing interpretation of risk within RA and TA

Science	Risk assessment	Technology assessment
<b>Classical interpretation of risk</b>	Risk = Probability x Effect Calculable risk based on past experience	(Potential) social effects
<b>Modern interpretation of risk</b>	Calculable risks based on past experience and uncertain (potential) risks based on assessment of the future	(Potential) effects and current social drivers
	<ul style="list-style-type: none"> <li>• Bad and good chances</li> </ul>	<ul style="list-style-type: none"> <li>• Bad and good chances</li> </ul>
	<ul style="list-style-type: none"> <li>• Role for public perceptions</li> </ul>	<ul style="list-style-type: none"> <li>• New types of effects (e.g. change in our moral vocabulary)</li> </ul>
	<ul style="list-style-type: none"> <li>• Role for broader set of social values to come into play</li> </ul>	<ul style="list-style-type: none"> <li>• Social visions and values that shape technology</li> </ul>
	<ul style="list-style-type: none"> <li>• Reflection on risk governance</li> </ul>	<ul style="list-style-type: none"> <li>• Reflection on role and impact of TA</li> </ul>

**4. Risk characteristics and RA and TA**

This section describes how, driven by the concept of uncertainty, attempts have been made to characterize risk or problem situations in order to clarify the limitations of the classical approach and to promote and legitimize participatory approaches in the field of risk management and TA.

**4.1. Risk situations and risk management strategies**

Inspired by the academic considerations on risk and uncertainty that were described in the former section, also the awareness among risk assessors and managers has grown that different situations of risk require different risk management strategies. In particular the *White paper on risk governance* (Renn 2005) by the International Risk Governance Council has played a major role in bringing academic ideas into the risk assessment and management field (see also the contribution by Hermans, Fox and van Asselt on Risk Governance in the present book). Based on the different states of knowledge about each particular risk, the risk governance framework distinguishes between ‘simple’, ‘complex’, ‘uncertain’ and ‘ambiguous’ risk problems. The argument is that the classical risk approach only suffices for simple risk problems. The other three types of risk situations require other risk strategies.

Resolving complex risk issues requires discussion among experts. Klinke and Renn (2002) plea for an “epistemic discourse”, within which experts argue over the factual assessment and the best estimation for characterizing the risks under consideration. The management of risks characterized by high uncertainties should be guided by a “reflective discourse”. Such a discourse includes policy makers, stakeholder groups and scientists. Besides dealing with the clarification of knowledge, reflective discourse is about finding a balance between over- and under-protection. Finally, ambiguity-induced risk problems are typified by the fact that risk information is interpreted differently by various stakeholders in society and (potential) intense conflict over values and priorities of what should be protected. According to the International Risk Governance Council (IRGC) this type of risk problems which are characterized by interpretative and normative ambiguity demand a participative discourse. Participative discourses are meant to search for solutions that are compatible with interests and values of the people affected and to resolve conflicts among them.

**Table 3.** Risk characteristics and their implications for risk management (Source: Renn 2005, p. 16)

Knowledge characterization	Risk management strategy	Stakeholder participation
'Simple' risk problem	Routine-based	Instrumental discourse
'Complexity-induced risk problems	Risk-informed & Robustness-focused	Epistemological discourse
Uncertainty-induced risk problems	Precaution-based & resilience-focused	Reflective discourse
Ambiguity-induced risk problems	Discourse-based	Participative discourse

**4.2. Characterizing problem situations and type of TA**

Interestingly, also with regards to TA attempts have been made to clarify the role of TA depending on the problem situation. Even more so, the approach taken by the IRGC has its roots within the practice and theory of participatory TA (cf. Renn 1999). Here we present a taxonomy developed by Grin et al. (1997) to decide about the role of TA with regards to a certain problem situation (see Table 4). According to these authors there will be little need for TA when there is little uncertainty regarding facts and little value dissent (so-called structured problems). When there is little value dissent, but high uncertainty about the facts (so-called moderately structured scientific problems), the role of TA may be to clarify the facts and their relationships. In such a situation classical TA suffices. When the problem situation is characterized by a great deal of value dissent expert-driven analysis is no longer sufficient. In case of (moderately structured or unstructured) political problems, participatory forms of TA need to come into play.

**Table 4.** Role and type of TA depending on problem situation (adapted from Grin et al. 1997, p. 21).

	<b>Uncertainty regarding facts: little</b>	<b>Uncertainty regarding facts: much</b>
<b>Value dissent: little</b>	Structured problem <i>Little need for TA</i>	Moderately structured scientific problem <i>Classical TA to clarify facts and their relationships</i>
<b>Value dissent: much</b>	Moderately structured political problem <i>Participatory forms of TA might be beneficial</i>	Unstructured political problem <i>Participatory forms of TA are required</i>

### 4.3. Comparative conclusions

The arrival of the notion of uncertainty regarding to science and values has led to a systematic reflection on the limits of the classical approach to TA and risk (see Table 5). This has led to the insight that in the case of ‘simple’ risk problems the classical risk approach works well. It is interesting to note that in such structured problem situations there is little need for TA. In other words, the practices and roles of classical RA and TA do not overlap each other. In case of complex, uncertain and ambiguity induced risk problems both practices start to overlap, or better, complement each other. In particular the latter two problem characteristics challenge TA and risk assessment and management to introduce participatory approaches in the political decision making process (see Section New (Participatory) Approches to TA and RA). Systematic reflection has – politically and intellectually – legitimized the need to use and experiment with participatory approaches. In fact, we saw that experience and reflection in the field of participatory TA at the end of the 1990s (Renn 1999) has had a marked influence into the field of risk management in the middle of the first decade of this century, leading to the so-called IRGC risk governance model (Renn 2005).

**Table 5.** Comparing the relationship between problem characteristics and their implications for risk management and role and type of TA (adapted from Grin et al. 1997, p. 21 and Renn 2005, p. 16)

<b>Knowledge characterization</b>	<b>Stakeholder participation within risk management strategy</b>	<b>Role and type of TA</b>
‘Simple’ risk problem	Classical risk approach: instrumental discourse	Little need for TA
‘Complexity-induced risk problems	Epistemological discourse	Classical TA to clarify facts and their relationships
Uncertainty-induced risk problems	Reflective discourse	Participatory TA might be beneficial
Ambiguity-induced risk problems	Participative discourse	Participatory TA is required

## 5. New (participatory) approaches to TA and RA

A second basic complaint about the expert-based classical approaches concerns the fact that they do not sufficiently represent (broader) public concerns about science and technology. To address this shortcoming new participatory approaches to TA and RA have been proposed and to a certain extent implemented. These approaches aim to involve a broader set of social actors within the political decision making process on technology related risks. This section describes and compares these new participatory approaches.

### 5.1. New (participatory) approaches to TA

We saw that classical TA aims to both rationalize public controversy and aims to strengthen representative democracy by empowering the role of parliaments vis-à-vis the government (see Table 1). In contrast to classical TA, new (participatory) approaches to TA seek to *represent* public controversies over technological change (Joss 2000). As such they attempt to organize the interface between the (political) decision-making arena and society in a more interactive manner. This participatory approach is also promoted to improve the interface between TA and the parliament in order to strengthen the impact of TA.

#### *Improving the interaction between TA and politics*

The establishment of OTA inspired MPs in various European countries to start discussing the need for parliamentary TA in their own country. During the 1980s, countries like Germany and Great Britain adapted the classical TA model. The institutionalization of parliamentary TA in Europe, however, also introduced new rationales and roles for TA. For example, the French MPs decided to start doing TA themselves, supported by the staff of OPECTS (Office Parlementaire d'Evaluation des Choix Scientifiques et Technologiques). In this way the French MPs organized the interface between science and politics in a novel way.

Namely, in the classical TA model, MPs are basically informed by technology assessors through written scientific reports. Communication through writing, which is dominant within academic circles, does not match well the dominant oral culture within parliaments. Moreover, the agendas of MPs are often overloaded. This has challenged parliamentary TA institutes to rethink and redesign the way they communicate and interact with MPs (Decker and Ladikas 2004). It was realized that playing a role in the interface between science and politics does not simply mean bringing scientific insights to the parliament. Instead communication implies a two-way process. This realization has led to more participatory forms of communication, in which issue framing and identification of information needs result from interactions between TA practitioners and MPs. In fact, OPECTS exemplifies such an approach. For other parliamentary TA institutes organizing hearings, expert workshops, and Future Panels present ways to stimulate the (direct) involvement of MPs. For a comprehensive overview of European parliamentary TA development, see Vig and Paschen (2000), see also [www.eptanetwork.org](http://www.eptanetwork.org).

## *TA as an interface between politics and society*

Parliamentary TA was also given a new and extra political role in countries like Denmark and the Netherlands. Besides playing a role within the interfaces between parliament and science and government, TA was set up to strengthen the interface between the political arena and society. This was an institutional response to social activism in the 1970s. Public demonstrations, notably around nuclear power, put public authorities under pressure and created a legitimacy crisis of the State. As a result, controversies over technologies were seen as a problem between the government, the parliament *and* the wider public (Van Eijndhoven 1997). Besides scientifically informing the Parliament, TA was also positioned as a more general and “open” process for involving the public in policy dialogues and building societal consensus on issues of technological change. As an attempt to represent public controversies over science and technology, participatory methods were seen as ways to deal with the interface between the (political) decision-making arena and society. Danish and Dutch MPs saw public engagement and deliberation as a legitimate add-on to representative democracy. As a result, besides monitoring and assessing technological development, the Danish Board of Technology’s (DBT) and the Dutch Rathenau Instituut got the task to also stimulate public debate.

In order to fulfill this task, the DBT and the Dutch Rathenau Instituut started to experiment with participatory methods to involve experts, stakeholders and citizens in TA. This involvement has taken various forms, including citizens’ panels and juries, scenario workshops, round tables and consensus conferences. An overview of different participatory methods is presented in Joss (1999) and Slocum (2003). These methods have become more widely established over the last two decades (Joss and Bellucci 2002). In particular, at the beginning of this century, concerns about the science-society relationship and calls for public dialogue became part of the mainstream policy discourse in Europe. In the context of nanoscience, the adjective “upstream” entered the existing discourse on public participation (Wilsdon and Willis 2004). Policymakers and the business and science communities wanted to avoid nanotechnology becoming ‘the next GM’.

Also participatory TA has been the target of criticism. First of all, participatory TA is as sensitive to framing as classical TA. In particular, the issue of representation – who should participate and what degree of representativeness should they have – presents a enduring challenge. Secondly, the lack of impact of participatory exercises on the political decision making process is a central source of concern for parliamentary TA.

### **5.2. New (participatory) risk approaches**

Participation has also been promoted in the field of risk assessment and management (Klinke and Renn 2002, Felt 2007 also include the reference: Klinke 2009). Participation is thought to enable the assessment sphere to take into account broader public concerns on risks. Allowing interested parties to participate in risk appraisal, however, is not yet a common phenomenon. Besides participation is employed to improve the interface between

risk assessment and risk management. One of the main promoters to include deliberation in the risk field is the International Risk Governance Council (IRGC).

### *The IRGC risk governance framework*

In the wake of BSE and the GMO controversy, a new risk approach developed in the first decade of this century (WRR 2008). The risk governance framework of the International Risk Governance Council (IRGC) forms the most prominent and most elaborated example of this new approach (Renn 2005). As we saw above the IRGC risk governance framework distinguishes between four types of problem situations and related risk management strategies (see Table 3). In particular, in the case of uncertainty-induced and ambiguity-induced risk problems the IRGC advises to make use of participatory exercises.

### *Risk assessment plus concern assessment*

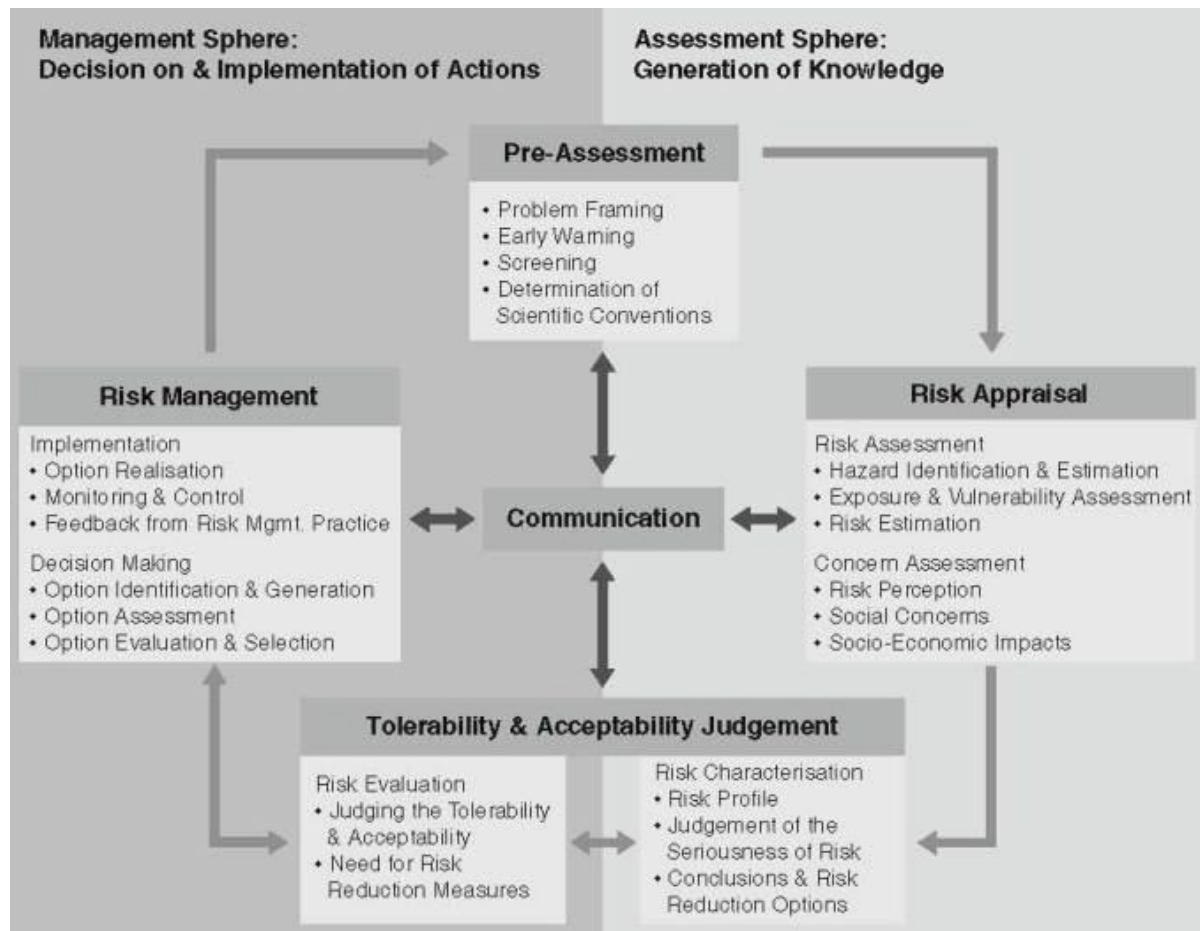
In the classical risk approach risk assessors are assumed to be able to calculate risks, and in that way would present the public interest. This assumption about the science – society interface has been severely criticized. In the risk governance framework, risk assessment is complemented by concern assessment (see Figure 1) (Renn 2005, pp. 12-15). Together they form the risk appraisal phase. Concern assessment is about getting “knowledge of stakeholders’ concerns and questions – emotions, hopes, fears, apprehensions – about the risk as well as likely social consequences, economic implications and political responses” (Renn 2005, p. 14).

### *Improving the interface between the risk assessment and management sphere*

The classical risk approach is based on a clear distinction of risk assessment and risk management. In this model the usability of the results of the expert-based risk assessment for policy decision making are taken for granted. The IRGC risk governance framework includes various extra activities in the risk handling chain to improve the interaction between the risk assessment sphere and the risk management sphere (see Figure 1) (Renn 2005, pp. 12-15). The framework proposes to include a pre-assessment phase. Risk framing is the first step of this stage. This exercise presents an attempt to come to a common understanding among relevant social actors on what kind of risk issues should be addressed.

After the risk appraisal phase, the risk governance framework proposes to have the stage of risk characterization and evaluation. Risk characterization is a decision-driven activity, directed toward informing decision makers, and is, therefore, the final and most controversial part of the risk assessment sphere. For long, risk characterization was commonly seen as a summarization of scientific information (National Research Council 1983, p. 20). In the early 1990s, the National Research Council in the United States started to promote risk characterization as a process which combines analysis and deliberation (Stern and Fineberg 1994).

**Figure 1.** IRGC Risk Governance Framework (Renn 2005, p. 13)



### 5.3. Comparative conclusions

Participatory approaches have been promoted and developed both in parliamentary TA and RA practices. These participatory exercises try to deal with the interfaces between TA and RA and society and the (political) decision-making arena (see Table 6). While classical TA aims to rationalize public controversy, participatory TA seeks to represent public controversy. For RA something similar is the case. Within the risk governance model the risk assessment sphere is complemented with new types of analysis and deliberation – notably, concern assessment, risk framing and risk characterization (see Figure 1) – that aim to include the concerns of various social actors. Besides improving the interface between society and RA or TA, participatory approaches can also be used to improve the interface between TA and MPs, and RA and risk managers.

If we take the risk governance framework as the exemplar of the new risk approach, it becomes clear that from a conceptual point of view TA and RA have grown closer to each other over the last decade. Actually, concern assessment, risk framing and risk characterization, which combine analysis and deliberation, can be seen as typical TA-like

activities. In fact from the perspective of risk governance parliamentary TA and risk assessment and management all have an important role to play. Unfortunately the complementary roles of these practices have not yet been given enough academic consideration. The next section explores the potential synergy between parliamentary TA and RA in the risk governance of nanotechnology in the Netherlands.

**Table 6.** Comparing the new approach to risk and parliamentary TA.

	<b>New risk approach</b>	<b>New parliamentary TA</b>
<b>Science</b>	Risk appraisal = Risk + concern assessment	Technology assessment
<b>Modern interpretation of risk</b>	Calculable risks based on past experience and uncertain (potential) risks based on assessment of the future	(Potential) effects and current social drivers
<b>Political role</b>		
<b>Interface science – policy making</b>	Informing risk managers within the government about technical risks	Informing MPs on social effects of S&T
	Risk characterization based on analysis and deliberation	Involving MPs in TA projects
<b>Interface society – policy making</b>	Pre-assessment: problem framing & early warning Concern assessment	Participatory parliamentary TA: representing public controversies over technological change

## 6. An Example: Risk governance of nanotechnology in the Netherlands

In 2003 the public debate on nanotechnology was in its infancy. At the same time, a strong growth in worldwide funding and patenting combined with high scientific and social hopes and concerns, fueled the debate. The Dutch government invested large sums in nanoscience, mainly within the framework of the national research program NanoNed. The debate in Europe received a strong impulse, when the ETC Group, an international civil society organization, called for attention to the issue of nanotoxicity at the European Parliament. Triggered by these events the Rathenau Instituut, the Dutch parliamentary TA organization, started activities which aimed to stimulate the public and political debate on the social and ethical issues related to nanoscience and -technology. This section presents some examples of various political roles played by parliamentary TA within the risk governance of nanotechnology.

### *Setting the agenda*

The Rathenau Instituut started by conducting a TA study, to provide an initial concept agenda for public and political discussion (Van Est *et al.* 2004). That first agenda included a broad range of topics, ranging from health effects of nanomaterials to privacy issues related to nano-electronics (and the vision of smart environments), and ethical issues related to human enhancement. The Rathenau Instituut also wrote a position paper (Van Keulen & Van Est 2004) and organized an expert-stakeholder workshop in February 2004 on the chances and risks of nanomaterials. At the workshop, the nanoscientific community was confronted with societal and policy actors for the first time. As a result the government commissioned exploratory studies by the National Institute for Public Health and Environment (RIVM) (Roszek *et al.* 2005) and the Health Council (Gezondheidsraad 2006). Researchers at RIVM had wanted to study the safety aspects of nanomaterials before, but had lacked funding because the issue had not been on the policy agenda before. These activities of the Rathenau Instituut helped in overcoming that deadlock and got a wider risk governance process going.

In 2004, the Rathenau Instituut continued by writing position papers and organizing workshops on various application fields of nanotechnology. All these public activities fed into a parliamentary hearing at the end of that year. Besides creating a first agenda for discussing nanotechnology, the Institute stimulated the development of an initial heterogeneous network of actors – consisting of nanoscientists, policy makers, politicians, social scientists, and people from industry and civil society organizations – to become involved in the public debate. In response to various discussions with the parliament, the government announced at the end of 2005 to come up with an integral policy on nanotechnology. An interdepartmental working group for nanotechnology (ION) was set up to prepare such a vision.

### *Setting up the risk governance machinery*

In the political discussion on dealing with the risks of nanotechnology the advice of the Dutch Health Council (Gezondheidsraad 2006) played an important role. The Health Council produced an extensive report, which used the IRGC risk governance framework (Renn 2005) as a model for dealing in an integral manner with complex, uncertain and even ambiguous risks related to nanotechnology. Anticipating the political significance of the Health Council advice, the Rathenau Instituut organized a workshop which brought together key experts and stakeholders to discuss the implications of the Health Council advice for priorities in risk policy (Malsch 2006). The workshop was attended by ION members who were preparing the Cabinet View on Nanotechnologies (Kabinet 2006).

In the Netherlands extensive discussions on dealing with systemic risks had led to the development of a particular risk governance framework, called *Dealing sensibly with risks* (VROM 2004). Within this model key strategies for dealing with risk are transparent decision making, a clear distribution of responsibilities, early involvement of citizens, balancing risks and benefits and factoring in accumulation of risks. The Cabinet view was based on this

model. In addition, however, the government announced to identify ethical and social issues relating to nanotechnology developments and to set up a broad public dialogue on these issues. From this point on the Rathenau Instituut focused on three challenges for risk governance: dealing with possible physical risks, how to organize a public dialogue, and further developing the wider public agenda, in particular, related to technological convergence (Van Est and Walhout 2010). We will focus here on the first two issues.

### *Dealing with “organized irresponsibility”*

With regards to dealing with nanotoxicity, the government followed the European Commission’s statement that the existing regulatory frameworks are sufficient to deal with nanomaterials, apart from specific amendments to be made. These regulations assign responsibility for safety primarily to producers. The government also recognized its responsibility for setting up the participatory aspect of risk governance. The government asked the Social Economic Council – an established negotiating platform for employer organizations and labor unions – to come up with an advice on occupational safety. Besides, a broad sounding board on nanosafety became part of the interactive policymaking the government already deployed for consumer and environmental affairs.

Assigning responsibilities and facilitating dialogue does not automatically leads to a proactive handling of nanotoxicity. By closely following the risk discussion the Rathenau Instituut recognized that the actual risk governance of nanotoxicity was hampered by a number of mutual dependencies, which caused acting voids and deadlocks. For example the combination of a lack of knowledge, definitions and oversight caused a lack of funding and inability for priority setting. This results into a lack of sense of urgency, which maintains the current deadlock. The Rathenau Instituut stimulated a political discussion about these examples of “organized irresponsibility” (Beck 1992). Together with a parliamentary committee, it organized in 2009 a parliamentary hearing, which allowed MPs to hear the voice of a broad range of experts and stakeholders. The Institute also advised the parliament about priorities for the political discussion.

### *Monitoring and debating risk governance*

In line with the suggestions of the Health Council, and thus the IRGC risk governance framework, the government had decided to organize a public dialogue on social and ethical issues. According to that model uncertainty about physical risks was to be discussed in expert-stakeholder settings, and more ambiguity-induced risk problems required communication and social discourse (see section Risk Characteristics and RA and TA). In practice, however, these issue categories and the related deliberative processes, can not be separated. In other words, these governance processes overlap and relate to each other. This has to do with the fact that both discussions often involve similar types of social actors, and with the priorities these actors have. When the issue of physical risks is surrounded with many uncertainties, most people are inclined to focus on such a concrete issue and tend to ignore or postpone a debate on often more intangible social and ethical questions. The

Rathenau Instituut highlighted this condition in the publication *Ten lessons for a nanodialogue* (Hanssen *et al.* 2008). Moreover, it advised the government about do's and don'ts with regard to setting up a public dialogue on nanotechnology.

#### *Parliamentary TA's role in risk governance*

The Dutch nanotechnology case shows that parliamentary TA can play various political roles within the risk governance process. Parliamentary TA may play a role in developing the public and political agenda. Parliamentary TA developed an initial public agenda and was instrumental in putting nanotechnology on the agenda of the government and the parliament. By using all kinds of participatory methods, parliamentary TA has also stimulated public and political debate by involving all kinds of stakeholders. Finally, parliamentary TA stimulated critical reflection and debate on the risk governance approach and processes itself. With regards to the safety issue the Rathenau Instituut has exposed various regulatory uncertainties that prevent effective governance. Moreover, it clarified that whereas the IRGC risk governance proposes different risk strategies for different risk issues, the practice of risk governance does often not allow for such a clear separation of issues.

## **7 Further research**

The structure of this chapter provides an interesting agenda for future research. We started this chapter by stating that the relationship between risk and technology assessment has been scarcely discussed. This chapter shows that such an exercise is fruitful since parliamentary TA may form a source of inspiration for RA. Whereas RA originally used a very narrow definition of risk, TA employed a common sense view on risk. The latter is due to the fact that parliamentary TA, because of its mission and institutional position, is continuously confronted with the political arena and society. As such it has to deal with analysis and deliberation on the one hand and power on the other. Defining itself as 'science' the risk field has (had) a hard time in dealing with the two poles of political practice. A crucial step is accepting a broader interpretation of risk, nowadays captured by the term 'uncertain risk'. TA's history, however, shows yet another challenge. Its focus on social effects was broadened with a view on social drivers. This links to the argument that RA and TA should pay equal attention to both "bad" and "good chances" (Wildavsky 1988), and the recent plea for a "philosophical hope / risk analysis" (Ferrari and Nordmann 2009). How to deal with such a broad interpretation of risk and the positive side of risk taking presents an interesting theme for further research.

A second research theme concerns the relationship between risk characteristics and the role and type of TA or the appropriate risk management strategy. Scholars like Renn (1999, 2005) and Grin *et al.* (1997) present their taxonomies as conceptual guidelines, instead of rigid normative prescriptions. Still these categorizations play an important normative and political role in the discourse on RA and TA. It would be relevant to study this, but also to analyze how the relationship between risk characteristics and the choice for a certain risk management strategy or TA approach is shaped in practice. In this respect, Van Asselt *et al.*

(2009) talk of the so-called “uncertainty paradox”. While there is great awareness among risk managers that a lot of uncertainties are in play, still there is a strong (institutional) tendency to use science to diminish uncertainty. These types of mechanisms are in need of more reflection and analysis.

Related to this it would be relevant to map in what kind of situations and to what extent new (participatory) approaches to TA and RA are actually used. Do these type of deliberative exercises still play a marginal role or have they become fully integrated? As we saw also participatory approaches face problems with regards to problem framing, representation, timing and impact. There is a need for more insight into how risk and technology assessors view and deal with these issues in practice. Moreover, modern approaches to TA and RA (in particular the IRGC risk governance framework) are about finding a balance between analysis and deliberation. There is still little knowledge on how science and involvement of various social actors is organized in practice. In particular, there seems to be a large gap between academic research done in this field and the way practitioners view and reflect on their practices.

This brings us to the big theme of risk governance. The history of TA and RA shows numerous attempts to deal with the social risks involved in science and technology. They present institutional attempts to address the democratic deficits of the modernist practice of managing technology. In *Risk Society*, Beck (1992) hinted at the above central research theme by dropping the term ‘organized irresponsibility’. The IRGC risk governance framework is a great attempt to develop an integral vision on risk governance. Namely, besides ‘risk assessment’ and ‘risk management’, this framework also aspires to look at “how risk-related decision-making unfolds when a range of actors is involved, requiring co-ordination and possibly reconciliation between a profusion of roles, perspectives, goals and activities” (Renn 2005, p. 11). In this chapter we have indicated that within the classical approach to risk and TA, the gap between RA and TA is impossible to narrow. In contrast, the new risk governance approach, in principle, has the potential to bridge these two practices. To put it stronger: parliamentary TA has a clear role to play within risk governance. Up to now, however, the democratic role parliamentary TA currently plays and may play within risk governance has received very little attention. To conclude: parliamentary TA’s role within risk governance presents a remarkable blind spot on the current research agenda.

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