Science, Technology & Innovation Studies
Vol. 9, No. 2, September 2013

ISSN: 1861-3675

STI Studies

www.sti-studies.de

Introduction

STS Policy Interactions, Technology Assessment and the Governance of Technovisionary Sciences

Christopher Coenen (Karlsruhe Institute of Technology, christopher.coenen@kit.edu)

Elena Simakova (Exeter University, E.Simakova@exeter.ac.uk)

Abstract

The introductory essay aims to set the stage for the contributions to this special issue by presenting an overview of earlier and current issues at stake in STS TA (science and technology studies / technology assessment) conversations and in the governance of such new and emerging technoscience as nanotechnology, 'converging technologies', synthetic biology and 'human enhancement technologies'. We put forward the notion of new technovisionary sciences in order to designate such fields of research and development. The essay offers an analysis of the growing corpus of relevant STS and TA literature on technovisionary sciences and on STS policy interactions and it introduces the contributions to the special issue. Furthermore, it outlines emerging perspectives and questions upon which future STS TA policy interactions may potentially be based.

1 Introduction

In recent times, new modes of construing and performing technosciences have come into existence. They contribute to what has been termed a "new assessment regime" (Kaiser et al. 2009) of emerging fields of research and development such as nanotechnology, converging technologies, synthetic biology and human enhancement technologies. Arguably, some of these changes have been inspired by science and technology studies (STS) and influenced by scholars from this field who participate in governance processes. (cf. Irwin 2006; Nordmann 2009; Nowotny 2007; Webster 2007a, 2007b; Wynne 2007)

We put forward the notion of new technovisionary sciences in order to designate the above-mentioned group of fields of research and development which have some features in common. Entailing "flows of scientific promises, reference to relevance, mobilisation of resources, and sponsorship" (Rip/Voß 2009: 5)[1], these technosciences in the making exhibit strong and contentious ideological features. They are also shaped by visions of progress and revolutionary implications. The emergence of these fields was marked by very early claims about their potential ethical and societal aspects and implications (ELSA, ELSI).

The objective of this special issue is to capture and analyse the spirit of current attempts to establish, assess and govern emerging technosciences. It focuses on the construction of content of these technosciences in governance and, in particular, in research policy and technology assessment. We discuss the latter both as a highly interdisciplinary and policy-oriented field of research (known as 'TA' for short, it is closely related to other fields of inquiry such as foresight studies) and as a general activity concerning current technological developments and their potential future implications. Contributors to this special issue, including ourselves,[2] have in recent years been involved in governance processes at the interface between STS and TA, and offer their understandings of these dynamics, paying special attention to the situated nature of claims about technovisionary fields that are interpreted as 'objects' of governance.[3] This special issue is also the result of several years of discussions and cooperation between a researcher (E.S.) from an STS background and a political scientist (C.C.) who works in the field of TA. TA, particularly in Continental Europe, has its own community and its own tradition that is related to a greater or lesser extent to the core of STS. During the course of our conversations and collaboration, we discovered many commonalities between our approaches and topics of research, though we also encountered differences, for example as regards our vocabularies, the boundary objects of our respective research communities and our theoretical and practical approaches to the sphere of research and technology policies.

The latter sphere has been the focus of TA work from the outset, and has become increasingly important for STS in

[1] Rip, Arie and Jan-Peter Voß (2009) 'Umbrella terms in the governance of emerging science and technology'; presented at the Spring Session 2009 '*The governance of future technologies' of the working group 'Politics, Science and Technology' of the 'German Political Science Association*"; Berlin, 22-23 May 2009: 5.

[2] Work on this special issue was prompted in particular by the project 'Converging Technologies and their Impact on the Social Sciences and Humanities' (CONTECS 2006-2008), which was funded within the Seventh Framework Programme of the European Union (EU), and by other policy-oriented research projects on new and emerging technologies in which we had the opportunity to get involved (see, for example, Coenen et al. 2009). The CONTECS website, featuring the final report (Andler et al. 2008) and other works, is available at http://www.contecs.fraunhofer.de.

[3] Or *policy-object*, as in Webster (2007).

recent times, provoking debates and altering the scope and, arguably, the general political-disciplinary orientation of STS research. Trends such as the boom in publicly-funded research on the ELSA of new and emerging technosciences and the "wild" mixing of schools of thought and disciplinary identities in publicly-funded European or national projects of scholarly and social-scientific research into technosciences have led to a blurring of the boundaries between STS, TA and similar fields, as well as within the respective fields. With regard to emerging technosciences in particular, a lively interaction has been evident between different approaches and research subcommunities (e.g. in the discussions and activities concerning the sociology of expectations, anticipatory governance, vision assessment (cf. Grunwald 2012a), and techno-scientific imaginaries; see, for example, Brown 2003; Grunwald 2007). All these approaches and activities, including ELSA studies, are part of the above-mentioned new assessment regime (Kaiser et al. 2010; cf. Coenen/Yang 2010) in which activities involving the discussion and addressing of societal aspects of emerging technosciences begin long before these fields become shaped as objects for regulation.

This editorial aims to set the stage for the five contributions to this special issue by presenting an overview of earlier and current issues at stake in STS TA conversations and the governance of new and emerging technoscience. When STS meets TA, it is not only a question of arguing that approaches to research policy-making should be re-examined on the basis of constructivist understandings of science, technology and knowledge – for decades the distinct domain of STS. It is also about rethinking notions of expertise, legitimacy and participation in terms of the assumptions that are currently informing policy deliberations, as they are at present arguably undergoing an interpretive and 'hermeneutic' (Grunwald 2012b) – and a 'participatory' – turn. Considering the significant role that policy plays in the production of technoscience, we will discuss the political stakes in new approaches to TA, such as vision assessment's potential (Grunwald 2012a) to tackle difficult questions concerning the mainstreaming and marginalisation of discourses of technoscience in policy making.

2 The magic of words

Firstly, let us examine the particular fluidity and malleability of certain terms that are employed in contemporary technoscience as interpretatively flexible, empty or floating signifiers (cf. Wullweber 2008). Rip/Voß (2009; and this issue) argue that the use of such malleable labels as "umbrella terms" in policy helps attribute significance to what are perceived as new "fields" of technoscience and to variously successful articulations of the necessity to mobilise political means.

This provokes practical dilemmas for policy makers in both security (Vogel, this issue) and civil technology assessment communities (Grunwald, this issue) when it comes to identifying the opportunities and risks of emerging fields. On the one hand, there is a general tendency, supported by the founders of such technovisionary fields, to initiate public discussions about ELSA of emerging technologies at the earliest possible point. On the other hand, critics warned against engaging in purely speculative ethics (Nordmann 2007), against exploiting the social sciences and humanities for technology marketing purposes, and against the dangers posed by a vicious circle of inflated promises (Coenen 2009; Nordmann 2007; Schummer 2008).

Against this backdrop, the interpretative flexibility (cf. Pinch/Bijker 1987) of terms of reference also constitutes challenges for policy makers as new initiatives, such as Responsible Research and Innovation (RRI), probe their potential for assessing the socie-

tal acceptability and relevance of emerging fields (Owen/Bessant/Heintz 2013; Simakova/Coenen, 2013).

3 STS meets TA

In what sense, and to what extent, did STS contribute to the rise of the technovisionary sciences? And what role was played by TA, understood as an institutionalised set of approaches that emerged mostly in Western and Central Europe as a set of research policy and research bodies, often engaged in policy advice for parliaments and other political institutions?

STS has increasingly presented itself as a diverse "multidiscipline" (Woolgar et al. 2009) accommodating "a large range of ideas and orientations" (Lynch 2009[4]); it has also opened the door to a greater involvement of TA researchers in STS. A similar presentational strategy was adopted by recent social scientific and humanist initiatives in the area of emerging technologies. The newly-formed Society for the Studies of Nanoscience and Emerging Technologies (S.NET) is one place where STS meets science, technology and innovation (STI) studies, the sociology of scientific knowledge (SSK), policy-oriented TA, foresight research, ethics of technology and other disciplinary fields or independent organisations dealing broadly with science, technology and society.[5]

Interactions between STS and TA and the potential for the two fields to learn from each other are especially evident in debates on new technovisionary sciences (e.g. Selin 2008; see also Grunwald, this volume).[6] To what extent, however, can a multidisciplinary STS stance accommodate and be conducive to a TA that has been largely concerned with seeking pragmatic truths about science and technology relevant to the "corridors of power"? On the other hand, would STS scholars be enticed to enter a domain of enquiry in which they would have to make definitive judgments about science and technology capacities, thus possibly compromising the purist ideals of academic scholarship?

In the domain of TA, there have often been debates about the need to draw a distinction between a 'classical concept of TA' and newer concepts. While the classical concept may never have existed in the way it is usually described, it nevertheless functions as a boundary object in the field's internal discussions. Grunwald (2009: 1114) emphasises that it incorporates "aspects of the way in which TA was practised during its 'classical' phase in the 1970s, in the Office of Technology Assessment (OTA) at the US Congress […] but in many respects it is a later stylization and not an adequate historical reconstruction." According to Grunwald, six elements are deemed to be constitutive of the classical concept of TA, namely positivism, etatism, comprehensiveness, quantification, prognosticism and an orientation towards experts: positivism entails providing policy makers with objective information and value-free knowledge, but not interfering in the decision-making process. It can be argued that policy makers were the only addressee of TA in the classical view. TA's conventional fixation on the state was crit-

[4] See Michael Lynch's Presidential foreword to the 2009 4S Meeting Programme (Lynch 2009).

[5] S.NET describes itself in the following terms: "S.NET represents diverse communities, viewpoints, and methodologies in the social sciences and humanities" (see http://www.thesnet.net/Statement.html last accessed 11 August 2013).

[6] The special issue is thus part of recent tendencies to strengthen the (social) studies of social sciences and humanities within the STS context (Mayer 2009, EASST Review volume 28, 7-14). This also includes a renewed interest in policy treatments of SSH in different countries; see http://www.sshstudies.net/ last accessed 11 August 2013).

icised early on, also within the TA community, which led to a number of concepts of 'participatory TA' being developed. TA generally strives to comprehensively capture the effects of a technology, not only in its classical phase, but in many cases still today. Detailed analysis is usually embedded within a broader scope which includes, for example, the socio-economic, political, ecological and safety aspects of a given field of science and technology – in recent years, its ethical and cultural aspects have also been increasingly taken into account. In line with its positivistic understanding of science, the classical phase of TA included a desire to overcome the "lack of inter-subjectivity" by means of quantification; it was seen, and indeed saw itself, as a provider of prognostic knowledge that should be as "hard" as possible, and as an early warning mechanism for technology-related risks. Possibly because it emerged as a new field of research in fairly technocratic times, the classical concept emphasised the role of experts to such an extent that some TA activities acquired an 'expertocratic' flavour. The fixation on the state was historically accompanied by a focus on parliaments; in Europe, parliamentary TA is at the heart of the field as a whole. TA often made inroads into the political system via institutionalisations of parliamentary TA. Parliaments in particular have a need for robust knowledge about science and technology that is provided independently of governments (with their many means of mobilising expertise), and TA has been able to provide this.

Based on our own participation in current conversations between STS and TA, we observe that questions are increasingly asked, in formal and informal interactions, about the potential mutual benefits of STS and TA. Such an 'alliance' appears to be able to further reinforce TA's capability to produce even more astute analyses of science, technology and society. For STS, contributions to the development of the assumptions that underpin the narratives of science, technology and society that figure in TA policy reports have proven to be a fruitful application ground.

A typical TA project today still resembles classical TA projects in many ways: it usually begins by collecting information, identifying experts and analysing the state of the art in a well-defined field of research and development; it also takes societal aspects and political challenges into account at the earliest possible stage. In all such projects, a scoping study of the field is carried out in an attempt to take expert opinions into account. Official political statements relevant to the project's topic are also collected. Depending on the type of project, the perspectives of a smaller or larger number of stakeholder groups may be included, as may participatory elements. In recent years, such TA work has often been performed in multi-partner projects or in broader networks which include STS practitioners, particularly as a consequence of the boom in publicly-funded ELSA studies.

While TA seeks to further distance itself from its classical tradition, thereby changing its role in policy processes, new challenges arise for STS too, for example as a result of a greater involvement in policy advice. The thorough study of techno-scientific practices and the detailed analysis of interpretations, to name but two characteristic strengths of STS research, are now part of what are deemed comprehensive, "global" research projects, often with clearly defined policy goals (such as supporting 'responsible innovation' with regard to a certain set of techno-scientific developments). While STS sensibilities and approaches have increasingly been integrated into the practice and repertoire of TA, STS have apparently also been quick to engage in a debate about the particularities of the field's diverse approaches to policy

advice (Nowotny 2007; Webster 2007a, 2007b; Wynne 2007).

As one source of scholarly advice that is well suited to dealing with socio-technical change, STS was able to bring new perspectives to the discourses of governance of science and technology, involving itself in conversations in the realms of TA (see, for example, Felt/Wynne 2007; Nordmann 2009), anticipatory governance and its critique (Guston/Parsi/Tosi 2007), or security policy (Vogel 2008). STS has become a player that interacts in the co-construction of credible narratives about new technovisionary sciences in "collective experimentation" (Nordmann 2009) that deal with ambiguities associated with the politics and content of such sciences. Scholars have also quickly engaged in a reflexive debate about their own diverse roles in policy interventions (Guston/Sarewitz 2002; Irwin 2006; Nowotny 2007; Webster 2007a, 2007b), with such debate increasingly becoming a reflexive element "incorporated into the social settings" (Lynch 2000).[7]

What are the new analytic gains achieved by such moves? Can STS hope to remain radical and provocative in these moves? And to what extent does STS exercise anthropological distance, acting like an outsider and making the familiar appear strange in these moves? Such entanglements, also in the fields of medicine, business or law (Woolgar et al. 2009; Lynch/Cole 2005; Cornell 2003; University of Oxford 2004, 2005), provoked questions about the identities of STS and transformations relating to its ability "to challenge extant claims to authoritative 'scientific' knowledge and treating STS as, itself, a positive source of epistemic authority" (Lynch/Cole, 2005: 269).

[7] Such engagements can even be explicitly framed in terms of 'reflexive governance' (Voß et al., 2006) of science and technology.

4 "Thinking in alternatives" as common ground?

In many ways, "thinking in alternatives" (Grunwald 2009: 1112) has been a characteristic of the TA concept and practice for many years. If a certain technology is assessed, technological and non-technological alternatives are usually taken into account in the analysis. TA has also been characterised from the outset by a highly interdisciplinary nature which, for example, entails that TA research is usually conducted jointly by natural scientists, engineers, social scientists and humanists. Post-classical TA, in its various shades, takes even more pluralities into account. Participatory TA has strived to abandon or mitigate positivism, etatism and the orientation towards experts. Moreover, it has provided TA with a wide range of new ways to involve stakeholders and citizens.

While TA has been able to achieve considerable diversity by participating in democratic deliberations about science and technology, the issue of plurality and public participation has also acquired particular significance and drawn critical attention for STS (Irwin 2006). For both STS and TA, one major question is whether they are sensitive enough to the kinds of narratives about science, technology and society that acquire dominance by marginalising other ways of accounting for socio-technical change. Invited or indeed pushed by political institutions and private funding agencies increasingly to include strong elements of public participation in their work (particularly in emerging technoscientific developments), TA and STS must increasingly ask themselves how they construe publics and how they select 'stakeholders' (and to what extent they allow them to select themselves). Who is included and who is excluded, and why?

Questions about the knowledge made available to policy makers must certainly not be separated from epistemological concerns about how such

knowledge is obtained and governed. Secrecy, due to the military-industrial orientation of technoscience or to industrial and scientific competition, is something that any effort to gain a better understanding of technoscience's "inner workings" has to take very seriously. Moreover, discourse on technovisionary sciences is often characterised by competing claims – often made on shaky grounds – about future options and potential applications. While uncertainty is a general feature of any kind of future-oriented technology assessment, technovisionary sciences differ from other fields, for example with regard to the relation between evidence-based statements and mere speculation.

Are there ways in which even more productive approaches can be developed by mobilising both STS and TA sensibilities in an attempt to increase plurality, and what challenges does this involve?

5 STS and TA in the governance of technovisionary sciences

Current modes of assessing and governing technosciences usually treat them as policy objects that can and must be subjected to public deliberation. Participants in deliberations on emerging technologies, and social scientists in particular (Gisler/Schicktanz 2009), need to give increasing consideration to and deal with broader accountabilities due to a greater involvement of audiences and interests beyond two-way science-policy conversations. These developments correspond to the emergence of inclusive concepts for the political shaping of science and technology which can be observed not only in STS[8] and TA[9], but also in research and technology policies in general. The new inclusive modes of governance (which, however, may entail new exclusions) embrace, for example, multi-stakeholderism[10], upstream engagement[11] and new TA approaches such as "real-time TA" (Guston/ Sarewitz, 2002) and "constructive TA".[12] Even the previously protected domain of intellectual property has been opened up to wider public deliberation (Hilgartner 2009).

Given that many major research and technology actors have explicitly committed themselves since the 1990s to the use of participative and inclusive approaches, it is no wonder that STS concepts for the societal shaping of science and technology have become more and more relevant in policy contexts (cf. Felt/Wynne 2007; Irwin 2006; Markus 2009; Nordmann 2009). The "Policy Street" and the "Democratization Boulevard", which at the beginning of the decade still appeared to be "distinct routes" for STS (Bijker 2003), thus appear to have converged during the course of the 2000s.

One could argue that technovisionary science discourses reinforce central

[8] The rise of participatory approaches in STS was so rapid and dramatic that it has been characterised as a "normative turn" in STS (Lynch/Cole 2005). See also Ashcroft (2003) and Stirling (2008) for analyses of the discursive shift in the focus of governance from expert agency towards participatory deliberation.

[9] For the participatory turn in TA since the 1990s, see for example Hennen (1999); Joss/Belucci (2002); Reber (2006).

[10] Arguably, the World Summit on the Information Society (WSIS), held in 2003 and 2005, has been a major exercise in multi-stakeholderism. Since then, the positive and negative aspects of the large-scale involvement of civil society organisations have been analysed in a significant number of papers (e.g. Mueller et al. 2007).

[11] The concept of 'upstream engagement' was introduced by the British think tank DEMOS (cf. Nature Editors 2004); for two interesting uses and critiques of the concept in the context of technovisionary sciences, see, for example, Joly/Kauffmann (2008); Rogers-Hayden (2007).

[12] Since constructive TA focuses on emerging technoscientific fields, it is of particular interest (see, for example, Rip 2008).

theoretical assumptions and stances of STS: the ideas of the social shaping of science and technology and the critique of determinism are part and parcel of the concept of societal relevance of technovisionary fields. In these discourses, the various actors play new roles in a new assessment regime of technoscience under conditions of very high contingency and interpretative openness.

Arguably, the loosely defined and highly visionary fields are co-construed by activities and research on ELSA to an extent not previously seen in other technoscientific fields. The very process also raises questions about the inclusion and exclusion of these various actors in the governance deliberations and about the shared understanding of what constitutes the emerging technovisionary sciences, e.g. the ambiguities and lacunae involved.

This is one of the points of departure for this special issue: to what extent can the ambiguities associated with the content of technovisionary sciences form a productive foundation for scholarly and policy analysis? The use of vague, ambiguous or umbrella terms (Swierstra/Rip 2007; Rip/Voß 2009) when naming the fields in question is a notable feature of the current technoscientific landscape. As Rip/Voß (2009; also this volume) argue, such umbrella terms serve to "blackbox a variety of activities", only making specific (and sometimes conflicting) descriptions of technoscience available to researchers, policy makers and the public alike. It has also been observed that these terms acquire specific meanings for the purposes in question when it comes to accounting for scientific practices on various occasions (Simakova 2011, 2012). The vagueness of meanings, however, has to date only rarely become a productive topic of enquiry, analyses of laboratory accounts (e.g. of nanotechnology) being one major exception (see, for example, Wienroth 2009; Simakova 2012).

In the policy context, attempts have been made to promote a shift in policy conversations from consensus-seeking deliberations towards debates in which it is recognised that actor strategies serve particular interests and deploy sets of recurring tropes and argumentative patterns (Swierstra/Rip 2007). The new assessment regime of technoscience reflects upon the diverse (and often competing) strategies pursued by different actors as a basis for policy making (Felt/Wynne 2007; Kaiser et al. 2009). Participants in pertinent activities are faced with significant changes to traditional constellations. Defining and describing a new technovisionary field often proves problematic and necessitates thorough reflection on one's own positions in the discourse. This relates, for example, to the way professionals perceive themselves in the new collective governance experiments and to the positions they adopt with regard to competing expectations.[13] As Nordmann argues in his analysis of transatlantic identity politics revolving around converging technologies, the outcome of such interactions can increasingly be framed in terms of changing the rules of the game and advancing and testing new options in the co-shaping of science and technology (Nordmann 2009). Does the highly visionary character of these fields undermine or even subvert traditional roles in and rules of discourse on science and technology? Or, on the contrary, does it reinforce roles and rules that were believed to have been overcome long ago? In the words of Jasanoff (2003; cf. Nordmann 2009): will the new technovisionary sciences give birth to technologies of "humility" or to technologies of "hubris"?

Building upon Irwin's (2006) suggestion that new modes of scientific governance are a legitimate object of study in themselves, we suggest that

[13] This is a common thread which runs through all parts of the final report of the CONTECS project (Andler et al. 2008).

studies of technovisionary sciences need to take into account the situated nature of claims about the object of governance. In other words, we would like to draw analytic attention to the uncertainties (associated with both the content and the accountability relations in which decision-makers operate) that arise as new fields of scientific research and emerging technologies proliferate into policy domains and find their way onto the lists of priorities in terms of attracting attention, interests and resources to themselves. At some point, the new initiatives become what Webster (2007b) called "policy-object" (genetic medicine in his case): "an object which is instantiated at various levels of practice, discourse and governance" (Webster 2007b). The politics of the new technovisionary sciences are arguably characterised not only by a dense flow of visions and expectations exchanged between participants on different levels. The above-mentioned particular fluidity and malleability of the terms employed as interpretively flexible, empty or floating signifiers (e.g. Simakova 2012; Wullweber 2008) contributes to the attribution of significance to these fields and to the articulation of the need to mobilise political means.

The specific example that initially helped us to further elaborate on new approaches to science and technology policy is the concept of 'converging technologies' (CT). CT refers to the conjunction of two or more technologies or fields of research and most frequently to processes of convergence in nano-, bio-, information and communication technologies, as well as in cognitive and neuro-technologies (the so-called 'NBIC' technologies). The CT discourse was initiated in the United States and for many years was strongly influenced by science managers and policy-makers, with inputs from the academic community and from civil society actors (Coenen 2009). It often symbolises a new phase in the conceptualisation of present or imagination of future relations and mergers between technoscience, society and humankind, e.g. under the guise of trans- and posthumanism (cf. Grunwald 2007). In this context, CT have been said to represent challenges for the social sciences and humanities, thus stimulating various research policy initiatives aimed at assessing the new fields.

In the above-mentioned CONTECS project[14], some contributors, including ourselves, advanced a post-essentialist take (Grint/Woolgar 1998) on the diversity and vagueness of claims about CT (Woolgar et al. 2008). This served as a starting point for an analysis of the dynamics of CT discourse. We argued that definitions of convergence are best seen as constructs articulated for the purposes under discussion and for performing expertise in converging technologies, in a widely varied manner. This, in turn, may influence the ways in which these emerging discourses proliferate into science and technology research and policy contexts. Technovisionary sciences are associated with the emergence of a broad set of cultural entities performed in the discourse and practices of the emerging fields. Some of these become iconic symbols of a new field, such as the IBM logo in nanotechnology. Others, such as 'transhumans', 'posthumans' and 'artificial intelligence', become notable ideological entities populating the techno-social imaginary of the new field.[15] As argued by Woolgar et al. (2008), "the outcome (effects, impacts, consequences) of the various

[14] Another example of a notable CT project in which STS practitioners have been involved is KNOWLEDGE NBIC (http://www.converging-technologies.org/project.html).

[15] Interestingly, large parts of this techno-social imaginary date back to the prehistory and early history of discourse on science, technology and society in the 1920s (cf. for example Woolgar et al. 2008) and have in more recent times been revived and further developed by 'transhumanist' authors who are now increasingly active in ELSA research (cf. Coenen 2009).

moves, claims and performances of CT will depend on the extent to which its ontological politics make available subject positions which are adopted and enacted".

As calls are made for qualitatively new advice on science and technology issues, there is also a perceptible need to articulate STS roles in the policy conversations. While such calls are often "articulated in a language that may still be foreign to many inside STS" (Nowotny 2007: 487), they arguably provide "opportunities for (re-)constructive STS work within policy domains" (Webster 2007a: 472). The new roles for STS have been increasingly analysed by practitioners in the field, drawing attention to the diversity of modes of policy intervention (Gisler/Schicktanz 2009; Wynne 2007; Webster 2007a, 2007b; Nowotny 2007; Sarewitz/Guston 2002). In any case, these academic writings become a reflexive element that is "incorporated into the social settings" (Lynch 2000: 26f.).

If policy can be seen as an instantiation of efforts to embody particular programmes of intended actions into technologies (Sorensen 2004) what policy implications does this have for the contentious developments of these technosciences in the making?[16] Speaking about policy as an element of the cultural politics of technology, Sorensen stresses "the contingencies related to ways that politics may or may not be attached to particular technologies" (2004: 189). The contingencies arise and need to be resolved within the micropolitics of interactions that are embedded in broader societal and policy communicative settings. This relates to the culturally situated nature of practical knowledge about how to perform consultations and achieve satisfactory policy advice (e.g. Hilgartner 2000).[17] Such practices construe specific versions of the technologies in question, for example by selecting relevant experts as participants. Knowing "how to" define certain technologies as relevant is an important element of expertise in the new assessment regime. After producing the material artefacts (e.g. project reports and other "deliverables") that embody the emergence and political maturing of a field in question[18], the involved STS, TA, ethics and foresight experts rapidly move on to the next technoscientific field, acting as generalists.[19]

6 Assessing visions

The new techno-visionary sciences are construed in a way that makes it very difficult to disentangle (Nordmann 2007) their individual elements which are taken, inter alia, from science, popular culture, the history of utopianism, research policy programmes and science fiction. Working with "low data" (Weldes 2006) – taken, for example, from literary dystopias or technovisionary films – acquires a greater relevance in the (policy) analysis of dis-

[16] Such efforts may involve, for example, inscribing the notions of "unethical" into particular technologies; prioritising the kind of technological developments that should be assessed by think tanks and expert committees; or assessing a technology's potential to provoke public controversies (and ways of handling the controversies).

[17] Apart from work in STS, the consultancy work was usefully conceptualised in critical consulting studies in terms of managerial fads and fashions (cf. Clark/Fincham 2002).

[18] Such exercises purport to assemble a version of the future in the form of reports, recommendations and agendas that are "constituted through an unstable field of language, practice and materiality in which various disciplines, capacities and actors compete for the right to represent near and far term development" (Brown et al. 2000: 5). Practically speaking, the production of deliverables may be described as an objective in itself.

[19] They may, however, not hope in vain to be able to draw lessons from similarities between the discourses on different visionary technosciences (cf. e.g. Coenen/Link/Hennen 2009; Molyneux-Hodgson/Meyer 2009; Torgersen 2009).

course on science and technology than was previously the case.

Since promoting new techno-visionary sciences often involves re-labelling certain areas of established fields of science and technology, interpreters have to ensure that their views of the *interpretandum* and their selection of stakeholders are not overly narrow: if they accept as relevant only those who are already using terms such as 'nanotechnology' or 'synthetic biology', they run the risk of becoming mere assistants to those who can be defined as the 'promoters' of these fields. Such 'assistance' with re-shaping existing and creating new, politically defined 'fields' of research and development may contribute to others being left behind, such as those who cannot or do not want to 'jump on the bandwagon'. From an STS perspective, distinguishing in this way between promoters and non-promoters might smack of a normatively motivated construction, by means of which the bad guys (promoters) appear to be doing (dubious) business and the good guys appear as honest brokers, striving for a better policy. TA, on the other hand, having worked close to the "corridors of power" for decades, often with a mandate to remain "impartial" and "neutral" in a milieu dominated by lobbyism, has become highly sensitive to attempts by others to exploit its work results for their own ends.

However, in choosing highly interpretive or 'hermeneutic' approaches such as vision assessment (Grunwald 2012a, 2012b), which also deal with interpretations of fantastical images of the future and their political use and cultural roots, TA is leaving familiar terrain without being able to cut the elusive *interpretandum* in question – be it nano, synbio, CT or human enhancement – down to the size of a traditional, well-defined *interpretandum* of TA. STS approaches that focus on what is going on in the labs will likewise be able to produce 'only' descriptions of situated practices of the *interpretandum*, feeding back into a 'bigger picture' of technoscience descriptions.

Some critics of vision assessment (Schaper-Rinkel 2006) have argued that assessing promises and visions by subjugating them to certain procedures in an attempt to tame their power and reduce them to the current form of technology-political rationality constitutes a refinement of instruments near the 'corridors of power'. Surprisingly, Grunwald (at least originally) used a rather instrumentalist language – vision assessment comprises, for example, not only "vision analysis" but also "vision management" – a language that is reminiscent of a technocratic past. His use of this kind of language, however, may be interpreted as having a subversive element. By arguing for close scrutiny of who uses visions strategically or tactically when and for which purpose, Grunwald defines it as post-classical TA's job to be aware of the interrelations between (sub)cultural politics and policy agendas. Besides cui bono considerations concerning the current obsession with highly unlikely futures (such as certain transhumanist ones), this approach to the politics of emerging technosciences enables some form of criticism: it allows an analysis that can show that the visions in question are not the product of "innocent" subcultures but of a milieu that is close to political, economic and military power (for evidence of this, see, for example, Coenen et al. 2009a) and aspires to lend scientific and policy insignia to a set of beliefs which itself is technocratic at its core. By fighting fire with fire, the proclaimed inevitability of the transhumanist and similar futures is questioned with reference to the "authority" of the "scientific method" and to the ideal of a democratic shaping of science and technology – "thinking in alternatives" thus remains possible.

Being one important way to construe the (ir)rationalities of the fields in question, visions pose a policy challenge because they introduce the

threatening image of unregulated science, entailing the promise both of control and (at the same time) ambiguities, and at times including references to the dark side of emerging technologies. As Hilgartner (2007: 154) observed, political legitimacy hinges on the assumption that policy has certain tools at its disposal to prevent – through analysis – technological developments from going wrong. Grunwald (2009a) argues that one should continuously strive to improve TA repertoires on the path towards "better" TA (even if older and newer methods and tools may eventually coexist). This raises questions about the role of interpretation in TA, however. In methodological terms, interpretation is thus supposed to become a policy analysis 'tool' (Grunwald 2009a: 1138), yet does the rhetoric of tools really help us to interrogate the role of interpretation in and for policy? As Berg (1997) argued some time ago, formalising a domain (e.g. medical practice, or in our case research policy) apparently entails aligning and disciplining both the domain and the tools themselves. As such, systems and tools are constantly being negotiated between each other rather than being a simple combination of tool and practice understood as monolithic entities.

In other words, the 'tools' of analysis need to be replaced by distributed practices, with power also being distributed within a socio-technical hybrid rather than placed in the hands of the individual tool-holder. If vision assessment is not to be seen as a tool but as something that is based on distributed practices[20], what consequences does this have for TA and for our discussion of the role of vision assessment and interpretation in the political shaping of technosciences?

As an element of TA, vision assessment can be deemed a particularly suitable means of interpretive analysis when one has to deal with pre-policy and early policy stages of emerging technosciences. Recently, Grunwald argued in this context for a 'hermeneutic' technology assessment (Grunwald 2012b); as a consequence of one of its moves away from a technocratic past, the mainstream of TA has long since emphasised that TA should never be technology-driven, but should instead be oriented towards problems (see, for example, Decker/Fleischer 2010), above all social ones.[21]

[20] Grunwald's post-2000 conception of 'vision assessment' was first presented at a workshop that dealt with TA and foresight methods. The language of tools might be explained to a certain extent by this context and the wish to introduce a new way of analysing emerging technosciences in a traditional setting. Grunwald's own works, as well as studies inspired by his concept of vision assessment, indeed often emphasise that the societal process of producing and dealing with visions of the future is based on distributed practices.

[21] An extreme case of a new visionary technoscience are the sciences and technologies that are now often grouped together as means of "improving human performance" (as in discourse on converging technologies), or as means of a more general "human enhancement" that includes visions of a massive modification or even replacement of the human body (as also in discourse on converging technologies and on "human enhancement technologies"). This imagery suggests that the debate is not technology-driven – even if this is posited by many of its proponents and critics – but that visions of transhumanist or posthumanist futures are projected onto technologies that do not yet exist or are only in their infancy. Are then the debates on human enhancement problem-driven? If so, the problem is construed in terms of human corporeality: the human body is portrayed as deficient, and this is presented as the problem. Acknowledging the lack of existing technologies to start with, TA would then resort to vision analysis as a guide to performing vision assessment studies on this topic and to integrating for this purpose such fields of research as anthropology (including philosophical anthropology), utopian studies, science fiction studies, gender studies, disability studies and many more. In many cases TA would then resemble the commentary-style STS, inasmuch as its analyses arise from a position that is somewhat detached from politics. Such analyses deal intensively with

However, vision assessment might also be understood more broadly as a socially distributed practice by means of which societies deal with the future. Such an interpretation of vision assessment also encounters specific challenges. TA and STS could provide society with the means for discourse (such as anthropological and historical insights, analyses of the emerging politics and policies, and others). While addressing the public may mean that the "professional" interpreters contribute to stabilising the discourse in question, the hope is that society's own, often forgotten potential to deal with such issues can be mobilised through the specific expertise of social and policy sciences and the humanities. STS and TA would then serve societal vision assessment purposes, not by claiming to be the honest brokers in policy making (or in its preparation), but by providing the means to consider alternatives – past, current and future ones. A hidden technocracy might remain, however: in a kind of hubris, interpretive approaches might be seen as means of enlightening a society that is "ignorant" of its own history and cultural plurality, and policy analysis might become an instrument that "reveals" what is going on "behind the scenes" of emerging technosciences with their visionary rhetoric.

7 The contributions to this issue

Vision assessment appears to be an apt deliberative space in which to raise and debate questions about the emergence of visionary narratives and the marginalisation of alternatives when it comes to assessing the societal promise of science and technology. As we argued elsewhere (Simakova/Coenen 2013), however, such deliberations are best informed by what we termed an 'empirical response' that pays close attention to the everyday practices in both science and policy as well as in society at large.[22] By opening a debate on the politics and the political in the emerging technovisionary fields, however, we are certainly not assuming that a single driving force behind the dominance/marginalisation dynamics can be found, for example, in the power of labels or 'umbrella terms' to mobilise support.[23]

As all contributions to this special issue illustrate, attention must be paid to the interactions between and strategic use of various narratives about a technovisionary field. When we talk about getting a technology story right or choosing one for policy analysis purposes, are we aware of the alternative stories? Who is in a position to say which is the most current, relevant or far-reaching vision? Or is it more a question of moving between the sites (scientific labs, policy rooms, TA exercises) where such visions are produced and interpreted, and indeed sometimes rejected?

This special issue was initiated by our desire to bring together analyses of

identity politics; however, there is no declared goal to include itself, or individual analysts, in such identity politics beyond discursive intervention in the form of publishing the results of such studies.

[22] Cf. a recent presentation by (Fleischer 2012) calling for more attention to practices of TA surprisingly understood as… laboratory!

[23] When attempts are made to explain how some representations become more persuasive than others, the essentialism associated with the natural properties of real objects is sometimes replaced by the determinism of social and political interests, or by textual determinism such as the 'pragmatic values' and 'rhetorical strategies' of the text. Questioning the merits of such a move, Woolgar/Cooper (1999) compare the form of Winner's Moses's Bridges story to an urban legend. The authors offer self-criticism by saying: 'although the focus (substance), the particular aspect of modernity at the centre of the story, might change, the form (structure) of the tale remains more constant' (p. 441), thus retrospectively rendering the narrative form responsible for the story's success and currency.

such processes, showing sensitivity to the circumstances and interactions in which policy decisions are produced and governance is performed. Its overarching goal is to examine the potential for "thinking in alternatives" on the basis of the first-hand experiences and reflections of researchers participating in on-going conversations that shape technology assessment and policy practices. We explicitly asked the authors to explore the extent to which interactions at the STS policy interface provide "opportunities for (re-) constructive STS work within policy domains" and how possible challenges and tensions are dealt with (cf. Webster 2007a). In the following, we aim to outline the main arguments of the papers and explain how they address the governance of technovisionary sciences.

Armin Grunwald describes on-going changes in the governance of science and technology and emphasises the central role that TA plays in proposing and implementing concepts for policy advice concerning technovisionary sciences, such as vision assessment. While such new approaches urge us to acknowledge the ambivalence of techno-visionary futures, the paper argues that such understanding also entails blurring the boundaries between political institutions, TA and citizens, and necessitates new forms not only of participation but also of policy advice. Grunwald evaluates the existing modes of STS TA interactions – understood as a mutual exchange of TA experience in engagement and STS experience in observation – and argues for even more practical cooperation between STS and TA, in terms not only of deconstruction, but also of reconstruction.

Arie Rip and Jan-Peter Voß present an approach to analysing technovisionary sciences that focuses on the use of umbrella terms in policy and governance discourse. Their two examples are 'nanotechnology' and 'sustainability research'. The institutionalisation of research areas gives rise to considerable wrangling over these umbrella terms in the politics of inclusion and exclusion involving resource distribution. Shifting attention from the policy of science and technology to its governance, Rip/Voß consider the role that might be played by STS scholars engaged in de facto governance, a role that would be based on opening up the black box of technoscience.

Kathleen Vogel poses questions pertinent to assessments of technology in the world of intelligence. Her case study of the U.S. intelligence community's scientific advisory body, the Biological Sciences Experts Group (BSEG), highlights the need to reconsider the conditions of assessment in an environment characterised by secrecy and a dominance of technical interpretations of technology. Vogel presents her personal experience of beginning to ask questions about the potential to overcome the disconnectedness between academia and intelligence with a view to enabling a flow of ideas involving constructivist understandings of science and technology. This, Vogel argues, will not only facilitate a more widespread acknowledgement of the historical contingency of assessing biological threats; it will also address the challenges posed by new forms of collaboration between STS scholars and intelligence analysts aimed at examining and revealing how bioweapons assessments are conducted and at finding new ways of collecting and analysing data for such assessments, and, in turn, at mitigating errors.

Commentary papers by Alfred Nordmann and Richard Owen focus on the visionary character of various current science and technology policies and offer distinct insights into possible alternatives to visions-based governance of science and technology in which STS scholars participate. Nordmann discusses 'visioneering' as a form of expert or stakeholder activity which claims to produce causal links between current states of science and technology and a certain future. He argues that

past debates on technovisionary sciences, and critical comments in these debates in particular, are a resource for democratic deliberation that cannot proceed freely under assumptions of technological inevitability. Advocating the importance of freedom of speech, Owen discusses the changing landscape of social norms and values that require mechanisms of responsiveness to be introduced in governance processes. Apparently, vagueness and the technocratic orientation of technovisionary narratives are not helpful when attempts are undertaken to address major societal challenges.

As guest editors, we hope that this special issue will contribute to the already burgeoning discussions about alternative approaches to the governance of technovisionary sciences. In our case, focusing on the creation and interpretation of visions at different levels of STS TA policy interactions has enabled us and the contributors to this special issue to raise and begin to answer questions about how it can be helpful to open up the black boxes of technoscience in order to achieve the deconstruction and reconstruction of values, thereby setting another example of responsiveness and societal discourse as essential elements of the governance of technovisionary sciences.

8 Acknowledgments

This project was partly supported by the Center for Nanoscale Systems in Information Technologies, Cornell University, a NanoScience and Engineering Center of the National Science Foundation under Award # EEC-0117770, 0646547, jointly with the Department of Science & Technology Studies (S&TS) also at Cornell between 2008-2010; it benefited from the guest editors' participation in the FP6 project CONTECS (Converging Technologies and their Impact on the Social Sciences and Humanities (http://www.contecs.fraunhofer.de) in the years 2006-2008. We would also like to thank the Ministry of Education and Science of the Russian Federation under their Federal Target Programme "Human Resources for Research and Education in the Innovation Russia" (2009-2013) for contributing to continuing collaboration between the guest editors. Thanks also go to numerous anonymous reviewers for their valuable contribution to the publication, as well as to the editorial team of Science, Technology, and Innovation Studies.

References

Andler, Daniel, et al., 2008: *Converging Technologies and their Impact on the Social Sciences and Humanities*, final report of the CONTECS project, May 2008. <http://www.contecs.fraunhofer.de/images/files/contecs_report_complete.pdf>

Ashcroft, Richard, 2003: Constructing Empirical Bioethics: Foucauldian Reflections on the Empirical Turn in Bioethics Research. In: *Health Care Analysis* 2003, 11; 3-13.

Berg, Marc, 1997: *Rationalizing Medical Work: decision-support techniques and medical practices*. Cambridge, MA: MIT Press.

Bijker, Wiebe E., 2003: The Need for Public Intellectuals: A Space for STS, pre-presidential address, 2001 Annual Meeting of the Society for Social Studies of Science, Cambridge, MA. In: *Science, Technology & Human Values*, 28, 443-450.

Brown, Nik/Brian Rappert/Andrew Webster (eds.), 2000: *Contested Futures: A Sociology of Prospective Techno-Science*. Aldershot: Ashgate.

Calvert, Jane, 2001: Is there a role for 'basic research' in Mode 2? In: *VEST Swedish Journal for Science and Technology Studies*, Vol. 13, Issues 3-4, 35-51.

Clark, Timothy/Robin Fincham (eds.), 2002: Critical Consulting: New Perspectives on the Management Advice Industry. Oxford, Malden, MA: Blackwell.

Coenen, Christopher, 2009: Deliberating Visions. The Case of Human Enhancement in the Discourse on Nanotechnology and Convergence. In: Mario Kaiser et al. (eds.), 2009, *Governing Future Technologies*. Dordrecht, et al.: Springer, 73-87.

Coenen, Christopher, et al., 2009: *Human Enhancement*, IPOL/A/STOA/2007-13; PE 417.483. Brussels: European Parliament.

Coenen, Christopher/Leonhard Hennen/Hans-Jürgen Link, 2009: The ethics of synthetic biology. Contours of an emerging discourse. In: *Technikfolgenabschätzung - Theorie und Praxis* 18, 82-86.

Cornell, 2003: Call for Papers for Conference on 'Connecting S&TS: the Academy, the Polity and the World', Department of Science and Technology Studies, Cornell University, 26–28 September 2003.

Decker, Michael/Torsten Fleischer, 2010: When Should There Be Which Kind of Technology Assessment? A Plea for a Strictly Problem-Oriented Approach From the Very Outset. In: *Poiesis and Praxis* 7(1-2), 117-133.

Gisler, Priska/Silke Schicktanz, 2009: Special issue 'The role of social sciences in policy making'. In: *Science, Technology and Innovation Studies* 2009; 5 (September 2009).

Grint, Keith/Steve Woolgar, 1997: *The Machine at Work: Technology, Work, and Organization*, Cambridge: Polity Press.

Grunwald, Armin, 2007: Converging Technologies: Visions, increased contingencies of the conditio humana, and search for orientation. In: *Futures* 39, 380-392.

Grunwald, Armin, 2009: Technology assessment – Concepts and methods. In: Anthonie Meijers (ed.), *Philosophy of Technology and Engineering Sciences*, Handbook of the Philosophy of Science 9. Amsterdam, et al.: Elsevier, 1103-1146.

Grunwald, Armin, 2012a: *Responsible Nanotechnology. Philosophy and Ethics*. Singapore: Pan Stanford Publishing.

Grunwald, Armin, 2012: Synthetische Biologie als Naturwissenschaft mit technischer Ausrichtung. Plädoyer für eine „Hermeneutische Technikfolgenabschätzung". In: *Technikfolgenabschätzung – Theorie und Praxis* 21/2, 10–15.

Guston, David H./Daniel Sarewitz, 2002: Real-time technology assessment. In: *Technology in Society* 24, 93-109.

Guston, David H./John Parsi/Justin Tosi, 2007: Anticipating the Ethical and Political Challenges of Human Nanotechnologies. In: Fritz Allhoff/Patrick Lin/James Moor/John Weckert (eds.), *Nanoethics: The Ethical and Social Implications of Nanotechnology*. New York: John Wiley and Sons, 185-97.

Felt, Ulrike (rapporteur)/Bryan Wynne (chairman), 2007: *Taking European Knowledge Society Seriously*. Report of the Expert Group on Science and Governance, to the Science, Economy and Society Directorate, Directorate-General for Research, European Commission, Brussels: European Communities, January 2007.

Fleischer, Torsten, 2012: *Technology Assessment as 'Laboratory' – On the role of TA in the process of shaping emerging technologies*, paper presented at the 4S Annual Meeting, Copenhagen Business School, Frederiksberg, Denmark, October 17, 2012.

Hennen, Leo, 1999: Participatory Technology Assessment: a response to technical modernity? In: *Science and Public Policy* 26, 303-312.

Hilgartner, Stephen, 2000: *Science on Stage: Expert Advice as Public Drama*. Stanford: Stanford University Press.

Hilgartner, Stephen, 2007: Overflow and Containment in the Aftermath of Disaster. In: *Social Studies of Science* 37(1), 153-158.

Hilgartner, Stephen, 2009: Intellectual Property and the Politics of Emerging Technology: Inventors, Citizens, and Powers to Shape the Future. In: *Chicago-Kent Law Review*, 84, 197-224.

Irwin, Alan, 2006: The Politics of Talk: Coming to Terms with the 'New' Scientific Governance. In: *Social Studies of Science* 36, 299–320.

Jasanoff, Sheila, 2003: Technologies of Humility: Citizen Participation in Governing Science. In: *Minerva* 41, 223-244.

Jasanoff, Sheila (ed.), 2004: *States of Knowledge: The Co-production of Science and Social Order*. London: Routledge.

Joly, Pierre-Benoit/Alain Kaufmann, 2008: Lost in Translation? The Need for 'Upstream Engagement' with Nanotechnology on Trial. In: *Science as Culture* 17, 225-247.

Joss, Simon/Sergio Bellucci (eds.), 2002: *Participatory Technology Assessment – European Perspectives*. London: University of Westminster.

Kaiser, Mario, et al. (eds.), 2009: *Governing Future Technologies*, Sociology of the Sciences Yearbook 27. Dordrecht, et al.: Springer.

Lynch, Michael, 2000: Against reflexivity as an academic virtue and source of privileged knowledge. In: *Theory, Culture & Society*, 17, 26-54.

Lynch, Michael 2009: *From the 4S President*, the Program of the 2009 4S Meeting.
<http://www.4sonline.org/4S_Program2009_lg.pdf>

Lynch, Michael/Simon Cole, 2005: Science and Technology Studies on Trial: Dilemmas of Expertise. In: *Social Studies of Science* 35, 269–311.

Markus, Eszter (rapporteur), et al., 2009: *The MASIS report: Challenging Futures of Science in Society*.

Emerging Trends and cutting-edge issues (final report of an EU expert group; chair: Karen Siune), EUR 24039. Luxembourg: Publications Office of the European Union.

Molyneux-Hodgson, Susan/Morgan Meyer, 2009: Tales of Emergence—Synthetic Biology as a Scientific Community in the Making. In: *BioSocieties* 4, 129-145.

Mueller, Milton L./Brenden N. Kuerbis/Christiane Pagé, 2007: Democratizing Global Communication? Global Civil Society and the Campaign for Communication Rights in the Information Society. In: *International Journal of Communication* 1, 267-296.

Nature Editors, 2004: *Going Public*, editorial. In: *Nature* 431, 883.

Nordmann, Alfred, 2007: If and Then: A Critique of Speculative NanoEthics. In: *NanoEthics* 1, 31-46.

Nordmann, Alfred, 2009: European Experiments. In: *Osiris* 2009, 24, 278-302.

Nordmann, Alfred/Arie Rip, 2009: Mind the Gap Revisited. In: *Nature Nanotechnology* 4, 273–274.

Nowotny, Helga, 2007: How Many Policy Rooms are There?: Evidence-Based and Other Kinds of Science Policies. In: *Science Technology Human Values* 32, 479-490.

Owen, Richard/John Bessant/Maggy Heintz (eds.), 2013: *Responsible innovation: Managing the responsible emergence of science and innovation in society*. Chichester: John Wiley.

University of Oxford, 2004: *'Does STS Mean Business?'*. A one-day workshop at the Saïd Business School, University of Oxford.
<http://www.sbs.ox.ac.uk/news/archives/Main/Does+STS+Mean+Business.htm>

Reber, Bernard, 2006: Technology Assessment as Policy Analysis: From Expert Advice to Participatory Approaches. In: Frank Fischer/Gerald Miller/Mara Sidney (eds.), *Handbook of Public Policy Analysis. Theory, Politics and Methods*, Public Administration and Public Policy Series 125. Rutgers University: CRC Press, 493-512.

Rip, Arie, 2006: A co-evolutionary approach to reflexive governance – and its ironies. In: Jan-Peter Voß, et al. (eds.), *Reflexive Governance for Sustainable Development* Cheltenham: Edward Elgar, 82-100.

Rip, Arie, 2008: Nanoscience and Nanotechnologies: Bridging Gaps Through Constructive Technology Assessment In: Gertrude Hirsch Hadorn, et al. (eds.), *Handbook of Transdisciplinary Research*. Swiss Academy of Arts and Sciences: Springer, 145-157.

Rip, Arie/Jan-Peter Voß, 2009: *Umbrella terms in the governance of emerging science and technology*, presented at the Spring Session 2009 'The governance of future technologies' of the working group 'Politics, Science and Technology' of the 'German Political Science Association", Berlin, 22-23 May 2009.
<http://politics-science-technology.org/files/VortragsfolienBerlin09/Rip-Voss_UmbrellaTerms.pdf>

Rogers-Hayden, Tee, 2007: Moving engagement "upstream"? Nanotechnologies and the Royal Society and Royal Academy of Engineering's inquiry. In: *Public Understanding of Science* 16, 345-364.

Schaper-Rinkel, Petra, 2006: Governance von Zukunftsversprechen: Zur politischen Ökonomie der Nanotechnologie. In: *PROKLA. Zeitschrift für kritische Sozialwissenschaft* 36/4(145), 473–496.

Schummer, Joachim, 2008: The Popularization of Emerging Technologies through Ethics: From Nanotechnology to Synthetic Biology. In: *Spontaneous Generation* 2, 56-52.

Selin, Cynthia, 2008: The Sociology of the Future: Tracing Stories of Technology and Time. In: *Sociology Compass* 2, 1878-1895.

Simakova, Elena, 2011: Collaboration Talk: the folk theories of nano research. In: *Science as Culture* 12(2), 177-203.

Simakova, Elena, 2012: Making Nano Matter: an Inquiry into the Discourses of Governable Science. In: *Science, Technology & Human Values* 37 (6), 604-626.

Simakova, Elena/Christopher Coenen, 2013: Visions, Hype, and Expectations: a place for responsibility'. In: Richard Owen/John Bessant/Maggy Heintz (eds.), *Responsible innovation: Managing the responsible emergence of science and innovation in society*. Chichester: John Wiley, 241-266.

Sorensen, Knut H., 2004: Cultural Politics of Technology: Combining Critical and Constructive Interventions? In: *Science, Technology and Human Values*, 29(2), 184-190.

Stirling, Andy, 2008: "Opening Up" and "Closing Down" – Power, Participation, and Pluralism in the Social Appraisal of Technology. In: *Science, Technology & Human Values* 33, 262-294.

Swierstra, Tsjalling/Arie Rip, 2007: Nanoethics as NEST-ethics: Patterns of Moral Argumentation About New and Emerging Science and Technology. In: *Nanoethics* 1 (1), 3-20.

Thompson, Neil, 1998: The Ontology of Ageing. In: *British Journal of Social Work* 28, 695-707.

Torgersen, Helge, 2009: Synthetic Biology in Society - Learning from past Experience?. In: *Systems and Synthetic Biology* 3(1-4), 9-17.

Vogel, Kathleen M., 2008: Iraqi Winnebagos of Death: Imagined and Realized Futures of U.S. Bio-weapons Threat Assessments. In: *Science and Public Policy* 35(8), 561-573.

Voß, Jan-Peter/Dierk Bauknecht/René Kemp (eds.), 2006: *Reflexive Governance for Sustainable Development*. Cheltenham: Edward Elgar.

Webster, Andrew, 2007a: Crossing Boundaries: Social Science in the Policy Room. In: *Science, Technology and Human Values* 32, 458-478.

Webster, Andrew, 2007b: Reflections on Reflexive Engagement: Response to Nowotny and Wynne. In: *Science, Technology and Human Values* 32, 608-615.

Weldes, Jutta E., 2006: High politics and low data: globalization discourses and popular culture. In: Dvora Yanow/Peregrine Schwartz-Shea (eds.), 2006: *Interpretation and Method: empirical research methods and the interpretive turn,* . Armonk, NY, London: M. E. Sharpe, 176 - 186.

Wienroth, Matthias, 2009: *The lowest common denominator?A Newcastle case study on research practice and disciplinarity in nanoscale science and technology*, PhD Thesis, Newcastle University, School of Geography, Politics and Sociology.

Woolgar, Steve/Geoff Cooper, 1999: Do artefacts have ambivalence? Moses' Bridges, Winner's Bridges and other Urban Legends in S&TS. In: *Social Studies of Science* 29(3), 433-449.

Woolgar, Steve/Christopher Coenen/Elena Simakova, 2008: The Ontological Politics of Convergence'. In: Daniel Andler, et al., *Converging Technologies and their impact on the Social Sciences and Humanities*, Appendix C. <http://www.contecs.fraunhofer.de/images/files/contecs_report_complete.pdf>

Woolgar, Steve/Catelijne Coopmans/Daniel Neyland, 2009: *Does STS Mean Business?*, editorial. In: *Organization* 16, 5-30.

Woolgar, Steve/Daniel Neyland (forthcoming): *Mundane Governance: objects, technology and accountability*. Oxford University Press.

Wullweber, Joscha, 2008: Nanotechnology – An Empty Signifier à venir? A Delineation of a Techno-socio-economical Innovation Strategy. In: *Science, Technology & Innovation Studies* 4, 27-45.

Wynne, Brian, 2007: Dazzled by the Mirage of Influence?: STS-SSK in Multivalent Registers of Relevance. In: *Science Technology and Human Values* 32, 491-503.