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# Knowledge and the regulation of innovation

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**Abstract** Technology assessment (TA) is an important instrument for the regulation of innovation. From the perspective of sociology of knowledge, the regulatory process can be understood as a complex interplay between different forms of knowledge. The prevailing instruments of TA, expertise and participation, are both facing difficulties in dealing with the limits and impasses of regulatory knowledge in the realm of innovation. Nevertheless, as is argued in this article, reflexive forms of TA offer a good, if not the only, answer to the question of how we can deal with the contradictions and paradoxes involved in the regulation of innovation.

**Résumé** L'évaluation de la technologie est un instrument important de la régulation de l'innovation. A partir de la perspective de la sociologie de la connaissance, le processus réglementaire peut être compris comme une interaction complexe entre différentes formes de connaissances. Les instruments existants de l'évaluation de la technologie, à savoir l'expertise et la participation, rencontrent tous les deux des difficultés concernant les limites et les impasses de la connaissance réglementaire dans le domaine de l'innovation. Néanmoins, comme cet article l'indique, les formes réflexives de l'évaluation technologique offrent une bonne, si non la seule, réponse à la question « comment pouvons nous traiter des contradictions et paradoxes contenus dans la régulation de l'innovation » ?

**Zusammenfassung** Technikfolgenabschätzung und -bewertung (TA) ist ein wichtiges Instrument der Regulierung von wissenschaftlichen und technologischen Innovationen. Aus einer wissenssoziologischen Perspektive lässt sich zeigen, dass der Prozess der Innovationsregulierung von einer ganzen Reihe unterschiedlicher

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Wissensbestände beeinflusst wird, deren Verhältnis in mancher Hinsicht als dilemmatisch beschrieben werden kann. Die etablierten Formen der TA, Expertise und Partizipation, sehen sich vor diesem Hintergrund mit empirischen Problemen konfrontiert. Gleichwohl, so wird argumentiert, stellen reflexive Varianten der TA ein probates Mittel dar, mit den Widersprüchen und Paradoxien der Innovationsregulierung umzugehen.

## 1 Introduction

The term 'technoscience', as it has been established in parts of the scholarly debate for a couple of years, indicates a close conjunction between basic—or 'pure'—research and the technological realisation and implementation of scientific knowledge. The debate has strongly put forward the argument that these two aspects cannot be treated separately in any convincing way. Rather, they should be understood as two sides of the same coin.

As a consequence of this development, decisions containing aspects of technology assessment will occur in all phases of an innovation process, particularly in the earlier stages, where, implicitly or explicitly, preferences for further developments are being formulated. The decision not to invest in a particular technological development contains evaluative moments, as does, for example, the decision to limit the legal possibilities for scientific research in stem cells. In other words, the assessment of scientific and technological innovations plays a major role in the early phases of every innovation process. It is legitimate, therefore, to raise the question of which role technology assessment plays in the process of innovation.

The aim of the current article is to shed light on the before-mentioned aspects of technology assessment in the course of innovation processes from the perspective of the sociology of knowledge. For this purpose, the term 'regulation of innovation' will be used as an overarching concept that can help answering the question of when TA could best be implemented in the innovation process. The term innovation indicates the emergence of something new that might provoke the societal need for assessment and regulation. It might be helpful, as I argue in the following, to study the various forms of knowledge involved in this critical moment of emergence. I ask which these forms are, which challenges they entail and in which way technology assessment could offer some answers to the demand of regulating innovations.

My argument is presented in three steps: first, I apply the perspective of sociology of knowledge in order to describe innovation as a process of social interpretation (1). Secondly, I investigate the forms of regulatory knowledge that are involved in processes of regulating innovation (2). Thirdly, I discuss the social function of a certain antinomy connected with regulatory knowledge and ask about the role of TA in the light of the regulatory 'illusion' (3).

## 2 Innovation as knowledge

In my following argument, I basically refer to Schumpeter's definition of the term 'innovation' (Schumpeter 1939/1961). In a very general sense, one may say that

according to Schumpeter, innovation has two aspects, namely, a creation—be it an intellectual or a material one—and its implementation in a social field, in the market, in science, or in politics, to name only a few examples. The decisive aspect, in other words, is the social interpretation and recognition of the creation *as* 'innovative'. Undeniably, this version of the term 'innovation' makes use of Schumpeter's concept in a very broad and generalised sense, as Schumpeter, obviously, focuses on the emergence of new developments in economic systems alone, and on the question of which changes in the supply of goods might be put forward by such new developments (Schumpeter 1961:91). Nevertheless—and this is the point I use in favour of my interpretation of Schumpeter's concept—he himself understands this emergence of the new in a very broad sense. He talks about new goods, technological improvements in the mode of production, about the exploitation of new markets (91), new organisational forms, and many other aspects. The term 'innovation', according to Schumpeter, covers each and every new practise in the realm of economy (91).

I suggest transferring the Schumpeterian concept to social realms other than the economy. The concept contains an important property that can be generalised beyond the economic sphere. In the passage from his text quoted above, Schumpeter explicitly notes that innovation is something different and more than the mere emergence of novelty. For such an emergence, he reserves the term of invention. Inventions, and this is Schumpeter's surprising and groundbreaking insight, are not factors of the economy at all, as one could easily see from the inventions of the ancient world and the middle ages, which have remained without any influence on economic life over centuries (15). Inversely, as Schumpeter argues, innovation is indeed possible without any activity that can be characterised as invention, and invention does not necessarily trigger innovation (91). Innovations are rather defined as facts that are created by the economic system. They are, in other words 'inner' or 'proper' factors, because they indicate the use of existing procedures or knowledge for a new, namely, economic purpose by applying only economic criteria (92). In his argument, incidentally, Schumpeter explicitly avoids any reductionistic reference to needs (91, footnote 11).

The described pattern—namely, the social interpretation of a novelty as an innovation—can be applied, in general, to other social fields. In the same way that the economy interprets inventions as economically relevant innovations, other social contexts also constitute the relevance of novelty by interpretation. Innovation is, in other words, an interpretive construction, a result of sense-making processes in multiple social situations. In this broad understanding, the use of the concept is not restricted to economic facts, but rather applies to all social fields. In particular, the development of science and technology in modern society can shed light on the ubiquitous importance of this kind of social sense-making. When asking whether a given advancement in science or a technological invention has to be addressed as an innovation, one will usually face parallel answers in different social contexts, e.g., not only in legal and political, but also in scientific as well as economic contexts. The scientific community, for instance, would usually decide by peer review or via funding mechanisms not only the innovativeness of single findings, but also of entire research programmes. The law would, on the one hand, regulate danger and risk by referring, among other aspects, to the state of the art in science and

technology, thereby alluding to the scientific interpretation of innovativeness, uncertainty and accepted knowledge. On the other hand, the law itself permanently creates social innovations in conflict resolution and legal relations between social actors. Politics, to quote a further example, strives to strengthen the potential of science, technology, and the economy for future development by supporting innovations and providing innovation-friendly structures. Similarly to science and law, politics also constantly produces social innovations within its own realm. All these fields—in the same way as every social subsystem of modern society in general—interpret novelty as innovation and thereby mark it as relevant for the future. The examples also show that innovation is not equally preferable in each and every field. Particularly in the economy and science, innovative creations have their economic and scientific values, respectively. In politics, however, there might also be good reasons in a given situation to stick deliberately to old, proven and tested solutions and to abstain from innovation. The examples given should have made clear that science, technology, and the economy are the main fields in which the political and legal regulation of innovation will take place. They also designate the starting point of my argumentation, which matches most of the positions in sociological literature (cf. Braun-Thürmann 2005).

By connecting the concept of innovation to the communicative construction of novelty *as* innovative, I take the position of the sociology of knowledge. From this perspective, innovation in general is an issue that touches the realm of knowledge, in other words: the realm of interpretive patterns or models (*Deutungsmuster*), which only turn intellectual or material novelty into innovation. In the following, the regulation of innovation in general and of technological assessment as an aspect of this regulation in particular is described from the before-mentioned perspective of the sociology of knowledge. From this point of view, so I argue, one becomes capable of comprehending not only the problems and the solutions, but also the unsolvable internal tension or paradox that underlies the regulation of innovation.

If we understand innovation in the before-mentioned sense as the implementation of socially constructed interpretations with respect to novel objects or events in a certain social field, we may then ask: which forms of knowledge characterise such a process of innovation? I suggest distinguishing three forms of knowledge that play a major part in the social construction of innovations.

1. *Inventive knowledge*, indicating the form of knowledge that facilitates intellectual or material creation.
2. *Emergent knowledge*, indicating the form of knowledge that is generated by intellectual or material creation.
3. *Interpretive knowledge*, indicating the form of knowledge that enables the social construction of an intellectual or material creation *as* innovative.

The history of science and technology is full of examples demonstrating the importance of the third form for all kinds of path dependencies in the development of technologies. Well-known cases, such as the mechanic typewriter (Knie 1991), the Wankel engine (Knie 1994), or the rise of modern genetics (Kay 2000) clearly show that social patterns of interpretation (*Deutungsmuster*) define objects as innovations and foster their evolutionary success.

All three forms of knowledge converge in the process of innovation in a way that enables a retrospective interpretation of a given novelty as innovative in the third form of knowledge. From the perspective of sociology of knowledge, we can see that innovativeness is not an ontological property of objects and events. These objects and events are being interpreted as innovative and, thereby, particularly as relevant for the future at a certain point of their implementation, when they are already known to the interpreting social actor or field. The act of interpretation necessarily follows the emergence of objects and events and is, insofar, necessarily retrospective. Innovations, therefore, are complex phenomena in both a social and temporal respect. They are socially complex insofar as they combine different social positions: in a functionally differentiated modern society, inventive, emergent, and interpretive knowledge is distributed over various social positions. They are temporarily complex insofar as their temporal structure interweaves the pure chronological order of the three forms of knowledge with the retrospective temporal determination in the interpretive act. As a consequence, the quasi-ontological property of innovativeness turns out to be a rather transient and elusive figure.

Against the background of the three forms of knowledge mentioned earlier, it is now possible to study the cognitive preconditions for regulating innovations. Regulation of innovation, in other words, shall also be examined from the perspective of sociology of knowledge. We have to pose the question of which forms of regulatory knowledge are being used in regulating innovations.

## 3 The forms of regulatory knowledge

The regulation of innovation is, as has become apparent in the discussion thus far, nothing else than the regulation of knowledge. It intervenes in the forms of knowledge that have been outlined in the previous section, and tries to influence them. This intervention occurs primarily with respect to future developments. This orientation towards the future distinguishes the regulation of innovation from the regulation of established technologies, which would prefer to continue with aspects of follow-up care. In contrast to such end-of-pipe regulation, the focus on innovation and the future is characteristic of the kind of regulatory approach that is associated with technology assessment.

Such a precautionary and future-oriented form of regulation obviously has its own dimension of knowledge. As with every regulation, the regulation of innovation also makes use of a particular form of knowledge. This knowledge will be called *regulatory knowledge* in the following. On the level of regulatory knowledge, we have again to distinguish three forms, each of which bears specific challenges for the regulation of innovation. For an overview of the three forms of regulatory knowledge, which are elaborately discussed in the following paragraphs, see Table 1.

*1. Prognostic knowledge* indicates the form of knowledge about expected innovation. According to the three forms of knowledge in innovation processes, prognostic knowledge refers to expected inventive, emergent, and interpretive knowledge.

**Table 1** Forms of regulatory knowledge and their difficulties

| Prognostic knowledge | Risk knowledge in decisions | Instrumental knowledge |
|---|---|---|
| Knowledge about the future:<br>Inventive knowledge<br>Emergent knowledge<br>Interpretive knowledge | Knowledge about:<br>The fact that unspecific knowledge coins every decision<br>The impossibility of anticipating future attribution of responsibility | Knowledge about forms and effects of instruments for the regulation of innovation |
| Difficulty:<br>Future interpretive knowledge depends on current regulation | Difficulty:<br>In decision-making, risks cannot be avoided | Difficulty:<br>Neither expertise nor participation can perfectly cope with the challenges related to prognostic knowledge and risk knowledge |

Prognostic knowledge always faces the question of its inherent limits. It is difficult, if not impossible, to extrapolate future trends in science and technology, and this is particularly the case for emergent knowledge, which always bears components of irreducible and not predictable creativity. With respect to the form of emergent knowledge, one can nevertheless concede the possibility of anticipatory assertions within the frame of causal or, at least, stochastic relations. One might say, therefore, that prognostic uncertainty in this respect is no major impediment to assessment and regulation, because each and every regulation is confronted with imperfect knowledge about the effects in the regulated field.

However, interpretive knowledge raises a much more difficult question, namely, that of reflexivity. Regulation has effects on future interpretive knowledge and, at the same time, is based on a prognosis about this future knowledge. Future interpretive knowledge, in other words, will make use of normative and evaluative criteria that themselves may depend on normative components of the regulatory decision. Our current interpretive schemata (*Deutungsmuster*) to a large extent influence the normative framework of our future interpretations. They have an effect on whether we will estimate a creation to be an innovation in the future, or will dismiss it as an irrelevant marginal note. Insofar, prognostic knowledge bears a reflexive component. Whether a creation will be viewed as an innovation in the future very much depends on our current will. However, how can we know in the present whether we shall want the future creation to be viewed in this way or not? The perspective of sociology of knowledge, in other words, turns the attention to the fact that the regulatory decisions are constitutively connected with risks. The aspect of risk leads us to the second form of regulatory knowledge.

*2. Risk knowledge in decisions* Innovations bear opportunities and risks, as has been noted quite often. The term *risk decision* addresses both aspects. It describes the need to select between different options, all of which may entail negative consequences for third parties and, therefore, provoke the issue of responsibility (Luhmann 1991). Regulating innovations incorporates such decisions. Therefore, it makes use of a particular form of knowledge that goes along with risk decisions.

This form of risk knowledge contains (1) the knowledge that non-decision is impossible; even inactivity contains a decision; (2) the knowledge that consequences will appear later, that are epistemologically unknown when the decision is taken; they will bear negative effects for others; (3) the knowledge that future consequences will be attributed to the decision and to the responsibility of the decision-makers (cf. Bora 2007a). The co-occurrence of these three components coins every decision.

From this perspective, the distinction between specific and unspecific non-knowledge (Japp 1996) is of high importance. Specific non-knowledge describes the case in which an actor explicitly knows that he/she lacks knowledge in a certain aspect. Specific non-knowledge, therefore, is a reason to start an enquiry and to try to produce new knowledge. It is the characteristic condition of scientific research: we try to expand our knowledge in an area where we still do not have (enough) knowledge. From the point of view of risk research, it is decisive that we positively do know about the existence of our non-knowledge. This form of specific non-knowledge has to be sharply distinguished from any kind of unspecific non-knowledge. Unspecific non-knowledge describes a case of categorical ignorance, where an actor cannot know that he/she lacks knowledge in a certain aspect. Unspecific non-knowledge transcends the barriers of our epistemic capacities in a given moment.

Against this background, as previously stated, a risk decision consists of a situation arising from the need to select between different options, all of which may provoke negative consequences for third parties and may, therefore, lead to the attribution of responsibility in the future. The form of knowledge that relates to this aspect of risk embedded in every decision is the second form relevant to the regulation of innovation.

*3. Instrumental knowledge* The third form of regulatory knowledge is related to the *modus operandi* and the effects of all kinds of regulatory instruments. It contains the whole range of empirical knowledge in the field of *governance of innovation* (Kuhlmann 2007) and addresses the question of how to cope with the beforementioned prognostic uncertainty and the risk embedded in decisions. Three modes of problem solving have emerged in this field and are shaping the relevant knowledge currently, as there are (*a*) *expertise*, (*b*) *participatory assessment,* and (*c*) *combined solutions*.

(*a*) *Expertise* typically treats problems with prognostic knowledge by trying to identify causal relations and by applying all kinds of scientific research methods in order to minimise specific non-knowledge. There has been an extended scholarly debate on expertise in the last years. It has been stated that expertise is losing credibility and has become contested. These circumstances are due to scientific dissent and, to an even larger extent, to the social context in which expert knowledge is produced. Without any doubt, cognitive resources are not distributed equally and differences in power and influence also affect scientific advice. To a certain extent, this fact reflects a flaw in the credibility of scientific expertise. However, it is obvious that expertise plays an important role in regulating innovations. Wherever regulation has to deal with factual knowledge, it is bound to scientific knowledge with all its advantages and problems. The latter also refers to

the cognitive limits of prognosis, as I have argued previously. Although expertise will never be able to transcend these constitutive limitations, it plays an important role in advising regulators (Bora 2007b, c, Buchholz 2007). For our purpose, it is relevant to note the ambivalence of expert knowledge in the context of regulation: an indispensable resource on the one hand, while contested and criticised as power-loaded on the other. For this latter reason, it is seen in particular as less suitable for solving the risk problem of decision-making.

(*b*) The crisis of expertise mentioned previously has led to an increase in *participatory decision-making*. Participation usually is understood as a form of dialogical process of shaping a technology and managing possible risks (Abels and Bora 2004). It is conceptually based on the before-mentioned critique of expertise and on a discourse about "democratising expertise" (Abels and Bora 2004, Funtowicz and Ravetz 1993). Participatory procedures, as a common hypothesis says, are more likely able to evoke the motivation to engage in decision-making, to broaden the basis of knowledge and the values involved, to initiate learning processes, to produce new possibilities of conflict solution, to realise common interests, and to increase acceptance and legitimacy of a decision (Bora 2007a). The term "participatory procedure" describes instruments and methods aiming at the inclusion of laypersons and/or stakeholders. With respect to risk decision, such procedures represent an important mechanism of risk externalisation. A broad inclusion of persons potentially affected by a decision may help absorbing protest. A person who has participated in decision-making will face difficulties when trying to blame decision-makers for a negative effect.

Besides all the possible advantages of participation, it is also necessary to see the weaknesses. Participatory procedures will not develop adequate commitments for all parties, unless they lead to a real win-win solution. Participants' loyalty vis-à-vis their organisational background will even force them to leave the procedure, if serious conflicts arise. The functional differentiation of society may create insurmountable barriers in communication (Bora 1999). Furthermore, these procedures often provoke questions regarding their political representativeness, imbalance of power, lack of political mandate for those involved, etc. One reason for these problems could be seen in the lack of embedding in the institutions of representative democracy (Abels and Bora 2004). Participation, therefore, is a means to cope with risk decisions and their problems. At the same time, it creates new problems, as I have tried to show.

(*c*) Social practise has realised these problems. It reacts to them by implementing various *combinations of expertise and participation*. Scientific expertise is a relevant feature in participatory procedures, but usually is embedded in concepts of deliberation among the laypersons and stakeholders. This combination results from the fact that the function of all these procedures is to integrate the issue dimension (questions of information, facts, truth, etc.) and the social dimension (questions of acceptance, trust, legitimacy, values, preferences, etc.). It is not possible to discuss the whole diversity of combinations in a comprehensive manner here. An attempt to systematise the variety of forms has been made in Abels and Bora 2004. Instead, I will discuss some recently developed combinatory approaches as examples.

The most well-known model is *Technology Assessment* (*TA*). Since the seventies, TA has been established in the regulation of science and technology as a characteristic way to generate instrumental knowledge, i.e., knowledge about how to regulate scientific and technological innovation. From being just an expert model in the beginning, TA has meanwhile evolved very strongly in the direction of a participatory procedure. Against this background, new approaches emerge at present that are designed to cope with the sort of problems that are described previously as being typical for the regulation of innovation processes. The following three forms can be named as examples of this:

The so-called *real-time TA* (Guston and Sarewitz 2002) pursues a form of assessment that begins very early on in the process of innovation and accompanies the process throughout its course. It combines four methodological components, namely, case studies, trend or potential analysis, collection of stakeholder opinions and participatory TA in the narrow sense of the word. Although representing an ambitious approach, it remains questionable whether the goal of contemporaneousness between technoscientific evolution on the one side and technology assessment on the other will actually be reached. The same may hold true for approaches such as *strategic niche management* (Lovell 2007), which intends to combine cognitive-anticipatory and evaluative knowledge through experiments with new technologies in protected 'niches'. As yet another example, the concept of *science and technology roadmapping* can be mentioned. In this model, the social design of technology is accompanied by technology assessment in the phase of innovation. Essential to this approach is a multidisciplinary body of experts, which is occasionally complemented by other actors. It has the task to identify all relevant aspects of an innovation and to describe their potential interdependencies in order to enable an assessment of the innovation. Forms of *responsive regulation* (Bizer et al. 2002) or of legal assessment could also be named here. Finally—using slightly different semantics, but with very similar forms—one could mention concepts such as *reflexive governance* (Voß et al. 2006), of which, for example, *sustainability foresight* is a particular manifestation. This combines strategies of generating knowledge, of anticipating future developments and of participation. In this approach, *governance* is conceived as interdependency divergent rationalities within a polycentric network of organisations and actors (Voß and Kamp 2006, p. 7).

All the models mentioned earlier try to follow the path from expert-based prognosis to social shaping of science and technology by using participatory procedures that include experts in various forms. In so doing, they are confronted with the task of integrating different and partially contested forms of cognitive and evaluative knowledge and thereby of allowing, ultimately, for societal learning.

Against this background, Arie Rip interprets the combination of expertise and participation as *co-evolution* (Rip 2006). He understands TA as negotiated expertise and participation as a form of institutionalised feedback shaping the relations between science, technology, and society, and thereby enabling the co-evolutionary development of the three fields (Rip 2006, p. 89). In normative terms, Rip does not draw any direct consequences from his evolutionary perspective. Rather, he quite convincingly introduces a concept of *second-order normativity* (Rip 2006, p. 85), which gives preferential treatment to those forms of innovation that enable further

evolution, thereby keeping the whole system more flexible and reversible. Regulation, from this point of view, loses its strong steering character—in the sense of early cybernetics—and assumes much more the character of accompanying 'repairs' in the process of innovation. Rip understands this 'repairing work' that happens while implementing science and technology as co-evolutionary regulation. It mainly consists of opening up learning spaces and of enabling '*anticipation in action*' (Rip 2006, pp. 88/91).

The above overview of contemporary forms of regulatory techniques not only shows that expert knowledge is often combined with participatory forms, but also implicitly hints at the before-mentioned difficulties that are linked with both prognosis and participatory risk allocation. Prognosis is confined by internal limits, which come to the fore as particular risks in decision-making. In regulating innovation these risks get even more significant, because, as I have argued above, regulatory knowledge influences future interpretive knowledge.

To avoid misunderstanding, I would like to stress that such problems will usually not become visible in the everyday routine of science, technology, and regulation. Rather, they will occur in the realm of epistemic uncertainty, where scientific and technological innovations reach virgin soil. This epistemologically new and unknown area is certainly not very large. It is definitely much smaller than the domain of established knowledge that is recognised as valid in scientific discourse (Weingart 1999). Nevertheless, uncertain and epistemologically contested knowledge designates the place where regulation—prevention of hazards and risk precaution—is particularly in demand and particularly difficult. Regulation needs knowledge that is up-to-date and reflects all prevailing problems in theory and practise. However, the more verified and reliable this knowledge is, the more useful it is for regulation. These two aspects describe contradictory expectations that create problems of expertise, which often give rise to public critique.

It is mainly due to these contradictory expectations that participatory forms of TA have merged. They include concerned parties and/or actors of civil society, in an attempt to cope with the before-mentioned critique. In so doing, however, they also create problems, insofar as they often remain institutionally vague, functionally unclear and weak in their democratic legitimacy (cf. Abels and Bora 2004).

With these few and rather sketchy remarks, I can only indicate the problems of new forms of governance with respect to innovation processes. Nevertheless, it should have become clear that these forms—similar to the 'classical' concept of expert-based regulation—have their difficulties in performing the tasks associated with the regulation of innovation. With respect to the forms of knowledge that have been described previously—prognostic knowledge and risk knowledge—they equally are only approximate and imperfect solutions.

Table 1 summarises the different forms of regulatory knowledge and their specific problems.

Up until this point, I have described the problems associated with the regulation of knowledge in the process of innovation. With respect to these challenges, one might be tempted to conjure the difficulties away by committing them to the self-regulation of markets. This exit option, however, does not work, as I have also tried to show above. Innovations, as described previously, are always constituted by

social interpretation and are, therefore, to a certain extent indeterminable by prognosis and calculation. The social dimension of innovations points to the omnipresence of risks in situations of decision-making. Accordingly, regulation indispensably depends on complex instruments and the knowledge correlated to them.

Against the background of these arguments, it is not really surprising that Arie Rip, at the end of his text cited above, assumes a position strongly reminiscent of Jacques Derrida's idea of justice as the impossible, but necessary, foundation of legal regulation. Rip states that, '[r]eflexive governance is good, because it maintains the illusion of governance' (Rip 2006, p. 94).

## 4 Productive contradiction: the 'illusion' of regulating innovations

Arie Rip's statement quoted here obviously contains a certain contradiction. The success of reflexive regulation, as he postulates, in fact depends on the perpetuation of an 'illusion' insinuating the possibility of perfect regulation. Strictly speaking, the success depends on the empirical impossibility of regulation. If this argument was turned critically on the new forms of governance described earlier, then one could accuse them of tokenism. This is because against the background of the regulatory 'illusion', they could be misused as instruments for creating acceptance—or at least they might be publicly interpreted as such instruments. This danger has indeed been recognised in the debate about participatory technology assessment and reflexive regulation. Nevertheless, I will use Arie Rip's intuition in order to accentuate a more optimistic view in this concluding section. In order to pursue this goal, I briefly investigate the social function of paradoxes. Although it does not represent a paradox in the sense of formal logic, Rip's regulatory illusion comes close to a paradox in its function. In order to make this argument, it is important to consider that all paradoxes incorporate the opportunity of stimulating the generation of structures in social systems. This could also be true with respect to the regulatory illusion. For quite some time, social and cultural sciences have been investigating this function of paradoxes. I mainly refer to the perspective developed by Niklas Luhmann (cf. Bora 2007c). According to this approach, a paradox is characterised above all by self-implication (re-entry) and by a certain gridlock in communication. A well-known example of such self-implication is the lying Cretan or Eubulides' paradox: 'This sentence is not true.' Such paradoxes, which have the form of distinctions applied to themselves (antinomy or performative self-contradiction), show a tendency to result in a communicative impasse. There are no—or at least no direct—possible ways to take the turn and continue the communication. What is instructive from a sociological point of view is the fact that communication systems treat this difficulty, and the way they go about it. Clearly, in spite of the danger of paradoxes, communication is empirically able to continue. The sociological interest focuses on the communicative means with which the continuation is realised. It is not the place here to discuss the various ways of managing paradoxes that allow social systems to keep antinomies invisible and to continue their operations past all paradoxes. However, paying attention to paradoxes

allows us to point to their social function. Paradoxes serve as driving forces for the generation of social structures. If we look at the regulatory illusion from this perspective, we can identify the contradiction in regulatory knowledge as an important potential on the level of social structure. The ubiquitous danger of making the regulatory illusion thematic and visible leads to the perpetual production of structural *innovation on the level of regulation*. The combination of expertise and participation described previously can be explained through the difficulties on both sides. Insofar, Rip's paradox formulation explains why the mergence of new forms of regulation adjusted to changing forms of innovative knowledge can be expected almost inevitably. This is the reason why we can dare to characterise Rip's contradiction as a *productive contradiction*.

Summarising my theoretical approach, it can be said that the social regulation of innovation makes use of different forms of knowledge, which refer on the one hand to the object of the regulation, and on the other hand to the regulation itself. Among the many problems related to the regulation of innovation, there is at least one of non-trivial quality. This problem in essence points to the aspect of risk embedded in every decision. It uncovers the contradictory nature of regulation in this field. The contradiction unfolds between the constitutive insufficiency of prognosis *and* participation on the one hand, and the need for both components—expert knowledge and citizen participation—for the production of particular regulatory decisions on the other. In this sense, the regulation of innovation is necessary and impossible at the same time.

Once we accept this description, it becomes clear that the earlier-mentioned approaches in the *governance of innovation* try to keep regulation as open and flexible as possible with respect to unknown and contingent futures.

Against this general background, the argumentation in this article tried to show that reflexive regulation also perpetuates the risks of decision-making. Attempts to minimise risks by combining prognosis and participation have an ambivalent nature. They are doomed to fail, on the one hand. On the other hand, they are empirically necessary in order to break the decision blockade, to handle contingencies and to enable particular decisions—in full awareness of all their limitations. In this tension, we can identify the productive role of the regulatory illusion.

Moreover, the perspective of sociology of knowledge suggests a certain caution against all technocratic promises, against recipes from the cookshops of business consulting, against simplifying ideas of 'manageable' futures, in general, and of perfectly 'shapeable' innovation, in particular. Instead, it will be helpful to develop tolerance for ambiguity in practise, which means to anticipate the challenges described previously and to use them as driving forces for regulatory adjustment. The illusion of reflexive governance guarantees a continuing search for regulatory forms, which keep the constitutive ambiguity invisible.

The regulation of innovation, as is argued in this article, makes use of a whole variety of different forms of knowledge. The complex interchange between these forms creates both risks and opportunities for the regulation of innovation. My argument concludes, therefore, with the perhaps slightly provocative hypothesis of the regulatory illusion.

If we return to the initial question of the regulatory 'kairos' for technology assessment, the answer is the following: TA is a relevant instrument for regulation in all phases of innovation. Throughout the process of innovation, TA is a form of observation that is obviously infected with irresolvable contradictions, but concomitantly is the only way of producing innovations *in* regulation. Such innovations are constantly necessary in order to repair the deficiencies connected with expertise, prognosis, and participation. Moreover, they are also necessary to break our trust in the seemingly self-evident performance of established forms of regulation. Insofar, they are, in spite of their fluid nature and their changing forms, the only reliable way of coping with the inherent risk of decision-making situations.

## References

Abels G, Bora A (2004) Demokratische Technikbewertung. Transcript, Bielefeld

Bizer K, Führ M, Hüttig Ch (eds) (2002) Responsive Regulierung. Beiträge zur interdisziplinären Institutionenanalyse und Gesetzesfolgenabschätzung. Mohr Siebeck, Tübingen

Bora A (1999) Differenzierung und Inklusion. Partizipative Öffentlichkeit im Rechtssystem moderner Gesellschaften. Nomos, Baden-Baden

Bora A (2007a) Risk, risk society, risk behavior, and social problems. In: Ritzer G (ed) The blackwell encyclopedia of sociology, vol VIII. Blackwell, Oxford, pp 3926–3932

Bora A (2007b) "Gesellschaftsberatung" oder Politik?—Ein Zwischenruf. In: Leggewie C (ed) Von der Politik–zur Gesellschaftsberatung. Neue Wege öffentlicher Konsultation. Campus, Frankfurt/M, New York, pp 117–132

Bora A (2007c) Die disziplinären Grundlagen der Wissenschaft. ita manuscript ITA-07-08. Österreichische Akademie der Wissenschaften, Wien

Bora A (2009) Innovationsregulierung als Wissensregulierung. In: Eifert M, Hoffmann-Riem W (eds) Innovationsfördernde Regulierung. Duncker & Humblot, Berlin, pp 24–43

Braun-Thürmann H (2005) Innovation. Transcript Verlag, Bielefeld

Buchholz K (2007) Voraussetzungen und Widersprüche der wissenschaftlichen Politikberatung. Zur Professionalisierungsbedürftigkeit politikberatenden Handelns. Dissertation Universität Bielefeld

Funtowicz SO, Ravetz JR (1993) The emergence of post-normal science. In: von Schomberg R (ed) Science, politics and morality. Scientific uncertainty and decision making. Kluwer, Dordrecht, pp 85–123

Guston DH, Sarewitz D (2002) Real-time technology assessment. Technology in Society 24:93–109

Japp KP (1996) Soziologische Risikotheorie: funktionale Differenzierung, Politisierung und Reflexion. Juventa, Weinheim

Kay LE (2000) Who wrote the book of life? A history of the genetic code. Stanford University Press, Stanford

Knie A (1991) "Generierung" und "Härtung" technischen Wissens: Die Entstehung der mechanischen Schreibmaschine. Technikgeschichte 58:101

Knie A (1994) Wankel-Mut in der Autoindustrie. Anfang und Ende einer Antriebsalternative. edition sigma, Berlin

Kuhlmann S (2007) Governance of innovation: Practice, policy, and theory as dancing partners. University of Twente, manuscript

Lovell H (2007) The governance of innovation in socio-technical systems: the difficulties of strategic niche management in practice. Science and Public Policy 34(1):35–44

Luhmann N (1991) Soziologie des Risikos. de Gruyter, Berlin

Rip A (2006) A co-evolutionary approach to reflexive governance—and its ironies. In: Voß J-P, Bauknecht D, Kemp R (eds) Reflexive governance for sustainable development. Edward Elgar, Cheltenham, pp 82–100

Schumpeter JA (1939) Business cycles. A theoretical, historical, and statistical analysis of the capitalist process. McGraw Hill, New York, London. Quote from the first German edition (1961): Konjunkturzyklen. Eine theoretische, historische und statistische Analyse des kapitalistischen Prozesses. Vandenhoeck & Ruprecht Göttingen

Voß J-P, Kamp R (2006) Sustainability and reflexive governance: introduction. In: Voß J-P, Bauknecht D, Kemp R (eds) Reflexive governance for sustainable development. Edward Elgar, Cheltenham, pp 3–28

Voß J-P, Bauknecht D, Kemp R (eds) (2006) Reflexive governance for sustainable development. Edward Elgar, Cheltenham

Weingart P (1999) Scientific expertise and political accountability: paradoxes of science in politics. Science and Public Policy 26(3):151–161