STI Studies

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

"Governance of Visionary Technosciences"

edited by Christopher Coenen and Elena Simakova

Contents

ISSN: 1861-3675

www.sti-studies.de

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

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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

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[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 sub-communities (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 societal 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).

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

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

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

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[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 multistakeholderism. 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]

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[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.

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

ISSN: 1861-3675

STI Studies

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Techno-visionary Sciences

Challenges to Policy Advice

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Abstract

Scientific policy advice on issues of science and technology looks back to a tradition of more than 50 years. Technology assessment (TA) has been developed since the 1960s, frequently in relation to or on behalf of political institutions such as parliaments and governments. In general, science and technology studies (STS) appear to be (or, at least, to have been until quite recently) more academic and more distant to institutionalised political decision processes in a strict sense (the 'political system').

Seen against this background, one main thesis of this paper is that the rise of new techno-visionary sciences, such as nanotechnology, significantly contributed to a process of convergence between STS and TA. The reason for this can be located in the particular relevance and virulence of the 'Collingridge dilemma' for these sciences. Due to the high uncertainties with respect to the knowledge about impacts of the related technologies, TA has to look for other than empirical or logical arguments to support 'upstream' technology impact analyses – and can find them partially in theory-based work in STS, for example in the context of the debate on the co-evolution of technology and society. STS practitioners, in turn, see options and the need for 'going public' in a new way (and at an early stage of development), now increasingly including the institutionalised political domain. Equipped with their refined analytic, interpretative and ethnographic capacities, STS are moving further into often unfamiliar policy terrain which has its own logic and distinct set of rules.

The paper analyses and reflects on ongoing shifts in the 'landscape' of scientific policy advice, focusing on the rise of techno-visionary sciences and converging technologies. Another aim of the paper is to orientate STS and TA toward mutual learning processes and intensified cooperation, based on existing experience in both fields.

1 Policy advice and the governance of science

The governance of science in society has become an important issue in the past decades. Reflexivity has increased in the sense that appreciation of as well as concerns about the roles and impacts of science in society have prompted calls for new elements in the governance of science (Markus/Siune, et al. 2009). Ongoing changes in the governance of science are indicated by the move to enhance democracy by including more stakeholders and bottom-up deliberative processes in science issues, the emergence of upstream analysis and engagement in important fields such as the nanosciences, and the advancement of notions such as 'responsible development' and 'responsible innovation'.

Overall, this subjects the governance of science and the shaping of technology to far more complex requirements than those imposed by earlier ideas. Governance of science nowadays is regarded as a phenomenon that is determined by multiple factors and involves citizens, scientists, research organisations, academic institutions, political actors, agencies, non-governmental organisations and authorities. It is thus clear that policy advice must adapt to this increasing complexity as has been explained by Markus/Siune, et al. (2009). This paper's point of departure is the observation that the emergence of techno-visionary sciences further increases the complexity of science and technology governance.

Scientific policy advice on science and technology issues has been provided for more than 50 years now. Many concepts have been proposed, developed and, in some cases, put into practice. 'Technology assessment', one of the more prominent approaches, has been developed since the 1960s, frequently in close cooperation with political institutions such as parliaments and governments (Bimber 1996; Vig/Paschen 1999; Grunwald 2009a). Applied ethics have expanded advisory activities in the past decade, mainly in the field of life sciences and medicine, and have recently also focused on new and emerging science and technology (Rip/Swierstra 2007). The issue of anticipatory governance and the concept of real-time technology assessment (Guston/Sarewitz 2002) have emerged at the borderline between technology assessment (TA) and 'science, technology and society studies' (STS) which over the past decades have developed in more or less separate ways. Although these approaches share some similarities, there are also differences, one of them concerning the role of self-perception: do they view themselves as distant observers or as part of the game aimed at intervention? The "classical" view of STS and the sociology of science has been characterised as follows: "The sociology of science is often accused of sitting on an epistemological fence (…). Although fence-sitting is still an honourable epistemic tradition, many in the field today enjoy camping out, not on fences, but on ‚boundaries'." (Webster 2007, p. 458)

This view is inherently ambivalent: it values "fence-sitting" as an "honourable tradition" because the observation of social issues in research often requires a detached observer. However, there is also a sense that this position, despite being necessary, may not be sufficient to satisfy current expectations. STS should thus go beyond fence-sitting and show more practical engagement: "The STS analyst can (and does) play an enabling role in such initiatives [projects that are designed to develop new forms of public inclusivity]. My argument is that the three entry points [the characterization and anticipation of emerging techno-science fields; the exploitation of (future) technoscience; the context in which technoscience applications are used] bring our focus down from the meta level to more meso and tractable forms of engagement and critique *within the policy room itself*." (Webster 2007, p. 472)

Technology assessment has arrived at a clear conclusion concerning its own position in this debate, as is also demanded by many research programmes: TA is to have impact and must therefore "make a difference" – and that means that TA admits to taking responsibility for intervening in ongoing decision-making processes (Decker/Ladikas 2004). TA has considerable experience in the field of advising political institutions such as parliaments with and without public participation, allowing the conclusion in many cases that TA really "made a difference" – and in other cases did not. Recent notions have been developed such as responsible innovation and responsible development[1], as well as interlinked and systemic models of R&D, of innovation and of innovation systems. These offer societal actors and groups – especially civil society organisations (CSOs), some of which have already contributed considerably to debates on emerging fields of technology such as nanotechnology and synthetic biology – opportunities to influence R&D and innovation processes. In such a world, 'responsible development' is not a symbolic reference, but can be made operational (Markus/Si une, et al. 2009).

In this paper I will address the emerging implications and consequences of the expanding field of techno-visionary sciences and the related debates (see Sec. 2) on scientific policy advice and ask for new approaches, concepts and methods of policy advice. The use of envisaged possible futures such as scenarios to achieve orientation has been established since the 1950s, first of all in the military domain. However, the use of such futures has changed over time, particularly with regard to emerging techno-visionary sciences. In this context, I will elaborate on the following hypotheses:

1. Scientific, public and political communication about techno-visionary sciences may frequently have a *genuine impact* on society – on public attitudes, perceptions of policy-makers and funding policies – irrespective of their degree of plausibility, feasibility and speculativity. Even highly fictional debates may also receive real power (Sec. 2).
2. Policy advice is thus also needed in these fields but faces not only the great lack of knowledge but also the hope and hype structure of visionary debates. Policy advice can therefore no longer be expected merely to give concrete information about the consequences of technology but to undertake more hermeneutic and reconstructive work on the content of the visionary futures; the very nature of these visions must be made transparent in terms of epistemic, normative and strategic issues (Sec. 3).

Meeting these challenges requires (a) more knowledge about the dissemination of visionary futures and the mechanisms by which they influence public debate and policy-making and (b) new assessment and reconstruction procedures concerning visionary futures (Sec. 4).

This paper has a programmatic and conceptual focus. It does not aim to present empirical data. On the basis of a sound diagnosis of the increasing role of techno-visionary sciences in public and policy debates about science, conclusions are drawn in order to identify further research needs and practical challenges in scientific policy advice. New assessment approaches will be tentatively presented – not as ready-made answers to the challenges identified, however, but as proposals

[1] Examples are the Dutch funding agency NWO's programme on *Maatschappelijk Verantwoord Innoveren* (www.nwo.nl/mvi), and the Norwegian Research Council's programme on Ethical, Legal and Social Aspects of New Technologies (www.forskningsradet.no).

and ideas for future research in this field.

In this context I can draw on some practical experience gained in recent years which indicates that policy makers are aware of the "real power" of techno-visionary communication and are seeking policy advice in the areas involved. For example, a chapter about techno-visionary communication on human enhancement, "converging technologies" (nano-bio-info-cogno convergence) and other far-reaching goals, compiled by the Office of Technology Assessment at the German Bundestag (TAB) as part of a comprehensive TA study on nanotechnology (Paschen et al. 2004), was very well received by the German Bundestag. By "isolating" the futuristic visions in a separate chapter, TAB performed a kind of 'boundary work' (Gieryn 1984) even at the study's design stage, yet at the same time giving plenty of room to these visions (cf. Simakova and Coenen 2013). The authors of the TAB study came to the conclusion that this techno-visionary discourse played an important and to some extent new role in the governance of science and technology (new at least in civilian research and development), while also entailing new challenges for TA. As regards techno-visionary communication, all political parties in parliament tended to be more enthusiastic about nanotechnology than the TA study was; nonetheless, just like other political institutions, they often also warned against futurism in much the same vein as the TAB, thereby contributing to the German variant of the boundary work on nanofuturism which in the US culminated in the Drexler-Smalley debate (Selin 2007).

Interestingly, several renowned researchers in nano-science and nanotechnologies communicated to the TAB team, or even publicly commented, that they found the study's discussion of futuristic visions and description of the networks promoting them very useful. The TAB team's initial concerns that discussing these often far-fetched visions in a study which would become an official document of the parliament and an influential early publication on nanotechnology could cause irritation thus proved to be unfounded. Subsequently, TAB was requested to conduct several other projects to explore various issues in the field of converging technologies in more detail: studies on the politics of converging technologies at the international level (Coenen 2008) and on brain research (Hennen et al. 2007), and a study entitled "*Pharmacological and technical interventions for improving performance.* Perspectives of a more widespread use in medicine and daily life ('enhancement')" (see Sauter/Gerlinger 2011 and TAB 2011).

This interest of policymakers in techno-visionary sciences is also evident at the European level, where the field of techno-visionary sciences is being addressed in an anticipatory manner by a fairly large number of projects (see, for example, Coenen et al. 2009b on human enhancement, European Parliament/STOA 2011 on a broad range of technologies) and other advisory activities (see, for example, the activities on nanotechnology, synthetic biology and ICT implants conducted by the European Group on Ethics in Science and New Technologies, EGE). The situation is much the same in the United States (see, for example, PCSBI 2010, i.e. the recent work on synthetic biology by Barack Obama's Presidential Commission for the Study of Bioethical Issues, and the work by George W. Bush's ethics council on human enhancement).

What is still missing, however, is a careful analysis of modified or new requirements concerning sound science-based policy advice in this emerging field. This is the main task of this paper. The notion of '(scientific) policy advice' will serve as an umbrella term for scientific and knowledge-based advice made available to policymakers. In the context of this paper, this always refers to advice on the broad field of science and technology governance described briefly above, including participatory processes. 'Scientific' here means that policy advice is given on the basis of the state of the art in the natural-scientific, social-scientific and humanist disciplines relevant to the given topic of advice.

2 Techno-visionary communication in ongoing debate

In the past decade, there has been a considerable increase in visionary communication on future technologies and their impacts on society. In particular, this has been and still is the case in the fields of nanotechnology (Selin 2008; Fiedeler et al. 2010), human enhancement and the converging technologies (Roco/Bainbridge 2002; Grunwald 2007; Wolbring 2008), synthetic biology (Coenen et al. 2009a) and climate engineering (Crutzen 2006). Visionary scientists and science managers have put forward far-ranging visions which have been disseminated by mass media and discussed in science and the humanities. These observations allow us to speak of an emergence of *techno-visionary sciences* in the past decade.

The emergence of this new wave of visionary and futuristic communication (Coenen 2010, Grunwald 2007, Selin 2008) has provoked renewed interest in the role played by imagined visions of the future. Obviously, there is no distinct borderline between the visions communicated in these fields – I will call them futuristic visions (Grunwald 2007) – and other imagined futures such as *Leitbilder* or guiding visions which have already been analysed with respect to their usage in policy advice (Grin/Grunwald 2000). However, the following characteristics may circumscribe the specific nature of futuristic visions:

- futuristic visions refer to a more distant future, some decades ahead, and exhibit revolutionary aspects in terms of technology and in terms of culture, human behaviour, individual and social issues
- scientific and technological advances are regarded in a renewed techno-determinist fashion as by far the most important driving force in modern society (technology push perspective)
- the authors of futuristic visions are mostly scientists, science writers and science managers such as Eric Drexler and Ray Kurzweil, though industry and CSOs are also developing and communicating visions
- milestones and technology roadmaps are to bridge the gap between today's state and the visionary future state (e.g. Roco/ Bainbridge 2002)
- high degrees of uncertainty are involved; this leads to severe controversies with regard not only to societal issues (e.g. Dupuy 2007) but also to the feasibility of the visionary technologies (e.g. Smalley 2001)

Futuristic visions address possible future scenarios for techno-visionary sciences and their impacts on society at a very early stage in their scientific and technological development. As a rule, little if any knowledge is available about how the respective technology is likely to develop, about the products which such development may spawn and about the potential impact of using such products. According to the Control Dilemma (Collingridge 1980), it is then extremely difficult if not impossible to shape technology. Instead, lack of knowledge could lead to a merely speculative debate, followed by arbitrary communication and conclusions (see Sec. 3.1).[2]

While futuristic visions often appear somewhat fictitious in content, it is a fact that such visions can and will have real impact on scientific and public

[2] One illustrative example is the ongoing debate on "speculative ethics" (Nordmann 2007, Nordmann/Rip 2009, Roache 2008, Grunwald 2010).

discussions (Nowotny et al. 2001). We must distinguish between the degree of facticity of the *content* of the visions and the fact that they are used in genuine communication processes *with their own dynamics*. Even a vision without any facticity at all can influence debates, opinion-forming, acceptance and even decision-making. Visions of new science and technology can have a major impact on the way in which political and public debates about future technologies are currently conducted, and will probably also have a great impact on the results of such debates – thereby considerably influencing the pathways to the future in two ways at least:

- Futuristic visions are able to change the way the world is perceived and increase the contingency of the *conditio humana* (Grunwald 2007). The societal and public debate about the chances and risks of new technologies will revolve around these visions to a considerable extent, as was the case in the field of nanotechnology (cf. Schmid et al. 2006) and as is currently the case in synthetic biology (Coenen et al. 2009a). Visions motivate and fuel public debate because of the impact these visions have on everyday life and on the future of areas of society such as the military, work or health care, and because they are related to some extent to cultural patterns (DEEPEN 2009). Negative visions and dystopias could mobilise resistance to specific technologies.
- Visions have a particularly great influence on the scientific agenda (Nordmann 2004) which, as a consequence, partly determines which knowledge will be available and applicable in the future. Directly or indirectly, they influence the views of researchers, and thus ultimately also have a bearing on political support and research funding. Visions therefore influence decisions about the support and prioritisation of scientific progress. This is an important part of the governance of knowledge (Stehr 2004), as revealed by the sociology of expectations (van Lente 1993, Selin 2008):

The factual importance (power) of futuristic visions in the governance of knowledge and in public debate is a strong argument in favour of providing early policy advice in the fields of techno-visionary sciences with a view to increasing reflexivity and transparency in these debates. Policymakers and society should know more about these visions – they must be informed and "empowered" to deal constructively and reflectively with futuristic visions in processes of "anticipatory governance" and "responsible development".

This conclusion is supported by calls for a more democratic governance of science and technology (Markus/Siune, et al. 2009) on account of the fact that futuristic visions contain a mixture of facts and values, allowing them to be used for ideological and interest-based purposes. Special consideration must therefore be given to the challenge of how democratic deliberation and public debate could be involved in shaping the future course of techno-visionary sciences, taking the described lack of knowledge and the Control Dilemma seriously. An open, democratic discussion of techno-visionary sciences is a prerequisite for a constructive and legitimate approach to shaping the future research agenda, regulations and research funding. The requirement for transparency with respect to future projections and the arguments, premises and visions they comprise is indispensable; this is the main point of entry for identifying challenges to policy advice and for deriving specific requirements for the organisation of policy advice in this field. Another essential point is that democratic debate depends on the capabilities and capacities of people and groups to engage in such debates. Access to adequate resources and information is necessary in general, and particularly when it comes to interpreting and debating futuristic visions.

3 Techno-visionary sciences: Challenges to policy advice

Having set forth arguments in favour of providing scientific policy advice for the governance of techno-visionary sciences despite a lack of knowledge, the next task is to analyse in some depth the specific challenges to policy advice. We need to identify the obstacles, pitfalls, risks and restrictions associated with attempting to meet specific objectives of policy advice in the field of techno-visionary sciences:

- to provide orientation for current decision-making in the field, e.g. with regard to research funding and its influence on the scientific agenda
- to identify possible requirements for regulation (in the case of synthetic biology, for example, risks of bio-safety and bio-security which are frequently debated issues today)
- to inform and enlighten democratic deliberation and public debate in line with theories of deliberative democracy
- to provide society today with better knowledge "about and for us": "What do these visions tell us about the present, what is their implicit criticism of it, how and why do they require us to change?" (Nordmann 2007, p. 41).

Policy advice on issues of technological progress is usually generated by undertaking future investigations, scenarios and reflections (Grunwald 2009a), in line with the general premise that decision-making processes in modern societies operate by looking to the future rather than the past (e.g. Luhmann 1997). The problem is that the familiar social conflicts will also influence the way the future is considered and assessed (Brown et al. 2000). Social conflicts and scientific controversies make it impossible to obtain converging views on futures (see Grunwald 2011 for the case of energy futures). This makes it more difficult for policy advice to provide orientation. In this section I will take a closer look at those challenges to policy advice that appear to be specific to the field of techno-visionary sciences.

3.1 The arbitrariness problem

A fundamental problem with far-reaching future visions or scenarios is the inevitably high degree to which material other than sound and reliable knowledge is involved. In many cases, entire conceptions of the future, or aspects of it, are simply "accepted" due to a lack of knowledge; this is typical of one of the branches of the Control Dilemma mentioned above. Huge uncertainties enter the field – these are gradually and imperceptibly transformed, first to possible, then plausible and finally probable development paths: "As the hypothetical gets displaced by a supposed actual, the imagined future overwhelms the present" (Nordmann/Rip 2009, p. 273). Indeed, it is not unusual in the field of techno-visionary sciences to include second- or third-level conditionality, namely when certain consequences might occur as a consequence of the use of techno-visionary products that themselves only *might* or *could* become reality, and then only if the respective technical development *were to* take place in the direction envisaged. As a rule, it is also possible in multilevel conditional sentences of this type for the outcome to be precisely the opposite of what was originally assumed. It would then be impossible to decide on which of the contradictory alternatives should be given preference and for which reasons.

Consider, for example, the different views on converging technologies expressed by Dupuy and Grinbaum (2004) and Roco and Bainbridge (2002). The future prospects of the converging technologies show the *maximum conceivable disorientation*: they oscillate between expectations of paradise and of catastrophe. If there were no methods of assessing and scrutinising diverging futures in a "rational" sense, the arbitrariness of futures would destroy any hope of gaining orientation by reflecting on future developments. This was the primary concern resulting from the examination of the debate on "speculative nanoethics" (Nordmann 2007; Grunwald 2010). It is essential that the problem of the feared arbitrariness of futures be satisfactorily resolved, as otherwise the decision-making cycle (Fig. 2) would amount to nothing more than self-deception. Providing orientation by communicating futuristic visions is therefore a highly ambitious and risky undertaking. The arbitrariness problem constitutes a severe challenge and raises doubts about whether such an endeavour could succeed at all. In accordance with the Control Dilemma (Collingridge 1980), it above all imposes limits on the excessive expectations of upstream engagement's ability to shape science and technology; alternatively, it gives rise to a need to develop new ideas to circumvent the Dilemma or, if this is not possible, to deal constructively with it.

3.2 The ambivalence of techno-visionary futures

Public attention has become a scarce commodity in the media society, with the corresponding consequences for the threshold of perceptibility. This leads to inflated scientific promises and announced paradigm changes, and greater expectations of something that is presumed to be "completely new". In futuristic visions, as in the debates on nanotechnology and converging technologies, what is *completely new* is frequently pushed to the foreground by its protagonists, because only in this manner can public and political attention be generated. This communication pattern is obviously not entirely new but has been extensively used over the past decade.

In the field of techno-visionary sciences, the high degree of uncertainty and low level of reliable knowledge mean that this type of communication entails specific risks because it is impossible to obtain a more or less clear picture of future developments and arrive at a (more or less) clear ethical judgment. If the anticipated future developments of techno-visionary sciences diverge dramatically between paradise and apocalypse, ethical assessments of these sciences will diverge in a similar way: "Tremendous transformative potential comes with tremendous anxieties" (Nordmann 2004, p. 4). This will then have dramatic consequences for public debate and public perception of techno-visionary sciences. Using metaphors to describe what is radically and revolutionarily new in terms of scientific-technical visions can backfire; an attempt to fascinate and motivate people by suggesting positive utopias can lead directly to rejection and contradiction. The visionary pathos in many technical utopias is extremely vulnerable to the simple question of whether everything couldn't just be completely different – and it is as good as certain that this question will also be asked in an open society. It is one of the core convictions of large parts of STS, in accordance with the field's underlying social constructivist paradigm, that existing technologies could have developed completely differently and that the development of future technologies is not determined by today's constellations.

Nanotechnology is a good illustration of how positive expectations can be reversed and become sinister fears. Ever since the now-famous article entitled "Why the Future Doesn't Need Us" (cf. Joy 2000) was published, self-reproducing nanobots have no longer been simply a vision intended to help solve humanity's gravest problems (cf. Drexler 1986), but in some cases have been publicly portrayed as a nightmare scenario. This example shows that revolutionary changes promised by new technologies give rise not only to fascination and motivation but also to concern, fear and objection. In the course of time, there may be winners and losers, there may be unexpected and possibly negative consequences, and there will certainly be a large degree of uncertainty. Revolutionary prospects do not automatically lead to positive associations, but may also provoke negative reactions. Futuristic visions may thus lead to a backlash and ultimate rejection rather than fascination and acceptance.

3.3 Lack of transparency

The existence of visionary futures in these fields reveals a high degree of uncertainty. They are difficult to assess with respect to their feasibility and possible impact on future society. Given their considerable impact on the way new technologies are perceived in society and in politics and given that they are an important part of their governance (see Sec. 2), they should be subject to democratic debate and deliberation. The significant lack of transparency and unclear methodical status of futuristic visions are, however, obstacles to transparent democratic debate.

Techno-visionary futures do not exist per se, nor do they arise of their own accord. On the contrary, they are "made" and socially constructed in a more or less complex manner. Futures – be they forecasts, scenarios, plans, programmes, visions, speculative fears or expectations – are "produced" using a whole range of ingredients such as available knowledge, value judgements and suppositions. This construct character of a future, that is to say the fact that its character is the result of a construction process, is particularly true of *scenarios*. The common reference to "scenario building" emphasises this construction process.

Visions of the future are created in accordance with available knowledge, but also with reference to assessments of relevance, value judgements and interests, and are often commissioned by political and economic decision-makers (Grunwald 2011). The construct character of futures can thus be exploited by those representing specific positions on social issues, substantial values and specific interests such that future visions are produced that reflect their interests and can be employed to assert their particular positions in debates (Brown et al. 2000; see also the remarks of the 'deconstructive side' of STS given by Webster 2007). The non-transparent nature of the visions communicated in public debate hinders democratic deliberation.

Visionary futures are frequently created by scientists and science managers who at the same time are stakeholders with their own interests. One possible scenario is that visionary futures suggested by science could dominate social debates by determining their frames of reference; this would leave the social debate with only aspects of minor importance (Nordmann/Rip 2009). In this case, those visionary scientific and technological futures could endanger public opinion-forming and democratic decision-making, thus perhaps constituting a new form of "covert" expertocracy. Against the background of normative theories of deliberative democracy, there is therefore a considerable need to improve transparency in this field.

3.4 Displaced politics?

The question arises whether the emergence of techno-visionary sciences creates or has created new policy rooms (Nowotny 2007) that are related to the communication medium of futuristic visions and new forms of governance. The current situation in the fields of enhancement technologies, synthetic biology and other techno-visionary sciences such as climate engineering might be regarded as an ongoing social experiment. STS research might feel itself to be in a kind of laboratory situation and attempt to directly observe ongoing changes and shifts in the "policy rooms" (Nowotny 2007) that govern the co-evolution of science and technology and society.

This topic covers a variety of subtopics which can be described by asking the following questions: What impact do techno-visionary futures have on politicians and other actors in the overall governance of visionary techno-sciences? Which aspects, properties or attributes of these futuristic visions have a crucial bearing on public opinion-forming and political decision-making processes? How do visions enter other subsystems of society such as the economy, political system or cultural institutions such as education or popular entertainment (films, books)? How are they absorbed by potential users? How are futuristic visions perceived, communicated and used in public debate? Research should also consider the role of scientific policy advice (i.e. parliamentary technology assessment and expert groups) as an intermediary channel for transferring scenarios from the academic to the political arena. Of particular interest, furthermore, is an investigation of how and to what degree futuristic visions structure public debate, influence the perception of risks and opportunities and determine technology acceptance or rejection.

Nahuis and van Lente (2008) refer to the political content and power of otherwise de-contextualised techno-scientific artefacts and related debates. They note that science and technology ''challenge the common meaning of (democratic) politics'', leading to innovation that ''has been conceived of as the continuation of politics with other means'', and is ''most successful when it bypasses established institutions of democratic politics'' (Nahuis/van Lente 2008, p. 560; Kastenhofer 2010). Other forms of displacement such as 'displaced technology', 'displaced sociality', 'displaced naturality' or 'displaced science' could be appropriate attributes if the hybrid character of techno-science is taken seriously (Kastenhofer 2010) – a hybrid character which is also evident in the futuristic elements of the ongoing communication on techno-visionary sciences. The landscape of the "policy rooms", where governance of techno-visionary sciences takes place, is changed by displacements, shifts and the dissolution of communication borders or the creation of new boundaries and boundary objects. Policy advice in these fields should be well-informed about these developments precisely because it has to operate in this changing environment.

4 Conclusions about a research programme in STS and TA

To meet the aforementioned challenges, one must build on existing experiences, bodies of knowledge and competencies of established policy advice approaches and concepts. This must be complemented by new approaches to research, analysis and assessment for societal debates on techno-visionary sciences.

4.1 Understanding the biography of futuristic visions

Futuristic visions are created and disseminated by authors, teams, scientists and science managers, or emerge from discourse within scientific communities. They are communicated via different channels, journals, networks, mass media, research applications etc. Some of them, finding no resonance, will "die" within these communication processes, while others will "survive" and motivate actors and groups to subscribe to or oppose the visions – in either case the story will continue. Only a few of the visions will find an audience via the mass media and will therefore be able to bring about "real" impact by influencing public debate and social perception or attitudes. Others may enter the political arena and result in political decisions, e.g. about research funding, and may then disappear.

These different "biographies" of futuristic visions could be extended by examining their historical roots (Coenen 2010) and the resonances they may subsequently generate. In this sense we could regard futuristic visions as part of an ongoing societal and scientific communication process in which specific visions – e.g. the molecular assembler (Drexler 1986) or enhancement of the brain's capability – act as the necessary catalysts with their own individual "biography" or "life cycle".

Biographies of futuristic visions are not well understood as yet. There is a particularly low level of knowledge about the factors that determine whether a particular vision will "die" (i.e. whether it will disappear during the course of the communication process without having had any impact) or will "survive" and stimulate further communication, possibly influencing societal perception and political decision-making. The entire 'life cycle' of futuristic techno-visions, from construction to assessment and impact, thus raises a huge variety of research questions which can only be answered by giving interdisciplinary consideration to all three aspects. The main objective would be to generate more knowledge about and greater insights into the social processes surrounding visionary futures, from their emergence and dissemination via different communication channels to their possible impact on decision-making in the policy arena and other arenas of public communication and debate. Innovative formats for improving communicative practice should be developed on the basis of this knowledge (Markus/Siune, et al. 2009). This may contribute to a 'normalisation' of techno-visionary sciences (see Grunwald/Hocke-Bergler 2010 for the case of nanotechnology). Generally, normalisation means that the perception of new and emerging science and technology (NEST) shifts from 'revolutionary' to more or less 'normal', displaying the familiar ambivalences as regards risks/ opportunities.

4.2 Epistemological deconstruction of techno-visionary futures

The arbitrariness problem (see Sec. 3.1), namely that reliable conclusions based on the usual scientific standards cannot be drawn if merely speculative and arbitrary futures are addressed (Hansson 2006), can be regarded as a challenge to epistemology, though it may be possible to avoid complete arbitrariness, at least to a certain degree. In order to deal constructively with the challenge of arbitrariness, methods and procedures for assessing the degree of rationality behind visions and images of highly uncertain futures must be developed. Deconstruction (see Webster 2007) must not only clarify the cognitive and normative content of the partially speculative future conditions but also assess their validity: "Instead of welcoming without scrutiny anyone who cares to add to the stock of promises and concerns about nanotechnology, we need to encourage discussions about quality of promises." (Nordmann/Rip 2009, 274)

Epistemological "deconstruction" of visionary statements is necessary in order to be able to qualify the object of subsequent ethical reflection or public debate, for example, with regard to its applicability and validity. Epistemological analysis of future conditions would initially have to uncover the cognitive content of the visions, i.e. the portions of knowledge and lack of knowledge that are involved, their respective premises, and the way they are combined to form coherent images of the future, such as scenarios. An important aspect would then be to examine the conditions necessary for such futures to become reality and the periods of time involved. Furthermore, the *normative content* of the visions would have to be reconstructed analytically: the images of a future society or human development, and the possible diagnoses of current problems, the solutions to which are supposed to be facilitated by the techno-visionary developments.

The de facto importance of futuristic visions in the nano debates was the main argument for postulating early vision assessment in order to allow for more rationality, reflexivity and transparency (Grunwald 2009b) consisting of an epistemological, a hermeneutical and an empirical division. Deconstruction thus not only means a philosophical endeavour rooted in epistemology, but should also include a deconstruction of the social processes involved in the construction, dissemination and use of elements of techno-visionary communication. In this way, both philosophical analysis and STS research are needed.

4.3 Hermeneutical reconstruction

In response to the issue of non-transparency (see Sec. 3.3), tools and methods must be developed and applied which allow the content of the visions debated in the field of techno-visionary sciences to be revealed (e.g. Pawson et al. 2005). Such visions must be made the subject of prospective *hermeneutical* analysis in order to better understand the content of the visions. The more speculative the considerations of the consequences and impacts of techno-visionary sciences, the less they can serve as direct orientation for concrete (political) action and decisions. Instead, conceptual, pre-ethical, heuristic and hermeneutic issues then assume greater significance by contrast. The primary issue is then to clarify the meaning of the speculative developments: what is at issue; which rights might possibly be compromised; which images of humankind, nature and technology are formed and how do they change; which anthropological issues are involved; and which designs for society are implied in the projects for the future?

Thinking about these issues is obviously not aimed at direct policy action but is more about understanding what is at stake and issue in the debates on nanotechnology – contributing to a 'hermeneutics' of possibly changing elements of the *condition humaine*. In this way, hermeneutical reflection based on philosophical and social science methods such as discourse analysis can prepare the groundwork for anticipatory governance informed by applied ethics and technology assessment. Ultimately, this may promote democratic debate on scientific-technical progress by investigating alternative approaches to the future of humans and society with or without different techno-visionary developments. However, this would necessitate additional effort to make issues transparent and understandable to non-academics.

This "hermeneutics" of visions should address not only the cognitive but also the normative content of the visionary communication, both of which are culturally influenced. In a normative respect this would mean preparatory work for ethical analysis. As regards cultural issues, hermeneutical analysis could result in better understanding of the origins and roots of the visions by uncovering underlying cultural elements. An example of this type of analysis can be found in the DEEPEN project (DEEPEN 2009, von Schomberg 2010). One of the findings was that cultural narratives such as "Opening Pandora's box" and "Be careful what you wish for" also form the backdrop to many of the visionary public debates and concerns.

The expectation is that hermeneutical analysis and reconstruction will help realise orientation functions of futuristic visions, thus addressing at least to a certain extent the problems of ambivalence (Sec. 3.2) and lacking transparency (Sec. 3.3). It might benefit from recent thoughts on how to bring STS more constructively into a position of engagement with science and technology policy. Webster (2007), referring to the long-standing critical thrust of STS analysis, asks quite explicitly how science, technology and the social relationships on which they are based can be reconstructed in a more socially useful way (p. 460). He also acknowledges that the STS critic embraces normative intervention into ongoing governance processes; this comes close to the picture of technology assessment which was introduced in Sec. 1 – STS as a reconstructive approach is supposed to "make a difference" by providing socially robust insights that contribute to both more democratically and more technically warranted knowledge (p. 460).

If these general thoughts are applied to the field of techno-visionary sciences, it would appear that they are in line with more philosophical ideas of a hermeneutical reconstruction of futuristic visions – this *reconstruction* must necessarily be based on an epistemological and social *deconstruction* of these futures (Sec. 4.2).

4.4 The changing nature of participation

For years, participation in technology assessment was regarded as a key approach to more democratic governance of science and technology (Joss/Belucci 2002). The initial constellation was rather simple: TA institutions and projects were supposed to advise political institutions such as parliaments and governments, and many of them used participatory procedures to provide more socially robust advice, or advice based on greater legitimacy. This tradition in itself gave rise to many problems with achieving the far-reaching objectives, such as problems with selecting participants, problems with legitimacy and problems with transferring the results of participatory processes to formal decision-making procedures and problems.

In the field of techno-visionary sciences, however, things become even more complicated if the challenges mentioned in Sec. 3 are taken seriously. The following quote – read "techno-visionary sciences" for "technosciences" – may serve as an illustration of the increased complexity of governance in this field: "The role of technoscience as serving as a boundary object between science, technology and society can be interpreted even more broadly. Technoscience then becomes a kind of ''magic gate'' to introduce social, cultural and political elements into the scientific realm, and from there into the economic and industrial sphere, and vice versa. As soon as such aspects (be they objects, actors, discursive rationalities or governance regimes) leave their original sphere, they become intangible for instruments, mechanisms and actors pertinent to this sphere while still staying powerful" (Kastenhofer 2010).

The classic borders between political institutions, TA institutions and citizens become blurred in the field of techno-visionary sciences. The formerly rather clear images about the technology under consideration (take a nuclear waste disposal site, for example, or elements of new traffic infrastructure) are, in this field, elements of a highly uncertain future: whereas people in the past would be concerned or affected by specific technologies which had an impact on their concrete interests, there is now a shift towards a mere feeling of fascination or unease about techno-visionary sciences, and clear decisions that need to be taken are transformed into broader but indistinct images of future developments or of the "future of human nature" (Habermas 2001). What could participation contribute to governance of science and technology in these new "policy rooms" and what form might it take in terms of approaches and methods? Classical instruments such as consensus conferences or scenario workshops may well fail: "Public engagement is full of tensions, and after the recent wave of enthusiasm, it is time to consider renewal, at least in its relation with governance of science-in-society" (Markus/Siune, et al. 2009).

Even at the objectives level, participation may need to be completely reinvented from scratch. Rather than providing additional knowledge and diverse perspectives and values, thereby enriching concrete decision-making processes, the main task now would shift to hermeneutical work, in line with Sec. 4.3. However, how should people be motivated to engage in participatory processes where no concrete decisions are to be shaped or supported? Why should they spend their time at round table meetings or in focus groups where values and "grand issues" are at stake but no personal interests are affected? The changing nature of participation is also evident from the additional actors who are entering the game: "With the many upstream and midstream engagement exercises, the expectation of more to come, and thus a certain institutionalization of public engagement (in its various forms), a new kind of actor has emerged, the engagement mediator, consultant and entrepreneur. This will professionalize public engagement, so that it will be more immediately productive, but it may also undermine the original intent of deliberative democracy" (Markus/Siune, et al. 2009).

There is also a danger that participation in the field of techno-visionary sciences will amount to nothing more than mere conversation, as was found to be the case in the field of "speculative nano-ethics" (DEEPEN 2009). Altogether, it seems that an in-depth review of participation is necessary in this field, including an analysis of the mistrust displayed towards participation following suspected misuse due to partisan interests, when for example acceptance is simply created for decisions already taken.

5 Perspectives

Based on the observation that futuristic visions can strongly influence the scientific agenda, political decision-making, public attitudes and the structure of risk and opportunity debates, tools need to be provided that allow transparent democratic debate about the different and possibly completely diverging futures. Research for policy advice should develop and use such tools as were described in Sec. 4 in order to support, enable and empower public debate as well as decision-making.

Policy advice must build on scientific knowledge and deal with uncertainties. Considerable requirements and challenges in the field of techno-visionary sciences mean that new and emerging assessment regimes (Kaiser et al. 2010) must be used and transformed into an advisory structure. According to current requirements for science governance, this advisory structure should address not only political institutions and policy-makers in a traditional sense but all stakeholders involved (Markus/Siune, et al. 2009). In particular, it should allow a transparent democratic debate about the different visionary futures put forward by different actors. Vision assessment, being a combination of social science and STS research into the biography of visions, epistemological effort and explorative hermeneutics, allows better-informed and more rational opinion-forming, assessment and decision-making (Sec. 4).

This result demands that widely-used classical approaches to research and policy advice, such as technology assessment, applied ethics and STS research, should converge or at least undergo a process of mutual learning. Among other things, the MASIS expert group (Markus/Siune, et al. 2009), which brought together STS researchers and TA practitioners, found that converging perspectives could be developed at a rather high degree of abstraction. Notions such as 'reflective science' and 'responsible innovation' (see below) served as common frames for describing changing relations between science, technology and society over the past decades. Viewed from a TA perspective, however, stories about such notions are only part of the game resulting from observations made by a distant observer – typically from a STS perspective. The much more 'down to earth' business of TA being involved in concrete arenas of deliberation and conflict and having to deal with particular persons, groups and even societal forces takes place at a different level. Mutual learning processes might help bridge this obvious gap.

In the field of techno-visionary sciences, these learning processes can be organised as (1) distant observation versus engagement, (2) fact provision versus hermeneutical analysis and (3) deconstruction versus reconstruction.

(1) The analysis given in this paper shows that the metaphor of epistemological fence-sitting (Webster 2007) mentioned earlier and the need for engagement should not be seen as an "either/or" choice. Analysing visionary communication and communicating the results of this analysis again constitutes an intervention in ongoing communication. Thus epistemological "fence-sitting" is not possible in a puristic sense in the field of techno-visionary sciences: analysis always implies intervention. On the other hand, this must not mean that policy advice becomes an intrinsic part of policy: "At the same time, we cannot simply become a branch of policy: independent STS critique, not least of the economic and political interests informing policy options, must be the *first* priority for the field." (Webster 2007, 474)

Maintaining the difference between scientific policy advice and policy is essential for its legitimisation and appreciation. Both engagement and scientific observation of ongoing developments are therefore essential to ensure legitimate and sound scientific policy advice. The TA experience in engagement and the STS experience in observation could benefit from one other.

(2) Traditionally, TA has been expected to deliver – as far as possible – facts about the future consequences of science and technology. In the field of techno-visionary sciences this is virtually impossible (Sec. 3); instead, hermeneutical and epistemological analysis is required (Sec. 4). In this respect, TA as scientific policy advice could benefit from the experience gained in this direction by STS.

(3) Policy advice generally has to analyse and "deconstruct" arguments and debates in order to reconstruct them in a transparent way. In the field of techno-visionary sciences, the interplay between deconstruction and reconstruction (Webster 2007) becomes even more important because of the threats of arbitrariness and ambivalence (Sec. 3).

The ideas of 'responsible development' in scientific-technological progress and of 'responsible innovation' in the field of new products, services and systems have been discussed with increasing intensity for some years now (Markus/Siune, et al. 2009) and have led to the phrase 'Responsible Research and Innovation' (RRI) being coined (von Schomberg 2012). The postulate of responsible innovation adds explicit ethical reflection to Technology Assessment (TA) and science, technology and society (STS) studies and includes them all in integrative approaches to shaping technology and innovation. On the one hand it focuses particularly on the notion of responsibility and its close relationship with the ethics of responsibility, e.g. in the tradition of Hans Jonas (1979) and his successors. On the other hand, this notion can bridge the gap between technology assessment and engineering ethics. Accordingly, RRI would allow for a more integrative perspective on ethical issues of technology design and development. Until now, however, it has more or less been an empty signifier that requires much greater clarification for it to become usable.

Responsible innovation brings together TA with its findings with respect to assessment procedures, actor involvement, foresight and evaluation with ethics, in particular within the framework of responsibility, as well as building on the body of knowledge about R&D and innovation processes provided by STS and STIS studies (science, technology, innovation and society). Regarding the fact that the very idea developed in the context of debating nanotechnology and society issues, and keeping in mind that nanotechnology is one of the major manifestations of techno-visionary sciences, it seems plausible that RRI will be an appropriate framework within which to analyse the themes put forward in this paper in depth and to develop answers to the questions raised and solutions to the challenges ahead.

References

Allhoff, Fritz, et al. (eds.), 2007: *Nanoethics. The Ethical and Social Implications of Nanotechnology*. New Jersey: Wiley.

Bimber, Bruce A., 1996: *The politics of expertise in Congress: the rise and fall of the Office of Technology Assessment*. New York: State University of New York Press.

Brown, Nik/Brian Rappert/Andrew Webster (eds.), 2000: *Contested Futures. A sociology of prospective techno-science*. Burlington: Ashgate Publishing Limited.

Coenen, Christopher, 2008: *Konvergierende Technologien und Wissenschaften. Der Stand der Debatte und politischen Aktivitäten zu "Converging Technologies"*. Berlin: Büro für Technikfolgen-Abschätzung beim Deutschen Bundestag (TAB Background Paper 16), summary in English: <http://www.itas.fzk.de/deu/lit/2008/coen08a_summary.htm>

Coenen, Christopher, 2010: Deliberating visions: The case of human enhancement in the discourse on nanotechnology and convergence. In: Kaiser, Mario et al. (eds.), *Governing future technologies. Nanotechnology and the rise of an assessment regime*. Dordrecht, et al.: Springer, 73-87.

Coenen, Christopher/Leonhard Hennen/Hans-Jürgen Link, 2009a: The ethics of synthetic biology. Contours of an emerging discourse. *Technikfolgenabschätzung – Theorie und Praxis* 18(2), 82-86.

Coenen, Christopher, et al., 2009b: *Human enhancement*. Brussels: European Parliament 2009 (IP/A/STOA/FWC/2005-28/SC32 & 39). <http://www.europarl.europa.eu/stoa/publications/studies/stoa2007-13_en.pdf>

Collingridge, David, 1980: *The social control of technology*. London: Open University Press.

Decker, Michael/Miltos Ladikas (eds.), 2004: *Bridges between Science, Society and Policy. Technology Assessment – Methods and Impacts*. Berlin: Springer.

DEEPEN, 2009: *Reconfiguring Responsibility. Deepening Debate on Nanotechnology.* <www.geography.dur.ac.uk/projects/deepen>

Drexler, Kim Eric, 1986: *Engines of Creation – The Coming Era of Nanotechnology*. New York: Anchor Books.

Dupuy, Jean-Pierre, 2007: Complexity and Uncertainty: a prudential approach to nanotechnology. In: Fritz Allhoff, et al. (eds.), *Nanoethics. The ethical and social implications of nanotechnology*. New Jersey: Wiley, 119-132.

Dupuy, Jean-Pierre/Alexei Grinbaum, 2004: Living with Uncertainty: Toward the ongoing Normative Assessment of Nanotechnology. In: *Techné* 8, 4-25.

European Parliament/STOA (ed.): *Making Perfect Life. Bio-Engineering (in) the 21st Century*. Brussels: European Parliament (IP/A/STOA/FWC-2008-96/LOT6/SC1); <http://www.itas.fzk.de/deu/lit/2011/boua11a.pdf>

Fiedeler, Ulrich, et al. (eds.), 2010: *Understanding Nanotechnology: Philosophy, Policy and Publics*. Heidelberg: AKA.

Gieryn, Thomas F., 1983: Boundary-work and the demarcation of science from non-science: strains and interests in professional ideologies of scientists. In: *American Sociological Review* 48(6), 781–795.

Grin, John/Armin Grunwald (eds.), 2000: *Vision Assessment: Shaping Technology in 21st Century Society*. Berlin et al.: Springer.

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

Grunwald, Armin, 2009a: Technology Assessment: Concepts and Methods. In: Anthonie Meijers (ed.): *Philosophy of Technology and Engineering Sciences*. Volume 9. Amsterdam, et al.: Elsevier, 1103-1146.

Grunwald, Armin, 2009b: Vision Assessment Supporting the Governance of Knowledge - the Case of Futuristic Nanotechnology. In: Gotthard Bechmann/Vladimir Gorokhov/Nico Stehr (eds.): *The Social Integration of Science. Institutional and Epistemological Aspects of the Transformation of Knowledge in Modern Society*. Berlin: Edition Sigma, 147-170.

Grunwald, Armin, 2010: From Speculative Nanoethics to Explorative Philosophy of Nanotechnology. In: *NanoEthics* 4(2), 91-101.

Grunwald, Armin, 2011: Energy futures: Diversity and the need for assessment. In: *Futures* 43, 820-830.

Grunwald, Armin/Peter Hocke-Bergler, 2010: In: Mario Kaiser, et al. (eds.): *Governing Future Technologies. Nanotechnology and the Rise of an Assessment Regime*. Dordrecht et al.: Springer, 157-177.

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

Habermas, Jürgen, 1970: *Toward a Rational Society*. Boston: Beacon Press. [orig. Jürgen Habermas, 1968 (ed.): Technik und Wissenschaft als Ideologie. Frankfurt am Main: Suhrkamp.]

Hansson, Sven Ove, 2006: Great Uncertainty about small Things. In: Joachim Schummer/ Davis Baird (eds.): *Nanotechnology Challenges – Implications for Philosophy, Ethics and Society*. Singapore, et al.: World Scientific Publishing Company, 315-325.

Joss, Simon/ Sergio Belucci (eds.), 2002: *Participatory Technology Assessment – European Perspectives*. London.

Joy, Bill, 2000: Why the Future Does not Need Us. In: *Wired Magazine*: 238-263.

Kaiser, Mario, et al. (eds.), 2010: *Governing future technologies. Nanotechnology and the rise of an assessment regime*. Dordrecht, et al.: Springer.

Kastenhofer, Karen, 2010: Do we need a specific kind of technoscience assessment? Taking the convergence of science and technology seriously. In: *Poiesis & Praxis* 7, 37-54.

Luhmann, Niklas, 1997: *Die Gesellschaft der Gesellschaft*. Frankfurt am Main: Suhrkamp.

Markus, Eszter (rapporteur), Karen Siune (chair), et al., 2009: *Challenging Futures of Science in Society*, MASIS Expert Group. Brussels: European Commission.

Nahuis, Roel/Harro van Lente, 2008: Where Are the Politics? Perspectives on Democracy and Technology. In: *Science, Technology & Human Values* 33, 558 – 581.

Nordmann, Alfred, 2004: *Converging Technologies – Shaping the Future of European Societies, High Level Expert Group 'Foresighting the New Technology Wave'*, Brussels: European Commission.

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

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.

Nowotny, Helga/Peter Scott/ Michael Gibbons, 2001: *Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty*. London: Polity Press.

Paschen, Herbert, et al., 2004: *Nanotechnologie. Forschung und Anwendungen*. Berlin et al.: Springer.

Pawson, Ray, et al., 2005: Realist review – a new method of systematic review designed for complex policy interventions. In: *Journal of Health Services Research & Policy* 10, Suppl 1, 21-34.

PCSBI (Presidential Commission for the Study of Bioethical Issues, USA), 2010: *New Directions: The Ethics of Synthetic Biology and Emerging Technologies*. Washington: PCSBI.

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

Roache, Rebecca, 2008: Ethics, Speculation, and Values. In: *Nanoethics* 2, 317 – 327.

Roco, Mihail C./William Sims Bainbridge (eds), 2002: *Converging Technologies for Improving Human Performance*. Arlington: WTEC.

Sauter, Arnold/Katrin Gerlinger, 2011: *Pharmakologische Interventionen zur Leistungssteigerung als gesellschaftliche Herausforderung*, TAB-Arbeits–bericht Nr. 143, Berlin: Büro für Technikfolgen-Abschätzung beim Deutschen Bundestag.

Schmid, Günter, et al., 2006: *Nanotechnology – Perspectives and Assessment*. Berlin et al.: Springer.

Schummer, Joachim/Davis Baird (eds), 2006: *Nanotechnology Challenges – Implications for Philosophy, Ethics and Society*. Singapore et al.: World Scientific Publishing.

Selin, Cynthia, 2007: Expectations and the Emergence of Nanotechnology. In: *Science, Technology and Human Values* 32(2), 196-220.

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

Simakova, Elena/Christopher Coenen, 2013: Visions, Hype, and Expectations: a Place for Responsibility. In: Richard Owen/Maggy Heintz/John Bessant (eds.), (2013): *Responsible Innovation*. Hoboken/NJ: John Wiley, 241-266.

Stehr, Nico, 2004: *The Governance of Knowledge*. London: Transaction Publishers.

TAB (Office of Technology Assessment at the German Parliament), 2011: *Information on the project 'Pharmacological and technical interventions for improving performance'*. <http://www.tab-beim-bundestag.de/en/research/u141.html>

van Lente, Harro, 1993: *Promising Technology. The Dynamics of Expectations in Technological Developments*. Delft: Faculteit Wijsbegeerte en Maatschappijwetenschappen, Universiteit Twente.

Vig, Norman/Herbert Paschen (eds), 1999: *Parliaments and Technology Assessment. The Development of Technology Assessment in Europe*. Albany: SUNY Press.

von Schomberg, Rene, 2012: Prospects for technology assessment in a framework of responsible research and innovation. In: Marc Dusseldorp/Richard Beecroft (eds.), *Technikfolgen abschätzen lehren. Bildungspotenziale transdisziplinärer Methoden*. Wiesbaden: Springer VS, 39-62.

von Schomberg, Rene/Sarah Davies (eds.), 2010: *Understanding public debate on nanotechnologies*. Brussels: European Commission (EUR 24169).

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

Wolbring, Gregor, 2008: Why NBIC? Why human performance enhancement? In: *The European Journal of social science research* 21, 25-40.

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

ISSN: 1861-3675

STI Studies

www.sti-studies.de

Umbrella Terms as Mediators in the Governance of emerging Science and Technology

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Abstract

Umbrella terms like 'nanotechnology' and 'sustainability research' have emerged as part of the new regime of Strategic Science. As mediators between science and society they have a dual role. Their overall promise allows resources to be mobilised for new fields which can then be productive in their own right. At the same time, however, they also put pressure on these fields to take relevance considerations into account. The process of emergence and stabilisation of umbrella terms is outlined and traced in detail in the cases of nanotechnology and sustainability research. What we see is interesting de facto governance of science, as well as new forms of involvement of STS scholars.

1 Introduction

It is intriguing how new fields of science such as nanotechnology or sustainability research have emerged in recent decades with names that not only indicate a field of research but also promise major industrial transformation (in the case of nanotechnology) or claim to address daunting problems (in the case of sustainability research). What we see here is the intersection of two developments: a longer tradition of emerging new fields labelled to entail a particular scientific promise, as with physical chemistry in the late nineteenth century and colloid science in the early twentieth century, and a recent transformation of science in the direction of strategic science (Rip 2002), where long-term relevance to societal problems, hence a societal promise, is an integral part of how the science is done. The intersection of the two developments is visible if we look at how labels like 'nanotechnology' or 'sustainability research' are used and what they do to shape and hold together certain patterns in the de facto governance of science. In light of this function, we propose that the labels be called umbrella terms.

Our argument in this paper is that, in studying the mechanisms of governance that shape scientific development de facto, it is worthwhile taking a closer look at the organisational qualities of particular terms that can work to connect and mediate between a variety of activities and concerns across different fields of science, science policy and society – even without any explicit frameworks structuring those relations de jure. They link up and translate discursively patterned practices. Umbrella terms start out as a fragile proposal by means of which a variety of research areas and directions can be linked up with one other and, in a sense, 'covered' (which is where the metaphor of an umbrella comes in), with a view to relating them, as a whole, to certain societal concerns and policy issues. In this way they provide a semantic reference for negotiating certain packages of scientific search practices with societal and political concerns. Over time, umbrella terms and the packages they hold together may stabilise and become reinforced with research infrastructures and through the institutionalization of funding schemes.

This phenomenon of umbrella terms as mediators that enable the creation and functioning of packages of scientific research and policy and societal relevance indicates a new way in which science is being governed – de facto. This deserves to be explored, and not just in science policy studies with their occupational bias of prioritising policy. Science and technology studies (STS) have to contribute because of their tradition of studying the dynamics of scientific developments in context. Such a study of the governance of science is a relatively new venture for STS,[1] particularly when we consider how the study of umbrella terms, their emergence and possible stabilization, even when carried out merely in the form of a scholarly study, will have implications for the governance of science and the role played in it by STS scholars. The attention paid to a specific umbrella term will reinforce its status, even if the study actually deconstructs the ongoing processes.[2] This is unavoidable. It is also an

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[1] There have been studies of governance of science by STS scholars all along, but they were considered to be at the margin of the field. This is changing now; see for example the shift in contents of the two STS Handbooks (Jasanoff et al. 1995 and Hackett et al. 2008). In 1995, all the classical themes of STS research were present, and one of the seven parts of the Handbook discussed science, technology and the State, with an emphasis on trends to be observed rather than governance questions. In 2008, two of the five parts were devoted to such issues, often explicitly discussing governance.

[2] The same comment can be made about STS scholars getting involved in the recent wave of technology assessment and ELSA studies of nanotechnology, and is being made, as one of us (AR) can testify.

indication that conducting STS in the real world requires further reflexivity.

We will explore the nature of the intersection of emerging scientific fields and strategic science, this being the location of the phenomenon of umbrella terms, in two steps. First, we will characterize the phenomenon of umbrella terms and locate it in present-day science within its respective contexts. Second, we will present two case studies with interesting differences, namely nanotechnology and sustainability research. While nanotechnology has become institutionalised as a field bearing this label, sustainability research has not, or at best has only done so to a partial extent, because different labels are competing to configure the science/policy link in particular ways. Furthermore, nanotechnology is about the opportunities and promises opened up by techno-scientific developments (with open and flexible links to societal and policy promises), while sustainability research (and its variants) are attempts to mobilise and position different scientific developments in relation to a socio-politically constructed global problem. Both are instances of the phenomenon of umbrella terms and how these function, broadly speaking, as mediators between science and science policy. In the concluding section we will reflect on the type of governance we can observe here, and also ask what our own role is in studying these developments.

2 Umbrella terms marking the intersection between strategic science and emerging scientific fields

Over the last three decades, the practices of scientific research, the institutions of science and their concrete contexts have all been changing, and there has been recognition of, and reflection on, these changes. There have been attempts to diagnose these changes, or certain aspects of them (Funtowicz/Ravetz 1993, Ziman 1994, Gibbons et al. 1994, Nowotny et al. 2001, Etzkowitz/Leydesdorff 2000, Bonaccorsi 2008, see also Bonaccorsi 2010, Lave/ Mirowski/Randall 2010). What is clear is that there is a general movement towards re-contextualisation of science in ongoing processes in wider areas of society (Nowotny et al. 2001, Markus et al. 2009), and that a new regime of Strategic Science has emerged after the opening up of the earlier regime in place since the Second World War (sometimes called Science, The Endless Frontier, after the title of the influential report of Vannevar Bush to the US President in 1945 (Bush 1945)). The opening up of this regime is already indicated in the influential 1971 Brooks Report to the OECD (OECD 1971), in which closer and more differentiated links between science and society were advocated, in contrast to the earlier regime in which 'science' is considered to be a unified whole. The next phase is indicated by the introduction of the notion of strategic research, linking basic research to societal problems and challenges. Irvine and Martin's (1984) characterisation of strategic research captures the nature of this link, indicating a new division of labour between the quest for excellence and for relevance:

Strategic research is
- basic research carried out with the expectation that it will produce a broad base of knowledge
- likely to form the background to the solution of recognised current or future practical problems.

The link is formulated in terms of expectations, but there are also new practices such as when research funding agencies started creating strategic research programmes,[3] and centres for excellent and relevant research were established inside or outside universi-

[3] So-called strategic research programmes already started to be drawn up and implemented in the 1970s (Rip 1990, Rip/ Hagendijk 1988).

ties from the 1980s, their continuing viability deriving from the emergence of markets of strategic research (Rip 2002). Also, priority setting became linked to foresight exercises. Such developments can be seen as creating institutionalised 'trading zones' between science and societal issues and their spokespersons.[4] Thus, there are reasons to speak of a new regime, a regime of Strategic Science. There are other developments as well, not directly related to strategic research, but compatible with it: the rechanneling of resources for scientific research through competitive project funding compared to block funding for universities and public research institutes, and the establishment of new audit and evaluation procedures.

In the 'trading zones' one sees packaging of social questions, opportunities, and scientific developments, which can be 'sold' to various audiences and which are often labelled so as to carry rhetorical force. An early example is the 'War on Cancer' programme in the USA in the 1970s (Rettig 1977). A recent example of such packaging is the discourse of 'Grand Challenges' in Europe and elsewhere (cf. EU: Lund Declaration, Horizon 2020). The way that the UK Research Councils have defined and outlined ten Grand Challenges (RCUK 2009) is illustrative of this, some in a technology-push or scientific-opportunity-driven mode, others in a society-pull or social-problem-

Box 1: *Two 'Grand Challenges' defined by Research Councils UK*

NanoScience through Engineering to Application	*Ageing: life-long health and wellbeing*
Nanotechnologies can revolutionize society. They offer the potential for disruptive step changes in electronic materials, optics, computing and in the application of physical and chemical understanding (in combination with biology) to generate novel and innovative self-assembled systems. The field is maturing rapidly, with a trend towards ever more complex, integrated nanosystems and structures. It is estimated that products incorporating nanotechnology will contribute US$1 trillion to the global economy by 2015, and that the UK has a 10 percent share of the current market. To focus the UK research effort we will work through a series of Grand Challenges. These will be developed in conjunction with researchers and users in areas of societal importance such as energy, environmental remediation, the digital economy and healthcare. An interdisciplinary, stage-gate approach spanning basic research through to application will be used. This will include studies on risk governance, economics and social implications	There is an unprecedented demographic change underway in the UK with the proportion of young people declining whilst that of older people is increasing. By 2051, 40 percent of the population will be over 50 and one in four over 65. There are considerable benefits to the UK of having an active and healthy older population with potential economic, social and health gains associated with healthy ageing and reducing dependency in later life. Ageing research is a longstanding priority area for the Research Councils. The Research Councils will develop a new interdisciplinary initiative (£486M, investment over the CSR period involving all seven Research Councils) which will provide substantial longer-term funding for new interdisciplinary centres targeting themes of healthy ageing and factors over the whole life course that may be major determinants of health and wellbeing in later life. Centres will be focused on specific research themes drawing on the interdisciplinary strengths of the Research Councils, such as Quality of Life, Physical Frailty and Ageing Brain.

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[4] See Galison's (1997) discussion of 'trading zones'. He considered mutual translations between different disciplines and fields of research that would lead to the emergence of pidgins and creoles. In our discussion, the translations are between fields of science and science policy, and society as a further reference. The point about the emergence of pidgins and creoles remains applicable, up to the emergence of a 'blizzard of buzzwords' (Ziman, 1994) that is part of the regime of Strategic Science. The recontextualisation of science in society is genuine, however (Nowotny et al 2001, Rip 2010, Markus et al. 2009).

driven mode. In Box 1 we quote two of them in some detail, which will also allow us to refer to them in our further discussion.

In these examples, a short phrase summarises the thrust of the Grand Challenge. For the second Grand Challenge, the problem is often denoted as "the ageing society", a label that allows easy reference to a set of complex interrelated issues, while at the same time black-boxing them to some extent. Reference to "the ageing society" then becomes a justification to speak of "ageing research" rather than more disciplinary-oriented names like "biogerontology" (Miller 2009). The label "ageing research" can become a package in its own right, referring to assorted research with a shared relevance to "the ageing society". This fits the notion of strategic research, but is now positioned on the field level rather than as research projects. In the first Grand Challenge, a similar easy reference coupled with some black-boxing occurs through the label "nanotechnology", as in the opening sentence (where the plural is used). The reference is to a technoscientific field that definitely already exists as a funding category. Even so, it covers a wide range of items,[5] and for that reason can already be called an umbrella term.

Packaging of new scientific approaches with the help of labels has occurred in the history of science, for example 'physical chemistry' in the late 19th century (Dolby 1976) and molecular biology from the 1930s onward (Bartels 1984, Kohler 1976). An interesting further example is the rise of the notion of colloid science in the 1910s and 1920s, when the term was presented as indicating a fourth phase of matter (in addition to solid, fluid and gaseous) and the key to understanding the nature of living matter – and thus worthy of support and further exploitation (Ede 2007). Here, the audience for what starts as an umbrella term (because its scope is still unclear) is a scientifically concerned audience, and non-scientific audiences that put various issues of relevance upfront are involved only at one remove.

This continues to occur, but by now policy and other societal audiences are important as well. This implies that there is not only a struggle for recognition (and funding) of new fields within science, but also a struggle for legitimacy and resources in direct interaction with policy communities and a variety of social groups who are looking for opportunities to endorse and fund interesting research programmes. For society, this means a field of opportunities. For science, it often means space for new interdisciplinary approaches. And the promise of opportunities encapsulated in the umbrella term provides a protected space for such new approaches. The broad base of knowledge to be created through basic research, likely to form the background to the solution of future problems (cf. Irvine and Martin's definition of strategic research), is held in place by an umbrella term.

The phenomena we describe here have been noted and conceptualised before, in particular by the Starnberg-Bielefeld Group in their work on the so-called finalisation thesis. Their original ideas centred on the diagnosis that fields have to mature before relevance considerations can productively be included in scientific agendas, including "finalised" theory development. Their conceptualisation is based on how scientific paradigms, in the sense of Kuhn (1970), evolve, while this is just one

[5] In the example of nanotechnology, the fact that it covers a wide variety of scientific approaches and technological options is recognised. After noting that nanotechnology 'has become a handy shorthand label for several phenomena', Hodge et al., (2010: 6) discuss 'the immense range of technologies that fall under the nanotechnologies umbrella'. A further indication is how the European Commission and the UK Research Councils now speak of nanotechnologies in the plural.

aspect of inter-organisational fields of research. Their case studies, e.g. on environmental research and cancer research, did show more complex dynamics, as well as the role of umbrella terms (Böhme et al., 1978; Van den Daele et al., 1979, see also Schäfer 1983, and Rip 1997). What they did not consider was the phenomenon of translation zones and mediators, while this has now become a striking feature of science in our society. Umbrella terms have become mediators between the logics of scientific search and the logics of various societal and policy worlds, and are thus constitutive of new patterns of re-contextualised science and technology.

3 Umbrella terms and their dynamics

While an umbrella term is a part of discourse, its use in ongoing struggles (e.g. in building coalitions of scientists and policy actors) and its eventual wider acceptance in labelling organisations and programmes turns it into an institutional and practical reality. The inter-organisational field of research organisations, relevant government agencies, civil society organisations and representatives from domains of application acquires coherence and stability through reference to the umbrella term.[6] Thus, it is important to understand how umbrella terms acquire force as mediators between science and science policy and society.

Let us start by identifying examples. We mentioned ageing research and nanotechnology already. An earlier (and less grandiose) example is membrane science and technology since the 1970s, where the promises created a space that was filled in by dedicated R&D and gradually realised functionalities (Van Lente/ Rip 1998). There are other (sometimes partial) examples like synthetic biology or geo-engineering, both of which are definitely on the radar of science policy actors and funding agencies at the moment.

The umbrella terms can also start from the other side, when the entrance point is a newly articulated function to be fulfilled by different scientific and technological developments. Examples are 'targeted drug delivery' and 'personalised medicine', or 'the information superhighway' of the early 1990s, promoted by Al Gore among others. Kornelia Konrad has shown the power of this umbrella term in the way it led government agencies and city governments to invest in projects and, when these failed, to attribute it to contingencies so that they would invest in further projects rather than reconsider the promise (Konrad 2004, 2006). Security studies are an example where a number of different fields merged, or at least collaborated, under this umbrella term to address topics high on the political agenda. A further example is how sustainability (and sustainable development) has become a powerful reference in discourse, also of science and science governance: as something like an ecologically extended version of the 'common good' it can be invoked as a meta-grand challenge of world society. Relating activities and projects to it carries a diffuse but positive message, and can thus be used to mobilise resources. While sustainability itself is not an umbrella term in the specific sense of this paper, since it has not (yet) been established as a fixed term for talking about, supporting and negotiating a bundle of con-

[6] As societal concerns for relevance are sought to be embodied in the organization of the field, specific conceptions of society and its problems that underlie the notion of 'challenges' become inscribed into the emerging configuration of social relations under the umbrella. As it becomes an institutional reality, an umbrella term may thus 'co-produce' a particular form of science with a particular politically articulated form of society. On this point see, for example, Miller's (2004) analysis of interrelations between the constitution of a science of the global climate with the constitution of a new global political order.

crete research activities, it is an entrance point to study ongoing attempts at creating a science of sustainability where various candidate terms circulate (e.g. global change research, earth system science, sustainability science). We will discuss this further in our second case study.

The umbrella terms are mediators through which scientific promises and definitions of public problems travel and get entangled in constructions of 'relevant science'.[7] Thus, the umbrella term is not just a word or a phrase in a discourse, it is also, eventually, a conduit through which specific scientific opportunities and promises interact with specific societal and policy goals and interests, thus providing for their mutual shaping.

We will consider the process of emergence and stabilisation of umbrella terms, together with the inter-organisational fields that are formed, a bit further. An umbrella term emerges in a specific constellation of discourse, activities and incipient as well as more established institutionalisation. This is not just a matter of scientists packaging promises. Science policy makers scan the horizon for productive fields that can be linked to a 'public interest' and occasionally they initiate or catalyse the formation of fields which they expect to be important and for which they believe corresponding societal support can be mobilised. Increasingly, large corporations and business associations, non-governmental organisations and social movements also actively search for research practices that promise relevance to their concerns and engage with the framing of science-society relations.

There is a long tradition of opportunistic resource mobilisation by scientists, as well as "politicking" by spokespersons for science to assure symbolic resources for science (Rip 1990). A newly proposed umbrella term then is a way of packaging a proposal which offers an investment in scientific capacity: a 'sales proposal'. Some such sales proposals are more successful than others, and scientists will anticipate what is on the agenda in science policy and in society more generally, and adjust their proposal in terms of content, and definitely in terms of terminology. Intermediary actors such as funding agencies, when they identify with science rather than policy, follow similar tactics (this is visible in the Grand Challenges discourse of the UK Research Councils). Further tactics of resource mobilisation using visionary umbrella terms are visible to acquire funding on top of disciplinary funding structures, and/or to circumvent disciplinary funding structures for new, interdisciplinary research agendas. Occasionally, scientists refer to umbrella terms to offer their service directly to policy or society, thereby bypassing funding agencies.

If scientists offering their packages are seen as the supply side, the demand side consists of science policy makers and other sponsors of science wanting to provide funding (and other support) in an interesting and useful way. There will be reference to problem areas and societal challenges used to justify science policy and R&D program budgets, which can lead to further articulation of such problems and challenges. In this sense, science policy makers can also be seen as brokers between scientific supply and societal demand.[8] The

[7] Here, we use the term 'mediator' in a commonsensical way, but we can also refer to Latour and to Callon. In Actor-Network Theory, mediators are circulating entities with an inside that can be 'read' in and through their action. Callon (1991), who speaks of intermediaries in the sense of what Latour (2005) called mediators, gave examples of texts (inscriptions), technical artefacts, human bodies and money (and other promissories).

[8] What we are describing here is a central dynamic of priority setting, where supply and demand meet and become entangled in their further articulation in a variety of ways.

net effect is that a name or a phrase that works both ways, for policy as well as for science (or is made to work for both sides), helps to fill in the "trading zones" and acquires a life of its own: an umbrella term is born. [9]

There will be expectations, policy declarations, strategy meetings, platforms and other collective initiatives, programmes of research and new centres, dedicated intermediary organisations etc. Further actors will join, which will involve some controversy and struggling over the definition of boundaries – what is in, what is out, what is at the centre and what is only peripheral. This is an inter-organisational field, with epistemic components (one can speak of a new scientific field) as well as institutional, economic and socio-political components linked to problems, challenges and actual applications. There will also be public statements and media reporting, while scientists (and policy makers) will anticipate public reactions and civil society responses. Institutionalisation then leads to specialised organisations, including education and training programmes. The umbrella term represents and helps to stabilise the inter-organisational field while it functions as a conduit between scientific activities and society.

Implicit in this stylised description of umbrella term dynamics in context is a further element, namely how 'demand' and 'supply' for scientific research can clinch through shared reference to an umbrella term, and thus give the term force. In the case of nanotechnology, there was a very visible clinching event when the US National Nanotechnology Initiative was announced in 2000. In the case of sustainable development, there is increasing interest from institutions and sponsors. Various local clinchings occur under labels which use modifications of the root term 'sustainable' and a recent attempt was made to bring a diversity of research networks and sponsors together for a global programme entitled "Future Earth: Research for global sustainability" in which several of the currently advanced candidate terms appear in combination. This adds up to umbrella term dynamics, even without a single dominant clinching event that establishes a particular term as the reference for all ongoing attempts at configuring a science of sustainable development.[10]

4 Nanotechnology

Originally, the term 'nanotechnology' was used in an ad-hoc manner,[11] together with variants like 'nanoscale science' and 'nanoscale technologies'. Based on secondary literature and our own work and experience, we will trace its ascendancy as an umbrella term since the late 1990s, together with the emergence of an inter-organisational field represented by and sustaining the force of the umbrella term. We will then explore its dynamics, and end with a brief diagnosis of the present situation.

In the 1990s, there was the visionary use of the term nanotechnology by Eric Drexler and his Foresight Institute (Drexler 1986), and the practical and somewhat ad hoc use in descriptions of funding programmes (Van der Most,

[9] In the trading zone between 'relevance' and 'ongoing science', the authority to translate, in the process of emergence of umbrella terms and their eventual institutionalization, will thus allow power to be exerted, resources mobilised and research governed. Struggles about the definition and scope of the field, which are very visible in nanotechnology, are struggles to become authoritative.

[10] To be sure, the notion of a 'clinching event' is retrospective: whether an event is 'clinching' will not be clear at the time. Depending on further developments in the area of sustainability and science, one or another present event may turn out to have 'clinched' supply and demand.

[11] The term 'nanotechnology' was coined by Taniguchi (1974) for his own purposes. He is duly referenced, but his definition is not taken up.

2009). For many scientists, 'nanotechnology' was not important as a label. They were happy to do materials science or supra-molecular chemistry. The earlier funding programmes (since 1996 in Germany and Sweden, but already in 1994 in Switzerland) had specific topics related to existing scientific fields and areas of application. The UK's earlier 'National Initiative on Nanotechnology' (since 1986) led by an alliance between the government Department of Trade and Industry and the National Physical Laboratories was similarly specific, even though the general label was used. The two Nobel Prizes now listed as highlights in the development of nanotechnology, the 1986 Physics Prize for Scanning Tunnelling Microscopy (first publication in 1980) and the 1996 Chemistry Prize for Fullerenes (or buckyballs; first publications in 1985), were seen as important in their own right, and only later became an argument for the importance of nanotechnology.[12] Thus the term was available and used, but not as an umbrella term.

The promise of research at the nanoscale was recognised,[13] but there were no grand visions, except for Drexler's programme of 'molecular manufacturing'. This programme was actively promoted by his Foresight Institute, established in 1986. It organised meetings and conferences, gathered followers and generated general interest.[14] Richard Smalley, who became critical of Drexler's programme, still acknowledged how he had been inspired by the vision and the meetings he attended (Regis 1996: 275-278).

The landscape changed with the USA National Nanotechnology Initiative (NNI), announced in early 2000 by President Clinton. The NNI became a reference point for funding agencies and policy makers worldwide, and led to a 'funding race' (Rip 2011). It needed to justify itself in terms of promises, up to a third industrial revolution. Scientists started to refer more emphatically to nanotechnology in their funding proposals and presentations to the outside world. Research institutes and centres were renamed so as to include nanotechnology in their title (this was happening already, but NNI reinforced the trend). Journals appeared with nanotechnology (or the prefix nano) in

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[12] Neither the press release (http://nobelprize.org/nobel_prizes/physics/laureates/1986/press.html) nor the acceptance speech by Binnig and Rohrer mention nanotechnology or nanoscale science. They locate their work with respect to surface science. (They do mention, at the very end, that their scanning tunnelling microscope might be used to move atoms, and thus work as a 'Feynman machine"; Binnig/Rohrer 1993: 407.) Ten years later, the new laureates (as well as the press release) still focus on the science, now of fullerenes, but do make a reference to what happens 'at the nanotechnology front" (Kroto 2003: 76).

[13] For example, the very early UK National Initiative on Nanotechnology was an awareness-raising initiative, primarily in terms of the market potential of the new research results, but could not generate industrial interest. Apart from two small activities, all was quiet on the nano front in the UK until the end of the 1990s. (Van der Most 2009: 59). In 1996, the UK Parliamentary Office of Science and Technology published an overview of possible applications, under the title *Making it in Miniature: Nanotechnology, UK Science and it Applications*, but was content to note improvements in the miniaturisation of chips, in sensors, in surfaces, in diagnostic tools (ibid.: 6).

[14] Running ahead of the story: when the label nanotechnology became institutionalised (almost overnight, with the announcement of the US NNI), it became important to define its scope and establish who could legitimately refer to the label. Thus Drexler's futuristic project had to be excluded from what was now to be the mainstream. It became common to refer to molecular manufacturing as 'science fiction'. The 2003 (orchestrated) debate between Drexler and Smalley on the feasibility of molecular manufacturing has become iconic. Drexler countered the mainstream moves by calling this work superficial rather than deep nanotechnology, and so claimed 'real ' nanotechnology for himself. He lost the struggle, though (Rip/van Amerom, 2009).

their titles such as NanoLetters (since 2000) and the Journal of Nanoscience and Nanotechnology (since 2000).[15] Furthermore, meetings and platforms were organised to articulate strategies for nanotechnology R&D and innovation. The recent European Technology Platform Nanomedicine is a good example of such anticipatory coordination in terms of participants and topics (cf. also Rip 2012), while it is also clear that 'nanomedicine' is itself an umbrella term that covers very different developments, each with their own dynamics. Taking all this together, it is clear that the nascent inter-organisational field had solidified, together with its umbrella term 'nanotechnology'.

In recent years, nanotechnologists and policy makers have explicitly referred to nanotechnology as an umbrella term, though mostly to indicate the difficulties of defining nanotechnology and the variety of research areas and approaches encompassed under this heading. The European Commission started to use the plural: nanosciences and nanotechnologies. This is not just a recognition of variety. It is a response to the homogenising effect of using the term 'nanotechnology', and the problems this introduces in the societal and political debate about the risks and regulations of 'nanotechnology'. The halo effect of the term 'nanotechnology' continues to be exploited, however, for example in the recent move to emphasise 'green nanotechnology' as the real promise.

Looking back, one can enquire into how the launching of the US NNI became the key event. There was fertile soil for what we called a clinching between supply and demand sides. By the late 1990s one sees attempts at stock taking by funding agencies in a number of countries, sometimes induced by leading scientists (Van der Most 2009). In the USA, the National Science Foundation's adviser for nanotechnology, Mihael Roco, organised a meeting in 1997 to bring disparate activities in nanoscience and nanotechnology together across different agencies. This led to the establishment of an Interagency Working Group which met throughout 1998 and worked out a vision for what ultimately became the NNI (McCray 2005: 185-186). What is striking is how NNI brought a large number of government ministries and agencies, not known for their willingness to collaborate in science funding and science policy, together in a concerted effort.

Roco acted as an institutional entrepreneur, but was also well embedded in the emerging world of nanoscience. He created and spread visions of nanotechnology, referring to nanotechnology in general rather than some specific field; in particular, visions of a third industrial revolution enabled by nanotechnology, and of nanotechnology as the basis for converging technologies for human enhancement. The willingness of scientists and engineers to join in had to do with the prospect of increased funding, of course, but they could also share part of these visions about the promises of nanotechnology. At the 22 June 1999 meeting of the House of Representatives' Committee on Science, nanoscientist Smalley could say: 'There is a growing sense in the scientific and technical community (..) that we are about to enter a golden new era.' (McCray, 2005: 187).[16]

[15] Also dedicated journals such as the Journal of Nanoparticle Research (since 1999) and the Journal of Micro-Nano Mechatronics (since 2004). Grieneisen (2010) notes the exponential growth, since the end of the 1990s, and definitely since 2005, of journals devoted to nanotechnology. The first journal devoted exclusively to nano–scale science and technology, *Nanotechnology*, was launched by the Institute of Physics Publishing in July 1990. During the 1990s, only a few 'nano-journals' were launched; by 1998, the total number was 18. By 2010, 165 'nano-journals' had been launched, and 142 were still producing.

[16] He actually called for the use of nanotechnology as an umbrella term: "Nanotechnology, Smalley concluded, presented

The net effect outside the USA was that countries started to consider nanotechnology a priority, or reinvigorated what they were doing already. Often, it was an alliance between scientists who wanted to mobilise resources by referring to the example of NNI, and a small but influential number of policy makers who wanted to buy into nanotechnology as a major new priority. As we noted already, a funding race emerged in which countries (and regions like the European Union) compared their R&D expenditure on nanotechnology and argued that they should not lag behind. In spite of the reference to trillion dollar markets and a third industrial revolution (originally offered to help justify NNI, and then adopted in policy documents all over the world), major innovations enabled by nanotechnology were slow to arrive. There was no innovation race in nanotechnology, and after the first round of enthusiasm (in the early and mid 2000s), venture capitalists started to withdraw.[17] The recent move to 'green' nanotechnology can be seen as a response: a way to recapture societal and investors' interest.

After the first enthusiasm and somewhat indiscriminate funding, which allowed scientists (now called 'nanoscientists') to pursue their interests, the late 2000s saw attempts from policy makers, partly because of pressure from political actors, to get some value for money, i.e. making sure that the research that was funded would be relevant. The RCUK Grand Challenge Nanotechnology emphasising the route to applications (see Box 1) is one example.[18] In other words, 'nanotechnology' as a mediator between science, science policy and society moved from primarily offering a protected space for scientists to also work in the other direction, thus ensuring the relevance of publicly funded research.

One can ask whether nanotechnology, i.e. nanosciences and nanotechnologies, is also becoming a new scientific field. There is productive interdisciplinarity, centring on the technoscientific objects that are created and studied which then also create links to application/innovation.[19] Newly launched journals exploit the present visibility of nanotechnology (and some fail to survive, cf. Grienesen 2010). They create outlets for ongoing research, and thus contribute to the build-up and establishment of the field of nanosciences and nanotechnologies. The institutes and centres that use the nanotechnology label to present themselves are sites where the new scientific field can be nurtured. Such epistemic and institutional investments will remain in place when the nanotechnology hype has passed by.

5 Sustainability research

The term 'sustainable development' is a political construction which was de-

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a 'tremendously promising new future.' What was needed was someone bold enough to 'put a flag in the ground and say: 'Nanotechnology, this is where we are going to go …'". (McCray 2005: 187).

[17] Innovation did occur, in micro-nano-electronics and with nanomaterials and nanostructured surfaces for mundane but useful applications like coatings, dirt-repellent textiles, and reinforced tyres and tennis racquets.

[18] In the Netherlands, the NanoNed R&D Consortium (2003-2010), funded by public money, framed its research themes as basic research with some possible applications. Its successor, NanoNextNL, again funded by public money and some industrial contributions, had to frame a large part of its research in relation to energy, water, health and food. There was also political pressure to have 15% of the budget spent on research directly or indirectly related to possible risks of nanotechnology. For NanoNed, see http://www.nanoned.nl/. For its successor, NanoNextNL, see http://www.nanonextnl.nl/

[19] The notion of 'technoscientific objects' is the topic of a recent research project led by Alfred Nordmann and Bernadette Bensaude-Vincent. Available at: http://www.philosophie.tu-darmstadt.de/goto/goto/home/home.en.jsp.

vised in the context of the World Commission of Environment and Development (WCED 1987). The term marked an effort to unite concerns about the global environment with those about economic growth, and thus to overcome antagonistic positions between environmental movements and industry, as well as between North and South.[20] Since the1990s we have also seen references to sustainable development or sustainability in relation to science. There are efforts to position research activity in relation to what appeared to become an overarching societal and political concern. Attempts were made to articulate "sustainability science" or "sustainability research" as a new epistemic programme. A variety of scientific initiatives and sponsors established themselves on the force of 'sustainability' as an ideograph.[21] We will report on these efforts by drawing on documents and websites, and on our own observations from doing research in sustainability related programmes. We will give an account of how, in recent years, "sustainability science" started to compete with earlier terms like "global change research" or "earth system science". The trading zone is clearly visible. While no specific term has become dominant, there are dynamics that affect the configuration of research practices in relation to a wider field of societal concerns.[22]

The World Commission on Environment and Development (WCED 1987) had presented the term 'sustainability' to highlight an integrated view of issues of the environment and development and the need for coordinated policy strategies. Sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own", and so required consideration of socio-economic as well as ecological dynamics. Inscribed into this view were the global nature of the challenge and a promise of "sustainable growth" as a solution to serve both the environment and the economy. As such, the term proved successful in the policy world. In 1992 it was endorsed as an overarching challenge and guiding principle of global public policy at the first "Earth Summit" in Rio de Janeiro. By the end of the 1990s sustainability had become a global buzzword, and an occasion to consider its translation into concrete action.[23]

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20 There is a history of the rise of terms like 'the environment' and 'environmental' in the 1970s, which functioned to some degree as an umbrella term under which funding programmes and university degrees took shape. Such use of the term 'the environment" continues, as in the title of Lubchenco's (1998) article: 'Entering the century of the environment'. Scientific unions rooted mainly in the natural sciences played a crucial role in articulating 'the environment' and its threat of deterioration or collapse. Prominent efforts were the 1972 Report to the Club of Rome on "the limits to growth" (Meadows et al. 1972) in connection with the first UN conference on the Environment in Stockholm in 1972, and its repercussions (e.g. establishment of UN Environment Programme and Environmental Ministries in many nation states).

21 The notion of an ideograph was introduced by McGee (1980) to capture the function of terms like "the people" that are diffusely defined, allow various meanings to be projected onto them and are important to capture in a debate because of their positive rhetorical value. Rip (1997) showed how 'industry' and 'sustainability' functioned as ideographs in science policy discussions and practices. The same holds true for 'sustainable development' and is not limited to science policy occurrences.

22 When using the term 'sustainability research' as the heading of this section of the paper, we might be seen as taking sides in the struggle. Since we needed a simple heading, we chose one which is relatively neutral as compared with the other possibilities.

23 There is an ongoing battle over precise definitions and concrete actions which reflect a continued struggle for dominance between ecological and economic concerns, North and South, global and local – all those oppositions which 'sustainable development', as a political term, sought to overcome (Voß and Kemp 2006).

The surge of 'sustainable development' in policy discourse also mobilised researchers and science entrepreneurs. As a holistic challenge it called for new approaches to knowledge production. Sustainable development became translated into an epistemic challenge of studying interlinked dynamics of social and ecological systems and how they were to be governed. Scientists started various initiatives to fill the newly opened space with dedicated programmes that went beyond the established disciplines and their sponsoring arrangements. The International Human Dimensions Programme (IHDP) was set up in 1996 with a view to strengthening the social sciences as compared to WCRP and IGBP, two programmes of global change research that had already been running before sustainable development was introduced.[24] The "Resilience Alliance" built a network of international scientists geared towards the study of what they referred to as social-ecological systems.[25] Such initiatives positioned groups of researchers, and their specific approaches, as knowledge providers for sustainable development. Universities also produced joint declarations, presenting themselves as incubators of research for sustainable development and as hosts of education and training programmes.[26] The organising and positioning of research capacity was undergirded by an abundance of programmatic publications which sought to set out the epistemic agenda of sustainable development (e.g. Norgaard 1994; Schellnhuber / Wenzel 1998; Costanza et al. 1999; Clark et al. 2001; Gunderson/Holling 2002).

Two developments stand out: the declaration of a new 'sustainability science' in 2001 (Kates et al., 2001) and the formation of the "Earth System Science Partnership" by the global change research programmes.[27] Sustainability science made the stronger epistemic claim, and sought to enrol research practices developed through-

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[24] In 1979 the World Climate Research Programme (WCRP) was established (with sponsorship by the World Meteorological Organisation, WMO, and the International Council of Scientific Unions, ICSU), leading up to the "Toronto Conference on the Changing Atmosphere" in 1988 (paving the way for the Intergovernmental Panel on Climate Change, IPCC, and subsequent negotiations of a UN Convention on Climate Change). A broader focus on the global environment, and how it was changing, was adopted by the International Geosphere-Biosphere Programme (IGBP) which was established in 1986, also sponsored by ICSU.

[25] The Alliance was established in 1999, see www.resalliance.org

[26] For example the 1990 Talloires Declaration of University Presidents for a Sustainable Future; the 1993 Kyoto Declaration on Sustainable Development by the International Association of Universities (IAU). This continued: see for one example the July 2008, G8 University summit ("27 of the leading educational and research institutions in the G8 member nations") producing the "Sapporo Sustainability Declaration" (Available at: http://g8u-summit.jp/english/ssd/); Alliance for Global Sustainability (Av. at: http://globalsustainability.org/)

[27] In 2001, the international research programmes on global environmental change (WCRP, IGBP, IHDP plus a newly established one on biodiversity, Diversitas) got together under the umbrella of the Earth System Science Partnership (ESSP). Their "Amsterdam Declaration" stated that "(…) the business-as-usual way of dealing with the Earth System is not an option. It has to be replaced ¬ as soon as possible ¬ by deliberate strategies of good management that sustain the Earth's environment while meeting social and economic development objectives (…) A new system of global environmental science is required. This is beginning to evolve from complementary approaches of the international global change research programmes and needs strengthening and further development. It will draw strongly on the existing and expanding disciplinary base of global change science; integrate across disciplines, environment and development issues and the natural and social sciences; collaborate across national boundaries on the basis of shared and secure infrastructure; intensify efforts to enable the full involvement of developing country scientists; and employ the complementary strengths of nations and regions to build an efficient international system of global environmental science".

out the 1990s, to make a case for fundamentally new concepts and methodologies: "A new field of sustainability science is emerging that seeks to understand the fundamental character of interactions between nature and society […] Combining different ways of knowing and learning will permit different social actors to work in concert, even with much uncertainty and limited information. [... It] differs to a considerable degree in structure, methods, and content from science as we know it. [...] In each phase of sustainability science research, novel schemes and techniques have to be used, extended, or invented […] Progress in sustainability science will require fostering problem-driven, interdisciplinary research; building capacity for this research; creating coherent systems of research planning, operational monitoring, assessment, and application; and providing reliable, long-term financial support" (Kates et al., 2001).

The term embodied a promise to develop and maintain links and interactions with the wider world, presenting itself as a bridge between the worlds of knowledge and action: "[Sustainability Science is] neither 'basic' nor 'applied' research but as a field defined by the problems it addresses rather than by the disciplines it employs; it serves the need for advancing both knowledge and action by creating a dynamic bridge between the two" (Clarke, 2007).

As a new candidate umbrella term, competing with 'global change research' or 'earth system science', sustainability science was launched by an international network of scholars,[28] which organised conferences, elaborated joint programmatic statements and liaised with science policy and funding agencies so that the term could achieve some consolidation. A scientific journal was established under this title in 2006.[29] The term was picked up by research ministries and funding agencies in several countries. In 2008 it became the title of a standalone section in the Proceedings of the US National Academy of Sciences (Clark 2007). Corporate sponsors also referred to the term in organising their relations with science.[30]

Independently of the efforts of such scientific entrepreneurs, sustainable development functioned as an increasingly forceful reference in the context of science policy. Sustainability-oriented research was part of an agenda to show that science could be activated in the service of broader societal challenges, not only competitiveness and economic growth. In 2002 the US National Research Council commissioned a study entitled 'Our common journey: A transition towards sustainability' (Board on Sustainable Devel-

[28] Its stronghold is at the Program of Sustainability Science at Harvard University's Center for International Development. See: http://www.hks.harvard.edu/centers/cid/programs/sustsci (see also Board on Sus–tainable Development 2002).

[29] *Sustainability Science*, established under the auspices of Springer Japan, introduces itself in the editorial as follows: "Sustainability Science provides a transdisciplinary platform for contributing to building sustainability science as a new academic discipline focusing on topics not addressed by conventional disciplines. As a problem-driven discipline, sustainability science is concerned with practical challenges such as those caused by climate change, habitat and biodiversity loss, and poverty. At the same time it investigates root causes of problems by uncovering new knowledge or combining current knowledge from more than one discipline in a holistic way to enhance understanding of sustainability."

[30] cf. the 2010 International Conference on Sustainability Science (sponsored by business corporations and set up with a view to furthering links between 'world scientific leaders in Sustainability Science and representatives from industry and civil society', see http://icss2010.net/?p=industry-profiles), or the journal SAPIENS, which is sponsored by the transnational company Veolia to publish review articles and evidence-based opinions that integrate knowledge across disciplines.

opment 2002) which contained a promise to achieve sustainable development in two generations, provided sufficient resources would be made available for research (Raven 2002: 957). In various locales around the world, priority programmes were established under the responsibility of research agencies or governments.[31] Special centres were also established, such as the Japan Integrated Research System for Sustainability Science (2005), the Stockholm Resilience Centre (2007), and the Institute for Advanced Sustainability Studies in Potsdam (2009). Such programmes, centres and platforms provided niches in which sustainability research was nurtured as parts of broader networks and discourses. This is how research became institutionalised to a certain degree, in a rather fragmented manner, and came to depend on coalitions between certain groups of scientists and entrepreneurial sponsors, which allowed established institutions of research funding and science policy profiling to be locally bypassed against the mainstream of economic-growth oriented R&D. There is a grey zone between such dedicated efforts and the relabeling of ongoing research as being related to sustainability for the sole purpose of increasing eligibility for funding. Furthermore, the epistemic status of sustainability research was contested, especially with respect to its interdisciplinary character and its orientation towards politically defined problems.[32]

On the policy side, the framing of sustainable development as a global problem entailed difficulties for translation into support of research. In contrast to political support for 'nanotechnology' or research on the 'ageing society', the sponsoring of scientific activities by reference to sustainability invokes a global public good, not a national or regional one. It thus implies a problem that requires collective action in the area of national or regional science policy making and research funding. This is recognised, and attempts have been made to set up international agreements of cooperation. An International Group of Funding Agencies for Global Change Research (IGFA) has met regularly since the beginning of the 1990s to coordinate support for international programmes of Global Change Research.

New efforts to mediate between science and policy with a view to achieving global sustainability were made in the run-up to another 'Earth Summit' in 2012, again held in Rio de Janeiro. The official objective of "Rio+20", namely to "secure renewed political commitment for sustainable development",[33] provided a reason to push fur-

[31] At the European Union, DG Research (now DG Research and Innovation) hosts a platform for 'sustainability science" and launched an initiative entitled Research and Development for Sustainable Development (RD4SD), which included a Conference on 'Sustainable development: a challenge for European research" in 2009. The German Research Foundation (DFG) had a "Schwerpunktprogramm Mensch und globale Umweltveränderung" (http://www4.psychologie.uni-freiburg.de/umwelt-spp/welcome.html), the German Federal Ministry for Education and Research (BMBF) set up a funding initiative for "social-ecological research" (http://www.sozial-oekologische-forschung.org/) in 2000, and later established 'research for sustainable development' (Fona) as an umbrella label for a variety of research lines that were brought together on a common 'platform" (http://www.fona.de/).

[32] There is a tension between natural and social sciences, cf. "Sustainability science has a good deal to say about how we can logically approach the challenges that await us, but the social dimensions of our relationships are also of fundamental importance" (Leshner 2002: 957). There are also discussions about the methods and quality criteria of sustainability science as a normatively oriented endeavour aspiring to inclusiveness with regard to a diversity of knowledge that is to be integrated (e.g. Thompson Klein et al. 2001; Nölting et al. 2004; Bergmann et al. 2005; Pohl/ Hirsch-Hadorn 2007).

[33] http://www.uncsd2012.org/objectiveandthemes.html

ther towards the establishment of an integrated knowledge base. In 2006, ICSU had already started a joint review of global environmental change programmes with the funders in IGFA.[34] This led to an Earth System visioning process, now together with the International Social Science Council (ISSC), for constructing the agenda of a disciplinary and regionally integrated science for sustainable development (ICSU 2002, 2005; ISSC 2012).[35] Various funding agencies articulated their demands and established a group of "high-level representatives", the Belmont Forum, in order to pursue negotiations with representatives of science.[36] In 2010 the Belmont Forum, together with representatives of ICSU and ISSC, and of UNEP, UNESCO and the United Nations University, met to negotiate a 10-year joint initiative of science policy to "[p]rovide earth system research for sustainable development". The initiative was finally launched under the label "Future Earth – research for global sustainability" at the Rio+20 conference.[37]

What we see is convergence towards an inter-organisational field while there is still a struggle over the preferred umbrella term. There is deliberate negotiation about how scientific supply and societal demand can be clinched, as well as about how various candidate umbrella terms could be combined to form a phrase that might function as an umbrella. Whether this was just a matter of tactics, or was based on dedicated reflection, is not clear.

6 Conclusion and reflections

We identified a phenomenon in the worlds of science, science policy and general politics: umbrella terms and their concomitant inter-organisational

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[34] It was concluded that "[t]here is a clear need for an internationally coordinated and holistic approach to Earth system science that integrates natural and social sciences from regional to the global scale" (ICSU-IGFA, 2008), and further that there is a "need for a unified strategic framework (…) to deepen understanding (…), deliver solutions".

[35] ICSU co-sponsored all programmes of global environmental change research as well as coordinated efforts on "joint projects on global sustainability" (in Water, Food, Carbon, Human Health) under the Earth System Science Partnership. In promoting IHDP since 1996, the Council has undertaken targeted efforts to give a role to the social sciences (see ISSC 2012). The Earth System visioning (2009-2011) articulated research questions as "five grand challenges" from the point of view of science: "observing, forecasting, thresholds, responding, innovating".

[36] The Belmont Forum, established in 2009 out of IGFA: "a high level group of the world's major and emerging funders of global environmental change research and international science councils [which] acts as a Council of Principals for the broader network of global change research funding agencies, IGFA [so] aligning international resources" constitutes a further attempt to create an inter-organisational field. "[It] developed a collective 'funders' vision of the priorities for global environmental change research" (Belmont Forum 2011). Cognitive challenges are identified, linked with action perspectives – and a candidate umbrella term: "recognition that the understanding of the environment and human society as an interconnected system, provided by Earth System research in recent decades [..] to provide knowledge for action and adaptation to environmental change [..] remove critical barriers to sustainability [..] integrated into a seamless, global Earth System Analysis and Prediction System (ESAPS), which will provide decision-makers with a holistic decision support framework" (ibid.).

[37] The declared aim of 'Future Earth' is "reorganizing the entire global environmental change research structure, and the way of doing research" with a view to "integrating the understanding of how the Earth system works to finding solutions for a transition to global sustainability". It seeks to build on and integrate earlier activities "and enhance (…) global environmental change programmes and projects", but looking towards "new solution focused projects". The approach is one of "co-designing and co-producing research agendas and knowledge" by "policy makers, funders, academics, business and industry, and other sectors of civil society" (ICSU 2012).

fields, which mediate between ongoing scientific research and policy requirements for societal relevance. We then presented two cases, nanotechnology and sustainability research, which qualified as established and emerging umbrella terms, respectively, and which allowed us to delve into actual complexities. What did we learn? We can compare and contrast the two cases. We can also step back and reflect on what we saw happening, and what this tells us about the dialectics of promising science and technology as modulated by umbrella terms. This will set the scene for a brief discussion of *de facto* governance of science through umbrella terms, and the role of STS scholars in such *de facto* governance.

There are two important differences between the two cases. First, nanotechnology offers open-ended promises about what it might enable us to do, while sustainability science and global change research and earth system science reason back from global challenges to what scientific research should contribute. While the histories are different, the process is the same, with the two cases being at different phases: there are struggles linked to potential umbrella terms, a dominant term emerges and becomes established, at least for some time, as a conduit which allows protection of ongoing research as well orientation towards relevance to societal problems and challenges.

One can zoom in and see an interesting parallel between the group of scientists that is pushing 'sustainability science' and the Drexler group that is pushing nanotechnology as molecular manufacturing. Both have visions about what a 'new kind of science' can achieve, and both get a hearing. In the case of nanotechnology, the clinching of supply and demand came from another direction thanks to the US National Nanotechnology Initiative and its international repercussions, which overtook (and eclipsed) the Drexlerian vision. In the case of sustainability science, the ambitions may also be too high, but the sustainability scientists (to coin a term in much the same way that the term nanoscientists emerged) appear to be well embedded in established international organisations and networks. They may make some progress in the coming years, even if more technocratic versions have to be accommodated in ongoing negotiations with disciplinary scientists and policy makers, as is visible in complementary references to 'Earth System Science'.

A hard-nosed question, for both cases, is whether umbrella terms merely reflect the latest fashion in science funding and sponsorship, and will be washed away when the next wave arrives. The umbrella term may disappear, but there will be lasting structural changes linked to inter-organisational fields that emerged and solidified. In the meantime, actors in the worlds of science and science policy will use actual and potential umbrella terms for their own purposes. But once an umbrella term is in place, i.e. after the clinching of supply and demand and some institutionalisation, it cannot be escaped (or only at a cost). So in addition to indicating a new pattern of science governance which combines relevance considerations and some autonomy of research (as befits the regime of Strategic Science), the term itself has a governance effect. Umbrella terms, once established, are a de facto governance technology, and actors realise this and struggle over the term and its articulation.[38] The eventual result of an umbrella term becoming forceful is the

[38] This is part of a larger problem which one of us has articulated for the case of policy instruments as a governance technology: on the knowledge production side there is linking and packaging to create an input in policy (such as the provision of solutions) which then somehow functions in the making and implementation of policy (such as the treatment of public problems) (Voß 2007b, 2007a).

outcome, at a collective level, of many actions and interactions.

Thus there are two ways in which umbrella terms are a governance technology: they constitute an arena for struggles about definitions, access/exclusion and resources;[39] and their eventual black-boxed use has effects precisely because the detailed struggles that went into them are eclipsed.

Two final reflections are in order. Firstly, about the governance of science: While use of the term governance helps us to move away from an exclusive focus on government and its attempts at top-down steering, there is still a top-down bias in many studies in the sense that government steering is the standard which now needs to be modified. What we have shown is that there are elements of science governance in ongoing developments, exemplified in this paper by the emergence and stabilisation of umbrella terms mediating between science, science policy and society. Governance then shifts from attempts to realise policy goals as such to considerations about what is happening anyway and how this is modulated in reference to public interests.

The second reflection concerns the role of STS scholars. Both authors were and are active in the fields we used as case studies in this article, and even benefited from the new resource flows by having their own research projects funded. We had discussions with actors in the field, and sometimes explicitly (albeit modestly) intervened.[40] The present article constitutes a further step: it opened up the black box of umbrella term dynamics – a typical STS approach – and if it were to be read by actors in the field, they could take it up as a move in their struggles. However, we are also contributing to the existence of the field because talking about 'nanotechnology' or 'sustainability science' helps make them become more real. This is unavoidable, and one should not retract from it, [41] but try to understand what is happening and position oneself reflexively.

References

Bartels, Ditta, 1984: The Rockefeller Foundation's Funding Policy for Molecular Biology: Success or Failure? In: *Social Studies of Science*, Vol. 14, 238-243.

Belmont Forum, 2011: *The Belmont Challenge: A global, environmental research mission for sustainability*. (White paper).

Bergmann, Matthias, et al., 2005: *Quality criteria for Transdisciplinary Research. A Guide for the Formative Evaluation of Research Projects.* Frankfurt am Main: ISOE.

Binnig, Gerd/Heinrich Rohrer, 1993: Scanning Tunneling Microscopy – from birth to adolescence. Nobel lecture, December 8, 1986. In: Gösta Ekspång (ed.), Tore Frängsmyr (ed. in charge), *Nobel Lectures, Physics 1981-1990*. Singapore: World Scientific Publishing, 389-409.

Board on Sustainable Development, National Research Council, 2002: *Our common journey: a transition toward sustainability*. Washington, D.C.: National Academy Press.

Böhme, Gernot/Wolfgang van den Daele/Rainer Hohlfeld, 1978: *Die gesellschaftliche Orientierung des wissenschaftlichen Fortschritts*. Frankfurt am Main: Suhrkamp.

Bonaccorsi, Andrea, 2008: Search regimes and the industrial dynamics of science. In: *Minerva*, Vol. 46, 285-315.

[39] A similar point is made for nanotechnology by Wullweber (2008), using Laclau's notion of 'empty signifiers' (Laclau 1996).

[40] As we did in our projects of constructive technology assessment of nanotechnology, we have conceptualised this as "insertion", see Rip and Robinson (forthcoming).

[41] This is an argument against Latour's position: 'The task of defining and ordering the social should be left to the actors themselves, not taken up by the analyst.' 'ANT simply doesn't take as its job to stabilize the social on behalf of the people it studies; such a duty is to be left entirely to the 'actors themselves' (…)' (Latour 2005: 23, 30).

Bonaccorsi, Andrea, 2010: *Institutional governance of science in fast moving scientific fields*, paper presented to the conference on 'Changing governance of research'. Frankfurt am Main, March 11-12, 2010.

Bush, Vannevar, 1945: *Science – The Endless Frontier. A Report to the President on a Program for Postwar Scientific Research.* Reprinted, with Appendices and a Foreword by Daniel J. Kevles, by the National Science Foundation, Washington, D.C., 1990.

Callon, Michael, 1991: Techno-economic networks and irreversibility. In: John Law (ed.), *A Sociology of Monsters. Essays on Power, Technology and Domination*. London: Routledge, 132-161.

Clark, William C., 2007: Sustainability Science: A room of its own. In: *Proceedings of the National Academy of Science*, Vol. 104, 1737-1738.

Robert Costanza, et al. (eds.), 1999: *Institutions, Ecosystems and Sustainability*. Cambridge: University Press.

DESA (UN Department of Social and Economic Affairs, Division of Sustainable Development) 1992: Agenda 21. <http://www.un.org/esa/dsd/agenda21/res_agenda21_00.shtml>

Dolby, Robert G.A., 1976: The Case of Physical Chemistry. In: Gerard Lemaine, et al. (eds.), *Perspectives on the Emergence of Scientific Disciplines*. The Hague: Mouton/Aldine, 63-73.

Drexler, Kim Eric, 1986: *Engines of Creation: The Coming Era of Nanotechnology*. New York: Anchor Press/Doubleday.

Ede, Andrew, 2007: *The Rise and Decline of Colloid Science in North America, 1900-1935. The Neglected Dimension*. Aldershot: Ashgate.

Elgert, Laureen, 2010: Politicizing sustainable development: the co-production of globalized evidence-based policy. In: *Critical Policy Studies*, Vol. 3, 375-90.

Etzkowitz, Henry/Loet Leydesdorff, 2000: The dynamics of innovation: from National Systems and 'Mode 2' to a Triple Helix of university-industry-government relations. In: *Research Policy*, Vol. 29, 109-123.

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.

Funtowicz, Silvio/Jerome Ravetz, 1993: Science for the post-normal age. In: *Futures*, Vol. 25, 735-755.

Galison, Peter, 1997: *Image and Logic: A Material Culture of Microphysics*. Chicago: University of Chicago Press.

Gibbons, Michael, et al., 1994: *The New Production of Knowledge. The dynamics of science and research in contemporary societies*. London: Sage.

Grieneisen, Michael L., 2010: The proliferation of nano journals. In: *Nature Nanotechnology*, Vol. 5, 825.

Gunderson, Lance H./C. S. Holling, 2002: *Panarchy. Understanding Transformations in Human and Natural Systems*. Washington: Island Press.

Hodge, Graeme A./Diana M. Bowman/Andrew Maynard, 2010: Introduction: The Regulatory Challenges for Nanotechnologies. In: Graeme A. Hodge/Diana M. Bowman/Andrew Maynard (eds.), *International Handbook on Regulating Nanotechnologies*. Cheltenham: Edward Elgar, 1-24.

ICSU (International Council for Science), 2002: *Science and Technology for Sustainable Development.* Consensus Report and Background Document, Mexico City Synthesis Conference May 20-23, 2002, ICSU Series on Science for Sustainable Development No. 9, Paris. <http://www.icsu.org/Gestion/img/ICSU_DOC_DOWNLOAD/70_DD_FILE_Vol9.pdf>

ICSU (International Council for Science), 2005: *Harnessing Science, Technology, and Innovation for Sustainable Development.* Report from the ICSU-ISTS-TWAS Consortium ad hoc Advisory Council. <http://www.icsu.org/Gestion/img/ICSU_DOC_DOWNLOAD/584_DD_FILE_Consortium_Report.pdf>

ICSU (International Council for Science), 2012: *Future Earth: Research for global sustainability*. Leaflet <http://www.icsu.org/future-earth/whats-new/relevant_publications/future-earth-leaflet>

ICSU-IGFA (International Council for Science-International Group of Funding Agencies for Global Change Research), 2008: *Review of the Earth System Science Partnership (ESSP)*. <http://www.essp.org/fileadmin/redakteure/pdf/others/ESSP_Review_08.pdf>

Irvine, John/Ben R. Martin, 1984: *Foresight in Science. Picking the Winners*. London: Frances Pinter.

ISSC (International Social Science Council), 2012: *Transformative Cornerstones of Social Science Research for Global Change*. International Social Science Council, 3 May 2012.

Jasanoff, Sheila, 2004: *States of knowledge: the co-production of science and social order*. London: Routledge.
Kates, Robert W., et al., 2001: Sustainability science. In: *Science*, Vol. 292, 641–642.
Kohler, Robert E., 1976: The Management of Science: The Experience of Warren Weaver and the Rockefeller Foundation Programme. In: *Minerva Biotecnologica*, Vol. 14, 279-306.
Komiyama, Hiroshi/Kazuhiko Takeuchi, 2006: Sustainability science: building a new discipline. In: *Sustainability Science*, Vol. 1, 1-6.
Konrad, Kornelia, 2004: *Prägende Erwartungen. Szenarien als Schrittmacher der Technikentwicklung*. Berlin: edition sigma.
Konrad, Kornelia, 2006: The social dynamics of expectations: The interaction of collective and actor specific expectations on electronic commerce and interactive television. In: *Technology Analysis & Strategic Management*, Vol. 18, 429–444.
Kroto, Harold W., 2003: Symmetry, Space, Stars and C60. Nobel Lecture, December 7, 1996. In: Ingmar Grenthe (ed.), *Nobel Lectures, Chemistry 1996-2000*. Singapore: World Scientific Publishing, 44-79.
Laclau, Ernesto, 1996: Why Do Empty Signifiers Matter to Politics? In: Laclau, Ernesto (ed.), *Emancipation(s)*. London: Verso, 34-46.
Latour, Bruno, 2005: *Reassembling the Social. An Introduction to Actor-Network Theory*. New York: Oxford University Press.
Lave, Rebecca/Phillip Mirowski/Samuel Randalls, 2010: Introduction: STS and Neoliberal Science. In: *Social Studies of Science*, Vol. 40, 659-675.
Leshner, Alan, 2002: Science and sustainability. In: *Science*, Vol. 297, 897.
Lubchenco, Jane, 1998: Entering the century of the environment: a new social contract for science. In: *Science*, Vol. 279, 491-497.
Markus, Eszter, et. al., 2009: *Challenging Futures of Science in Society. Emerging trends and cutting-edge issues.* Report of the MASIS Expert Group to the European Commission. Brussels: European Commission.
McCray, W. Patrick, 2005: Will Small be Beautiful? Making Policies for our Nanotech Future. In: *History and Technology*, Vol. 21, 177–203.
McGee, Michael Calvin, 1980: 'The Ideograph': A Link Between Rhetoric and Ideology. In: *The Quarterly Journal of Speech*, Vol. 66, 1-16.
Meadows, Donella H., et al., 1972: *The Limits to Growth: A Report to The Club of Rome*. New York: Universe Books.
Miller, Clark A., 2004: Climate science and the making of a global political order. In: Jasanoff, Sheila (ed.), *States of knowledge: The coproduction of science and social order*. London: Routledge, 66-76.
Miller, Richard, 2009: From Ageing Research to Preventive Medicine: Pathways and Obstacles. In: Healey, Peter/Steve Rayner (eds.), *Unnatural Selection. The Challenges of Engineering Tomorrow's People*. London: Earthscan.
Nölting, Benjamin/Jan-Peter Voß/Doris Hayn, 2004: Nachhaltigkeitsforschung – jenseits von Diziplinierung und ‚anything goes'. In: *Gaia*, Vol. 13 (4), 254-61.
Norgaard, Richard B., 1994: *Development Betrayed. The End of Progress and a Coevolutionary Revisioning of the Future*. London: Routledge.
Nowotny, Helga/Peter Scott/Michael Gibbons, 2001: *Re-Thinking Science. Knowledge and the Public in an Age of Uncertainty*. Cambridge: Polity Press.
OECD (Organisation for Economic Co-operation and Development), 1971: *Science, Growth and Society. A New Perspective*. Paris: OECD.
Pfaffenberger, Bryan, 1992: Technological dramas. In: *Science, Technology & Human Values*, Vol. 17, 282.
Pohl, Christian/Gertrude Hirsch-Hadorn, 2007: *Principles for designing transdisciplinary research*. Munich: oekom.
Raven, Peter H., 2002: Science, sustainability, and the human prospect. In: *Science*, Vol. 297, 954-8.
RCUK (Research Council UK), 2009: *RCUK Delivery Plan 2008/09 to 2010/11*. <http://www.rcuk.ac.uk/documents/publications/anndeliveryplanrep2008-09.pdf>
Regis, Ed, 1996: *Nano: The emerging science of nanotechnology.* New York: Back Bay Books.
Research Frontiers, 2011: *Session on Research Frontiers in Sustainability Science: Bridging Disciplines and Practices*. American Association for the Advancement of Science Annual Meeting, Washington, DC, 19 February 2011. <http://www.hks.harvard.edu/centers/cid/programs/sustsci/events/conferences-and-workshops/2011/aaas>
Rettig, Richard A., 1977: *Cancer Crusade. The Story of the National Cancer Act of 1971*. Princeton, N.J.: Princeton University Press.

Rip, Arie, 1990: An Exercise in Foresight: The Research System in Transition - To What?. In: Susan E. Cozzens, et al. (eds.), *The Research System in Transition.* Dordrecht: Kluwer Academic, 387-401.

Rip, Arie, 1997: A cognitive approach to relevance of science. In: *Social Science Information,* Vol. 36, 615-640.

Rip, Arie, 2002: Regional Innovation Systems and the Advent of Strategic Science. *Journal of Technology Transfer*, Vol. 27, 123-131.

Rip, Arie, 2006: A Co-Evolutionary Approach to Reflexive Governance - And Its Ironies. In: Jan-Peter Voß/Dierk Bauknecht/René Kemp (eds.), *Reflexive governance for sustainable development*. Cheltenham, UK: Edward Elgar, 82-100.

Rip, Arie, 2011: Science Institutions and Grand Challenges of Society: A Scenario. In: *Asian Research Policy*, Vol. 2, 1-9.

Rip, Arie, 2012: The context of innovation journeys. In: *Creativity and Innovation Management*, 21(2), 158-170.

Rip, Arie/Marloes van Amerom, 2010: Emerging de facto Agendas Around Nanotechnology: Two Cases full of Contingencies, Lock-outs, and Lock-ins. In: Mario Kaiser, et al. (eds.), *Governing Future Technologies. Nanotechnology and the Rise of an Assessment Regime*. Dordrecht: Springer, 131-155.

Rip, Arie/Rob Hagendijk, 1988: *Implementation of Science Policy Priorities*. SPSG Concept Paper No. 2, London: Science Policy Support Group, March.

Rip, Arie/Douglas K. R. Robinson, (forthcoming): Constructive Technology Assessment and the methodology of insertion. In: Ibo van de Poel, et al. (eds.), *Opening up the laboratory: Approaches for early engagement with new technologies*. Chichester: Wiley-Blackwell.

Schäfer, Wolf (ed.), 1983: *Finalization in Science. The Social Orientation of Scientific Progress*. Dordecht: D. Reidel.

Schellnhuber, Hans-Joachim/Volker Wenzel, 1998: *Earth system analysis: integrating science for sustainability*; complemented results of a symposium organized by the Potsdam Institute (PIK). Berlin: Springer.

Staudenmaier, John M., 1989: The politics of successful technologies. In: Stephen H. Cutliffe/Robert C. Post (eds.), *In Context: History and the History of Technology* Bethlehem, PA: Lehigh University Press.

Taniguchi, Norio, 1974: *On the basic concept of nanotechnology*. Proceedings of the International Congress on Production Engineering, Tokyo: JSPE.

Taylor, Peter J./Frederick H. Buttel, 1992: How do we know we have global environmental problems? Science and the globalization of environmental discourse. In: *Geoforum*, Vol. 23, 405-16.

Thompson Klein, et al., 2001: *Transdisciplinarity: Joint Problem Solving among Science, Technology, and Society. An Effective Way for Managing Complexity*. Berlin: Birkhäuser.

Van den Daele, Wolfgang/Wolfgang Krohn/Peter Weingart, 1979: *Geplante Forschung. Vergleichende Studien über den Einfluss politischer Programme auf die Wissenschaftsentwicklung.* Frankfurt am Main: Suhrkamp.

Van der Most, Frank, 2009: *Research councils facing new science and technology. The case of nanotechnology in Finland, the Netherlands, Norway, and Switzerland*. PhD Thesis, University of Twente.

Van Lente, Harro/Arie Rip, 1998: Expectations in technological developments: An example of prospective structures to be filled in by agency. In: Cornelis Disco/Barend van der Meulen (eds.), *Getting new things together.* Berlin, New York: Walter de Gruyter, 195-220.

Voß, Jan-Peter, 2007a: *Designs on governance. Development of policy instruments and dynamics in governance. PhD thesis*. Enschede: Twente University, School of Management and Governance.

Voß, Jan-Peter, 2007b: Innovation processes in governance: the development of 'emissions trading' as a new policy instrument. In: *Science and public policy*, Vol. 34 (5), 329-43.

Voß, Jan-Peter/René Kemp, 2006: Sustainability and reflexive governance: introduction. In: Jan-Peter Voß/Dierk Bauknecht/René Kemp (eds.), *Reflexive governance for sustainable developement*. Cheltenham, UK: Edward Elgar, 3-28.

WCED (World Commission on Environment and Development), et al., 1987: *Our Common Future.* New York: United Nations.

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

Ziman, John, 1994: *Prometheus Bound. Science in a dynamic steady state*. Cambridge: Cambridge University Press.

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

ISSN: 1861-3675

STI Studies

www.sti-studies.de

Necessary Interventions

Expertise and Experiments in Bioweapons Intelligence Assessments

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Abstract

This paper describes how the U.S. government has attempted to assess and govern emerging biological threats in the early 21st century, and how a science and technology studies scholar is aiming to bring new perspectives to these assessments. To do so, I trace the historical evolution of the U.S. intelligence community's scientific advisory body, the Biological Sciences Experts Group (BSEG). In light of failed U.S. intelligence assessments from the Iraq war and concerns about advances in biotechnology, the BSEG was created in 2006 to improve the detection and evaluation of bioweapons threats. In the U.S. policy community, the BSEG is seen as a natural, logical, and necessary policy response. Yet a study of the context and historical antecedents of the BSEG reveals a variety of actors and institutions that have worked to frame the bioweapons intelligence challenge as largely a "technical problem" in need of technical expertise. With this focus on the technical, however, other critical factors necessary to improve intelligence on bioweapons threats have been left out. I conclude with a description of my attempt to launch an intervention into U.S. intelligence to address these shortcomings by creating a new, unclassified dialogue on bioweapons threat assessments between scholars from the field of science and technology studies and U.S. intelligence analysts. Through its descriptive analysis of BSEG, this paper provides a look into the social machinery that has shaped technology assessment within the secret world of intelligence. This analysis also illuminates the ways in which alternative forms of knowledge making in intelligence can reflect more open, inclusive, and reflexive modes of technology assessment.

1 Introduction

On February 6, 2004, President George W. Bush announced the creation of the bi-partisan Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction (hereafter referred to as the WMD Commission), to examine American intelligence capabilities related to assessments of weapons of mass destruction (WMD) threats (Bush 2004). Bush's response came on the heels of growing criticisms that U.S. pre-war intelligence assessments on Iraq's WMD programs were wrong (Kay 2003). Within a year, the WMD Commission would issue a report on its findings and offer specific policy recommendations for intelligence reform that would be widely cited (Commission 2005). In its report, the Commission devoted special attention to the future threats posed by biological weapons, referred to as "The Greatest Intelligence Challenge" (cf. Commission 2005: 503). The Commission recommended that the U.S. Director of National Intelligence take the lead in catalyzing reform within the intelligence community on bioweapons threat assessments.

Approximately two years later, in May 2006, U.S. Ambassador Kenneth Brill, Director of the National Counterproliferation Center (NCPC), a then–newly formed center within the Office of the Director of National Intelligence, testified before the Subcommittee on Prevention of Nuclear and Biological Attacks of the U.S. House of Representatives' Committee on Homeland Security (Brill 2006). In his testimony, Brill described the steps the NCPC was taking to respond to the WMD Commission's charge to reform bioweapons intelligence assessments. A centerpiece of NCPC reforms was the establishment of a new science advisory group within the Office of the Director of National Intelligence called the Biological Sciences Experts Group (BSEG). As Brill described, the BSEG would be the first technical advisory group on the biological sciences to be of service to all sixteen members of the U.S. intelligence community, and would consist of a network of non-government biological science experts across a range of life science and related technical disciplines. These individuals, possessing security clearances at the highest levels, would provide technical advice to the intelligence community on a broad range of national security threats emanating from biology.

The BSEG is an exemplar of the kinds of technically oriented policy responses against bioweapons threats receiving current U.S. government attention and resources. These responses come in light of growing concerns about new developments in the life sciences and biotechnology that could lead to new and more dangerous types of biological weapons. In policy discussions, these concerns tend to invoke a consistent, dominant technovisionary narrative on the bioweapons threat — one that emphasizes the increasing pace and proliferation of new biotechnologies and their growing accessibility to terrorist groups or lone wolf "biohackers" to cause future harm.[1] As a recent National Intelligence Council report asserts, "For those terrorist groups that are active in 2025, the diffusion of technologies and scientific knowledge will place some of the world's most dangerous capabilities within their reach. One of our greatest concerns continues to be that terrorist or other malevolent groups might acquire and employ biological agents … to create mass casualties" (cf. U.S. National Intelligence Council 2008: ix). This narrative and the people, places, and things that structure it work to create a certain kind of understanding about the future of biotechnology and its security implications, as well as to shape particular kinds of public attention, policy

[1] I describe this narrative in more detail in Vogel (2008a,2013).

prescriptions, and government responses for intelligence assessments.[2]

In the United States, because bioweapons threats are increasingly framed as a problem of rapidly advancing and diffusing biotechnologies, policy attention and responses have focused on its material and technical dimensions, such as published scientific information, specific pieces of equipment or materials (Carlson 2003; Petro/Carus 2005; Chyba 2006). Some have argued that a lack of biological knowledge and expertise within the U.S. intelligence community has greatly hindered an accurate assessment of how new types of biological materials and resources could pose imminent and future bioweapons threats (Institute of Medicine and National Research Council 2006; Petro 2004; U.S. Central Intelligence Agency 2003). In response to these critiques and concerns, the establishment of the BSEG is part of a concerted U.S. government effort over the past ten years to increase the amount of life science expertise within U.S. government intelligence and policymaking communities to better anticipate future bioweapons threats.

Although technical expertise and knowledge are valuable, many of the critical questions in evaluating bioweapons threats are not purely technical. For example, assessing a bioweapons capability by individuals, teams, or states involves important social dimensions underpinning technical work such as the development of know-how, interdisciplinary forms of weapons knowledge, and the necessary organizational, management, and political structures to support weapons development. In addition, the motivations and intent of actors wishing to pursue bioweapons capabilities are also critical to integrate as part and parcel of any technical assessment. Yet, with the current technical focus, these alternative and more complex means of assessing bioweapons threats are not given policy attention. Rather, the implicit, default position among those in the policy community is that an interjection of technical expertise is the most important intervention needed to improve assessments on emerging bioweapons threats.[3] This perspective, however, is based on taken-for-granted assumptions, rooted in a series of historically contingent actors and activities regarding the nature of bioweapons threats, and the forms of expertise, knowledge and modes of assessment needed to counter those threats.

In this paper, I use the formation of the BSEG as a lens through which to trace the discourse and associated social and material elements that have shifted focus to technical dimensions of the bioweapons threat in order to show the limitations of existing policy prescriptions, as well as to illuminate more constructive interventions. I begin by examining President Bush's 2005 WMD Commission report, which first recommended the formation of a BSEG-like group and drew high-level public and policy attention to the lack of bioscience expertise within the intelligence community. I also discuss how a related collection of non-governmental reports, articles, hearings and actors have reinforced these recommendations, and how these perspectives continue to shape policy responses for U.S. bioweapons threat assessments. Next, I situate these claims

[2] Also, for a discussion of the role of narratives in shaping technology assessments, see Brown 2003), Wullweber 2008), and Expert Group (2007).

[3] With this said, however, scientific and other forms of technical expertise remain essential for bioweapons assessment. My critique here is that the dominant focus on the technical has marginalized and/or lost sight of other equally important forms of information and knowledge that should be brought to bear on intelligence assessments. Moreover, this critique relates specifically to contemporary bioweapons policy discourse and not necessarily to all security-related discourses.

within a broader historical context of how U.S. government assessments of weapons threats have been conducted. I then show how an alternative understanding of the bioweapons intelligence problem, informed by science and technology studies perspectives, suggests a different set of prescriptions to improve intelligence assessments of such threats. And I am attempting to launch an intervention into intelligence: the creation of a new, unclassified dialogue on bioweapons threats between scholars from the field of science and technology studies and U.S. intelligence analysts. My analysis of the BSEG provides a look into the social machinery that has shaped particular types of expertise and knowledge in technology assessments within the intelligence world. This analysis also illuminates how alternative forms of knowledge-making in intelligence are possible that reflect more open, inclusive, and reflexive modes of technology assessment.

2 The WMD commission report

In February 2004, President George W. Bush established the WMD Commission by Executive Order 13328 (White House 2004). The Commission, cochaired by former U.S. Senator Charles Robb and Federal Judge Laurence Silberman, was tasked with submitting to the President, within one year, a report of its findings and policy recommendations regarding U.S. intelligence capabilities on weapons of mass destruction and related 21st century threats. In terms of bioweapons threats, the Commission report examined three specific issues to inform its analysis and recommendations: pre-war intelligence on Iraq's bioweapons program; pre- and post-war intelligence on al Qaeda's bioweapons program; and advances in biotechnology. Below, I summarize the Commission's key findings on each of these issues, as well as their resulting policy recommendations.

Prior to the 2003 Iraq war, the U.S. intelligence community had assessed that Iraq had biological weapons, as well as mobile facilities for producing bioweapons agents. Yet, extensive post-war investigations found no evidence of bioweapons stockpiles or of mobile bioweapons production facilities in Iraq after the 1991 Gulf War. These investigations determined that due to its concerns over the intrusive United Nations (UN) inspection operations, Iraq had destroyed its bioweapons agents by 1992 (Duelfer 2004: 11), and had, by 1996, given up its ambitions for continuing a bioweapons program, after the UN destruction of its sole bioweapons production facility, Al Hakam (Duelfer 2004: 11). At the time, however, these pieces of evidence and their implications for a viable Iraqi bioweapons program failed to be captured by U.S. intelligence analysts. In its commentary on the problem of U.S. intelligence collection in Iraq, the WMD Commission stated that "the technical complexity of the WMD target … suggests that it may require a cadre of case officers with technical backgrounds or training" (cf. The Commission 2005: 159).

My own independent assessments of the intelligence failures on Iraq's bioweapons capabilities, however, suggest a different interpretation of where the key intelligence problems (and reforms) reside (Vogel 2013; Vogel 2008b). Using information gleaned from detailed interviews with former intelligence and related U.S. government officials, I have found that although there were problems with assessing the status of Iraq's bioweapons program, the larger issue was a conceptual and contextual one: How did intelligence analysts initially conceptualize Iraqi bioweapons capabilities? And then, how did they connect this conceptualization to facts on the ground? What I have found is that intelligence analysts assumed an advanced Iraqi bioweapons capability based primarily on material and technical considerations, with a limited exploration of how an Iraqi bioweapons program would develop in the more complex social, political, and economic context in Iraq since the 1991 Gulf War.[4]

It is necessary to understand that technical analysts within the U.S. Central Intelligence Agency (CIA) had little working interactions with political or economic analysts to inform their assessments of Iraqi bioweapons capabilities, and as a result, there existed disconnects between the technical assessments and other intelligence knowledge about Iraq (Kerr et al. 2005). Moreover, CIA analysts systematically ignored UN and other non-governmental data on and observations of the deleterious effect of inspections and sanctions on Iraq's WMD programs (Laipson 2005; Lopez/Cortright 2004; Findlay 2004). In their assessments, CIA analysts privileged material and technical details that reinforced and perpetuated a particular way of assessing Iraq's bioweapons capabilities — one that assumed advanced Iraqi bioweapons capabilities but did not take into account how social, economic, and political factors could shape Iraq's bioweapons intentions, abilities and actions. Thus, in contrast to the WMD Commission's final conclusions, I determined that the salient problem in the Iraq intelligence failures was not a lack of technical data or bioscience expertise, but rather, not knowing how to contextualize the technical data at hand.

The WMD Commission report also studied U.S. intelligence failures in assessing al Qaeda's bioweapons program. Before the 2001 war in Afghanistan, the U.S. intelligence community had assessed that al Qaeda likely had a small-scale bioweapons capability, primarily focused on developing crude methods for producing and disseminating biological agents. At that time, the intelligence community also judged that al Qaeda operatives had probably acquired a small quantity of anthrax and planned to assemble devices to disseminate it. Thus, prior to the war, the U.S. intelligence community assessed that al Qaeda had only limited and crude means to launch a bioweapons attack.

After the 2001 war, however, the WMD Commission report stated that the U.S. intelligence community found documents suggesting that al Qaeda's biological program was further along than previously assessed. For example, the WMD Commission report stated that seized documents indicated al Qaeda had scientific articles and handwritten notes about a dangerous biological agent referred to as "Agent X," and had considered acquiring a variety of other such agents. Moreover, the documents suggested that al Qaeda's bioweapons program was extensive (located at several sites in Afghanistan), well-organized (with commercial equipment and specialized technicians), had operated for two years prior to September 11th, and had developed a limited production capacity (The Commission 2005: 269-270).

Prior to the release of the WMD Commission report, some information on the captured post-war al Qaeda materials had been shared with the public. In December 2003, Defense Intelligence Agency analyst James Petro and Stanford Microbiology professor David Relman co-authored a paper titled "Understanding Threats to Scientific Openness," published in the journal Science (Petro/Relman 2003a). The article provided pictures and lists of the captured al Qaeda journals, books, and handwritten notes (Petro/Relman 2003b). These materials included books that explain the history of bio-

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[4] Former Director of the CIA Richard Kerr also notes this disconnect in his group's independent assessment of the WMD intelligence failures in the Iraq war (Kerr et al. 2005). Also, after the war, the Iraq Survey Group also showed that a more contextualized approach to bioweapons assessment was possible before the Iraq war (Duelfer 2004).

logical weapons, as well as specific scientific journal articles on anthrax and plague bacteria, botulinum toxin, and hepatitis viruses that dated back to the 1950s and 1960s. Petro and Relman described how the author of the handwritten notes appeared to have been technically trained, had attended European biotechnology conferences, and had visited a variety of biological companies to purchase pathogen cultures and equipment. With these findings, the authors recommended new partnerships between scientists and members of the national security community in order to help security professionals keep up with developments and applications in the life sciences that could be misused by terrorists.

Through a Freedom of Information Act (FOIA) request, non-governmental bioweapons expert Milton Leitenberg obtained additional declassified information on these captured al Qaeda materials, consisting of two three-page letters and accompanying handwritten notes (Leitenberg 2005: 30). Although the materials indicate the proposed layout of a biological laboratory, description of future work, personnel and equipment needs, there is no indication that al Qaeda had obtained biological material or commenced any work. From interviews with U.S. government officials, Leitenberg also learned that the Khandahar laboratory site where the materials were seized contained little biological equipment aside from an autoclave, and appeared not to have been functioning at the time of U.S. invasion. Subsequently, computer discs captured from a high-ranking al Qaeda official in 2001 appeared to indicate that al Qaeda (at the time) devoted only a few thousand dollars to support a bioweapons program, and after several months, considered it to have been "wasted effort and money" (cf. Leitenberg 2005: 35). Although Leitenberg used the al Qaeda findings to mark the real, failed development of a bioweapons capability by terrorists, Petro and Relman instead pointed to these findings as illustrating the potential that a more dangerous bioterrorist capability could develop over time with the increasing ubiquity of biological information, materials, and equipment.

But, if one looks closely at the WMD Commission report (beyond its highlighted conclusions), the report itself is inconsistent in how it discusses the post-war capture of the bioweapons-related al Qaeda documents. For example, the WMD Commission report states that within the intelligence community, regional, terrorism and state-level WMD technical analysts all came to different conclusions about al Qaeda's bioweapons capabilities from these captured materials. Thus, as in the case of Iraq, disconnects are also seen here between intelligence analysts across technical and non-technical disciplines. The Commission report also found that analysts writing on al Qaeda's WMD efforts in Afghanistan did not adequately clarify the basis for, or the assumptions underlying, their most critical judgments (i.e., al Qaeda's advanced capabilities) (The Commission 2005: 275).

Given these unresolved issues, the WMD Commission report briefly warned that outstanding questions remained about the reliability of the pre-and post-war intelligence assessments in Afghanistan. Yet little attention was given to further unpacking or highlighting this statement in the report, or connecting it to the intelligence assessment problems in the Iraq case. Instead, the Commission's final conclusions highlighted that U.S. intelligence found that "al-Qa'ida's biological weapons program was both more advanced and more sophisticated than analysts had previously assessed" (cf. The Commission 2005: 267). The Commission's internal deliberations on its al Qaeda findings have been kept classified, therefore it is difficult to ascertain how these final conclusions were reached given the analytic discrepancies described above.[5] In a private interview after the report was published, one member of the WMD Commission stated that, given the problems with the Iraqi WMD assessments, one should not be any less skeptical regarding the U.S. intelligence assessments made about al Qaeda's bioweapons capabilities (Leitenberg 2005: 39). This statement, however, has gone largely ignored by press and policy accounts that have drawn attention to the WMD Commission's final recommendations.

In addition to the Iraq and al Qaeda case studies, in a separate chapter, the WMD Commission report devotes significant focus to the growing bioterrorism threat, referred to as "The Greatest Intelligence Challenge" (cf. The Commission 2005: 503). To make its arguments, the report refers to an emerging "biotechnology revolution," in which advances in biotechnology are making even potent and sophisticated biological weapons available at low cost to small or relatively unsophisticated terrorists: "Scientists can already engineer biological weapons agents to enhance their lethality either through genetic engineering or other manipulations. Such weapons of science fiction may soon become a fact. Given the exponential growth in this field and access to insights through the Internet, our vulnerability to the threat might be closer at hand than we suspect" (cf. The Commission 2005: 506).

Yet, other than a few references to recent scientific publications, little evidence is provided to substantiate these claims (although a footnote indicates that a classified version of the report contains a more detailed description of this bioweapons threat). Instead, attention moves directly to the problems of intelligence collection due to the ubiquitous and diffuse nature of dual-use biotechnologies and biological information. Referring back to the Iraq and al Qaeda intelligence failures, the report here emphasizes the collection problem (i.e., lack of data) as the major reason for past failures, as well as the primary challenge facing future biological threat assessments. As I have argued elsewhere, many government and non-governmental assessments of bioweapons threats are flawed because of their predominant focus on the material aspects of biotechnology (e.g., codified knowledge, pathogens, genome sequences, biological supplies), at the expense of considering its tacit and social dimensions (Vogel 2008a; Vogel 2013).

In response to these bioweapons concerns, the WMD Commission report devotes a significant portion of a concluding chapter on policy recommendations for responding to these technically based threats. Two main recommendations are (1) increasing collaboration between the intelligence and biological science communities to increase scientific and technical expertise into the intelligence process; and (2) developing a comprehensive biological weapons targeting strategy aimed at increasing intelligence collection efforts. To meet these goals, the WMD Commission report recommends the creation of an intelligence community–wide National Biodefense Initiative, to increase the intelligence community's biological weapons–related expertise. This initiative would include creation of the following components: an elite, external biological science advisory group; a post-doctoral fellowship program that would fund scientists for up to two years of unclassified research related to biodefense and bioweapons intelligence; and a scholarship program for graduate students in biological weapons–relevant fields (The Commission 2005: 510-516). As is evident, this new initiative is focused solely on bringing in technical expertise to the intelligence community, ra-

[5] Subsequent policy briefings also do not discuss this disconnect in the al Qaeda bioweapons findings; for example, see Gronvall (2005).

ther than broader and complementary sets of expertise and knowledge.

3 Important antecedents to the WMD commission

Although the WMD Commission's recommendations garnered significant policy attention at their release, public calls for the interjection of bioscience expertise into intelligence had existed prior to 2005. For example, in 2003, Petro and Relman's article in Science on the post-war capture of al Qaeda documents in Afghanistan explicitly called attention to the need for closer interactions between the scientific and security communities to inform threat assessments: "Scientists can help ensure security professionals maintain a working knowledge of cutting-edge tools and data with national security implications. Such a partnership should include scientists who are given security clearance and national security participants that represent the spectrum of relevant agencies with a strong background and training in the life sciences" (cf. Petro/Relman 2003: 1898).

In follow-on papers published in policy-oriented journals, Petro continued to draw attention to the need to engage the life science community to anticipate threats from the biotech revolution. In his co-authored article, "Biotechnology: Impact on Biological Warfare and Biodefense," published in a high-profile biosecurity journal, Petro and his intelligence colleagues argued that "the national security community will need to become more engaged in educating academic and industrial researchers regarding foreign exploitation offers and establishing approved mechanisms for communicating suspicious activity" (cf. Petro et al. 2003: 165). Petro described how the knowledge gained through this engagement would help the intelligence community better target its collection capabilities and resources, as well as increase the number of life scientists attracted to work in the U.S. national security agencies. In a subsequent paper, "Intelligence Support to the Life Science Community: Mitigating Threats from Bioterrorism," Petro emphasized the tandem benefits to academic researchers from collaborations with the national security community. For example, he explained how life scientists could obtain access to classified information on the physical properties and characteristics of a range of unusual biothreat agents; such data could help academic scientists and engineers better design technological countermeasures against bioweapons threats. Later, Petro also argued that these partnerships "could play a critical role in establishing legitimacy, building confidence, and ensuring quality of [intelligence community] threat characterization research activities" (cf. Petro/Carus 2005: 300).

In the early 1990s, David Relman and a small cadre of other scientists also became interested in bioweapons threat issues when they were awarded biodefense research grants under the "Unconventional Pathogens Countermeasures Program," run by the Defense Advanced Research Projects Agency (DARPA). This grant was part of a larger DARPA program aimed at raising the level of awareness and knowledge of biological threats to the U.S. academic life science community. During bi-annual DARPA meetings held over eight years of grant support, the new crop of principal investigators such as Relman met various officials in the U.S. government who had worked on bioweapons threat assessments and policy responses. The meetings provided these scientists with rare opportunities to interact with the U.S. security and intelligence communities. It is through these DARPA-related connections that these scientists were later asked to become members of various government advisory groups focused on anticipating future biological threats.

For instance, in 2004, Relman was asked to co-chair a new Institute of Medicine and National Research Council study, Globalization, Biosecurity, and the Future of the Life Sciences, designed to examine current and near-term global scientific trends in biotechnology that could be developed into next generation bioweapons threats. In its 2006 final recommendations, the report outlined strategies for strengthening and enhancing the scientific and technical expertise and capacity in biotechnology within and across the intelligence and national security communities. To do this, the report recommended four actions: (1) create by statute an independent science and technology advisory group for the intelligence community to produce open and classified reports; (2) expand the intelligence community's relationships with non-governmental science and technical communities, to increase bioscience expertise; (3) create a new cadre of life science intelligence analysts with state-of-the art and hands-on experience; and (4) encourage cross-national sharing and coordination of future biological threat analysis between the U.S. intelligence community and its international counterparts (Institute of Medicine/ National Research Council 2006: 1-14). Once again, the focus on technical expertise and recommendations involving increased outreach to the life science community are evident in the report's key recommendations.

With these collective actors and activities, there existed various social and material antecedents to the WMD Commission report that were interwoven and built on one another to focus and reinforce policy attention on the technical solutions to the bioweapons problem. These solutions were a logical response to the framing of bioweapons threats as a primarily material and technical concern, although there is much that this framing left out. By tracing the presence and evolution of these antecedents, one can begin to see how calls for more technical expertise have become a taken-for-granted meta narrative in U.S. policy attention directed at improving intelligence on bioweapons threats. In doing so, this narrative begins to "tacitly define horizons of possibility and acceptable actions" (Expert Group 2007: 19). This outcome becomes increasingly evident in policy actions subsequent to the WMD Commission report.

4 Bioscience expertise and intelligence reform

After the WMD Commission report was released in March 2005, attention in Congress turned towards the report's bioscience recommendations. House Representative John Linder, then-Chairman of the Subcommittee on Prevention of Nuclear and Biological Attack of the Committee on Homeland Security, spearheaded Congressional attention on these recommendations because his committee held oversight responsibilities for U.S. Department of Homeland Security (DHS) biodefense and biothreat assessment programs.[6] While chairing this subcommittee, Linder held a personal interest in devoting more government attention and resources to the prevention of catastrophic nuclear and biological attack. In Linder's view, good intelligence was a key to prevention.[7] In addition to being influenced by the WMD Commission report, his attention to bioscience and intelligence reform at that time also stemmed from his receipt of a copy of the Institute of Medicine/National Research Council draft report, Globali-

[6] Rep. Linder began an initial series of hearings on how to assess the role and responsibility of DHS in preventing a bioterrorist attack in the United States in July 2005 (U.S. House of Representatives 2005).

[7] Telephone interview with former Linder staff member, 24 August 2007.

zation, Biosecurity, and the Future of the Life Sciences, that David Relman had co-authored.[8]

In light of these report findings, Rep. Linder organized a set of Congressional hearings to learn more about the bioweapons threats coming from the life science community and what the U.S. government was doing to respond to these threats. For the first hearing, "Bioscience and the Intelligence Community," held in November 2005, the Subcommittee asked recognized experts in the life science and biosecurity communities to speak. Given their technical expertise, David Relman and David Franz, former commander of the U.S. Army Medical Research Institute for Infectious Diseases (the primary U.S. biodefense facility), were asked to testify.[9]

In his prepared testimony, Relman critiqued the current physical science focus in intelligence, emphasizing that relatively few biologists have been recruited to work within the intelligence community (Relman 2005). He also argued that those biologists tend to be thinly and unevenly distributed across various agencies, assigned large portfolios, often reassigned to new positions, and quickly become cut off from advancing developments in life science research. In Relman's opinion, this has led to an inability of intelligence analysts to appreciate cutting-edge technologies in predicting future threats. Relman advocated that large numbers of researchers with doctoral degrees in the life sciences be recruited to work for the intelligence community, in ways that maintain their close connection with the cutting edge in their respective disciplines. In specific reference to the WMD Commission report, Relman also called for the establishment of an external bioscience advisory group. These recommendations were consistent with his prior writings advocating the increased need for technical expertise in intelligence.

In his testimony, David Franz emphasized the problems of evaluating the bioweapons activities of a state or terrorist group (Franz 2005). What is interesting in Franz's statement was his focus on technical solutions even when he acknowledged the problem was not solely technical. In Franz's judgment, understanding the intent of bad actors is key, due to the dual-use nature of biotechnology.[10] Yet Franz recommended that if intelligence analysts become more versed in understanding biological science and connecting that with specific pieces of intelligence, they would be able to better understand intent. Thus, what was being advocated was a prioritization of the technical, even while acknowledging that the problem of intent has critical social dimensions. An alternative recommendation that Franz could have given was to train intelligence analysts to become versed in the context of the intelligence information they receive and then connect that with biological science developments. Brian Rappert has argued that major deficiencies in the ability of intelli-

[8] This report is often referred to as the Relman/Lemon report, after its co-chairs David Relman and Stanley Lemon. Although the official report was not issued until January 2006, Linder's staff obtained a draft version of the report in the fall of 2005. Telephone interview with former Linder staff member, 24 August 2007.

[9] Franz is also a board member of the National Science Advisory Board for Biosecurity, director of the National Agricultural Biosecurity Center at Kansas State University, and served as Chief Inspector on three United Nations Special Commission biological warfare inspection missions to Iraq. He also served as a member of the first two U.S.-U.K. teams that visited Russia in support of the Trilateral Joint Statement on Biological Weapons. Franz has also served on senior S&T advisory biodefense panels for the Defense Threat Reduction Agency, Department of Homeland Security, and the Defense Intelligence Agency.

[10] "Dual-use" refers here to biotechnologies with peaceful scientific applications but could also be used for bioterrorism purposes.

gence and law enforcement officials to collect, share, and process information on terrorists have led to technologies being given a more prominent place in academic and policy biosecurity discussions, instead of focusing on how knowledge about these threats is gathered and analyzed (Rappert 2006). In this light, and given Franz' own technical background, his recommendations to Congress make pragmatic and logical sense, although they do not address the absence of context that persists in bioweapons intelligence assessments.

After this hearing, Rep. Linder's staff summarized what they saw as the primary take-home messages from the testimonies. In an internal memo written up by Linder's staff, two critical needs were emphasized: building a "robust, sustained and effective capability in the life sciences within the intelligence community"; and a "cadre of trained, motivated and educated personnel who can raise awareness and knowledge throughout the bioscience community of intelligence and the role it can play."[11] In the memo, a staffer outlined the need for technical expertise which largely reiterated Relman and the WMD Commission's earlier statements: "The intelligence community is only able to discern or anticipate a potential bioterrorist threat from seemingly innocuous research when intelligence analysts have a firm grasp of cutting edge bio-sciences and know what to look for. This knowledge base, unfortunately, does not lie in the intelligence community, but is based in the academic and research life science and engineering communities worldwide" (cf. Brill 2006: 4).

To prevent a biological attack through better intelligence, the memo emphasized the importance of integrating the scientific expertise held within the life science community into the wide reaching network of the U.S. intelligence community. Given the reports and testimonies available to Linder and his staff, these conclusions are not surprising. Yet, the absence of alternative voices and perspectives on the problems in bioweapons intelligence assessments limited the ability of Linder and his staff to see and consider a broader array of interventions to improve intelligence collection and analysis of bioweapons threats.

In the months after Linder's hearing, a set of other activities kept the policy focus on the technical problem of biothreat assessment. In January 2006, the Institute of Medicine/National Research Council officially released its report, Globalization, Biosecurity, and the Future of the Life Sciences. In concert with the report's release, some related news and opinion pieces were published. In a January 2006 article in the New England Journal of Medicine, David Relman argued that one must reject studying historical weapons programs as a guide to inform current biodefense policymaking because: "Today, anyone with a high-school education can use widely available protocols and prepackaged kits to modify the sequence of a gene or replace genes within a microorganism; one can also purchase small, disposable, self-contained bioreactors for propagating viruses and microorganisms. Such advances continue to lower the barriers to biologic-weapons development" (cf. Relman 2006: 114).

This statement again reveals a focus on the material and technical dimensions of biotechnology, rather than the broader array of social factors and that can shape bioweapons development.

In a Science editorial published the same month, Relman argued, "The risk that knowledge emerging from life sciences research could be misused, either intentionally or otherwise, needs responsible attention. … Those working in the life sciences must gain a

[11] Hearing Summary of *Bioscience and the Intelligence Community*, private communication.

greater awareness of the potential threats and learn to recognize, discourage, and report misuse or irresponsible behavior" (cf. Choffnes et al. 2006: 26).

Relman, who also served on the National Science Advisory Board for Biosecurity (NSABB), briefed the 2006 Institute of Medicine/National Research Council findings at the March 2006 NSABB meeting (Relman 2006b). Finally, in a fall 2006 article, "A Brave New World in the Life Sciences," published in the widely circulated policy journal Bulletin of the Atomic Scientists, Relman and colleagues emphasized the report's troubling, overarching conclusion: "the breadth of biological threats is much broader than commonly appreciated and will continue to expand for the foreseeable future" (cf. Choffnes et al. 2006: 28). Although Relman was not the only scientist working in front of and behind the scenes regarding these security concerns, he was one of the more visible and persistent actors emphasizing the technical dimensions of the threat and the need for more technical expertise to counter it.

Rep. Linder's staff organized a second, follow-on hearing in May 2006, which brought in high-level U.S. government officials with intelligence and counterterrorism responsibilities to discuss what the U.S. government was doing to address the gaps between the life science and intelligence communities. The witnesses included Ambassador Kenneth Brill, Director of the National Counterproliferation Center (NCPC), Office of the Director of National Intelligence; Mr. Charles Allen, Chief Intelligence Officer, Department of Homeland Security; Mr. Bruce Pease, Director, Weapons Intelligence, Nonproliferation, and Arms Control (WINPAC), Central Intelligence Agency; and Dr. Alan MacDougall, Chief, Counterproliferation Support Office, Defense Intelligence Agency. In opening the second hearing, Rep. Linder reiterated the intelligence problems identified in the first hearing, namely, the difficulties in keeping up with the pace of biotechnology and its applicability to terrorism.

To start, Ambassador Brill led the testimonies by describing what steps the NCPC had taken to address the WMD Commission recommendations (see Brill 2006). He explained that the NCPC's role in the intelligence community was to integrate the analysis and collection of intelligence by the CIA, Defense Intelligence Agency, and other elements of the intelligence community, as well as promote partnerships between the intelligence community and experts both inside and outside the U.S. government. Brill described the NCPC's approach as a priority setting and integrating role, which includes "determining what types of traditional intelligence and scientifically grounded information the intelligence community needs to better answer questions posed by senior policymakers, and how to ensure this information is distributed to all relevant parties within the intelligence community" (cf. Brill 2006: 5). Before describing his Center's efforts, Brill framed what he saw as the most important issues facing the intelligence community on biological threats: "The key questions for the intelligence community are primarily not highly technical in nature [emphasis in original]. We must determine if a state adversary has the intent to establish, maintain, or acquire a BW [bioweapons] program, because a country of concern typically will also have dual-use capabilities in those areas. Some non-state actors, such as al Qaeda, have publicly stated that they have the intent to have an offensive biologic capability, and the intelligence community must constantly monitor the plans and capabilities of these groups in order both to block the acquisition of such a capability, as well as to determine their plans for using such a capability if they acquire it. So focusing on technology alone will not answer these key questions … it can lead to speculation, based on nightmare scenarios that are not necessarily grounded in reality" (cf. Brill 2006: 2).

Curiously, however, in moving on to describe the Center's efforts, Brill primarily described technologically based solutions established by his office to better assess bioweapons threats, rather than non-technical approaches. This response was similar to David Franz's earlier testimony to the Committee and illustrates how a dominant narrative and framing of a problem (in this case, the need for technical expertise) co-opts alternative formulations, and gains popular policy momentum over time, marginalizing other possible articulations and focal points for the problem.

In his testimony, Brill described his creation of a new NCPC position, Senior Advisor for Biological Issues; Lawrence Kerr was appointed in April 2006 to serve in this position. Kerr holds a Ph.D. in Cell Biology and was previously on faculty at Vanderbilt University School of Medicine.[12] In his new position, Kerr was tasked to enhance the partnership of the intelligence community with non-government science and technical experts to improve overall intelligence collection on biological threats. One core component of this new partnership would be to establish what Brill described as "the intelligence community's first broadly focused biological science advisory group" (cf. Brill 2006: 4). This advisory group's members, who would be granted top-level security clearances, would work with the intelligence community (writ large) on a regular basis and report to the director of national intelligence.

Brill stated that he envisioned the new bio advisory group as having a two-tiered structure: a permanent "core" advisory group of leading scientific experts, and a larger network of biological scientists with security clearances that the core group could tap as needed. This new advisory group would identify for the intelligence community important cutting-edge biotechnologies and bioweapons threats to U.S. national security.

Following Brill, Charles Allen, speaking for the Department of Homeland Security, started his testimony by describing al Qaeda's interest in developing a bioweapons program (Allen 2006a). In contrast to the WMD Commission report findings, Allen described how al Qaeda managed to construct a "low-tech" facility in Khandahar, Afghanistan, but that subsequent U.S. intelligence and military operations in the region had further damaged al Qaeda's leadership and operational capabilities. Yet Allen maintained that concern remained about al Qaeda's intent to develop biological weapons. He said that, in addition to small, loosely affiliated terrorist cells, the Department of Homeland Security was concerned with threats posed by a technically competent "lone wolf." Yet, in responding to a question from Rep. Linder about threats from advances in biotechnology, Allen stated: "In this area we must exercise caution and not confuse capabilities of bioterrorists with state-level BW [bioweapons] programs. There is no doubt that the knowledge and technologies today exist to create and manipulate bio-threat agents; however, the capability of terrorists to embark on this path in the near-to–midterm is judged to be low. Just because the technology is available does not mean terrorists can or will use it. … In general, terrorist capabilities in the area of bioterrorism are crude and relatively unsophisticated, and we do not see any indication of a rapid evolution of capability. It is, therefore, unclear how advancements in high-end biotechnology will impact the future threat of bioterrorism, if at all." (cf. Allen 2006a: 3).

[12] Kerr also served as adjunct professor in microbiology and immunology at Georgetown University School of Medicine.

Allen went on to state that before advanced biological agents become a threat, he would expect to see the more frequent attacks or large-scale use of traditional biological weapons agents (e.g., anthrax or plague bacteria).

Addressing the gaps in knowledge about the nexus of biology and terrorism, Allen stated that any effort to enhance "bio-intelligence" must focus on targeting and collection over analysis. In advocating this position, he stated, "Our difficulties do not come from analyzing scientific information, but in obtaining credible, relevant information to analyze" (cf. Allen 2006a: 4). Thus, in his view, the problems are not inherent and do not stem from a limitation in existing technology assessments (i.e., their technical focus) but from the lack of inputs that would enter into these assessments. In spite of Allen's cautions about the low-tech character of bioweapons threats, his solution to improve intelligence is also a technical one: to partner the intelligence community with outside scientific experts to improve the targeting and collection of open source and classified scientific information, because "We simply must have more collection" (Allen 2006b).

Allen suggested focusing primarily on tracking technically trained people with the motivation, intent, and capability to become or aid bioterrorists, to aid intelligence collection. He cited Homeland Security's collaboration with technical subject-matter experts at several U.S. national laboratories, to obtain the necessary technical information for their assessments. Yet, Allen's focus on technical collection obscures a more refined discussion of how to better integrate social and technical forms of data and expertise in bioweapons assessments to judge threat capability.

Next to testify, Bruce Pease, the director of the CIA's main technical analytic unit, WINPAC, described bioweapons analysis as a thousand-piece puzzle: "Each bit of information is a piece of the puzzle, but alone, these pieces probably do not reveal much. Understanding the science of BW is a critical part of what we do, but still, it is only a piece of the puzzle" (cf. Pease 2006a: 6; emphasis in original). Pease also mentioned that the information the CIA receives from their collectors is typically not highly technical. He described how the CIA's analysis goes beyond the technical aspects of biology to other factors that might shed light on suspected bioweapons activities (e.g., motivation, intent, regional security, military and industrial infrastructures). In his spoken testimony, Pease described the difficulties in assessing the bioweapons threat: "The hard part is getting the information on where the threat is actually being developed, what they're developing, how they're doing it, and what they intend to do with it … the work that needs to be done there … needs to be both relentless and creative" (cf. Pease 2006b).

Yet again, in describing the CIA's strategy to increase its knowledge on bioweapons threats, Pease focused his remarks on an increase in recruitment of technical experts to the CIA and outreach to non-governmental academic and industrial scientists, rather than exploring broader sets of expertise to better evaluate how these threats might be developing. Although Pease stated that science is only a piece of the larger puzzle, his suggested solutions focus exclusively on the technical at the expense of the other, more complex pieces.[13] He left out a variety of non-technical issues that could have

[13] Moreover, WINPAC bioweapons analysts typically are technical analysts who are organizationally structured to work largely independently on their own technical assessments, disconnected from other intelligence analysts that could provide a more contextualized approach to understanding a state or non-state actor.

been suggested as alternative reforms for intelligence.

Alan MacDougall, from the Defense Intelligence Agency (DIA), chose to focus his testimony on two main efforts established within the DIA to connect bioscience expertise to intelligence: (1) an advisory group known as BioChem 20/20, and (2) the Jefferson Project (see MacDougall 2006). BioChem 20/20 is a scientific advisory group formed by the DIA in 1998 to help them anticipate the impact of new technologies and processes on biological and chemical warfare threats. In contrast to Brill's proposed new advisory group at the NCPC, BioChem 20/20 is a much smaller group of experts (about 20), and consists of both governmental and non-governmental scientists, working specifically for the DIA, with a focus on threats facing the U.S. military. Analogous to Pease and Brill's testimonies, MacDougall also stated that the DIA was looking to build its internal technical capacity by recruiting more biological scientists to aid in its assessments of bioweapons threats.

What is clear about these collective testimonies is the consistent focus on technical solutions, when there is awareness among several of these experts that technical issues are only part of the bioweapons assessment problem. This contradiction could have been further interrogated by Linder and his staff within and after the hearing — but was not. Instead, Linder's staff focused on the technical expertise recommendations emphasized in the testimonies. After the hearing, Rep. Linder's staff met with Kerr to obtain more detailed information about the plans within the Office of the Director of National Intelligence (ODNI) to establish a biological sciences advisory group. Kerr's presentations reassured Linder's staff that the ODNI was taking the appropriate steps to address the gap between the bioscience and intelligence community, so Rep. Linder did not press for additional Congressional mandates on this issue. Linder had planned to hold a third set of hearings looking into how intelligence "customers" (e.g., executive branch agencies) benefited from receiving bioscience information. But, with the 2007 Congressional shift in power, Linder lost his seat on the Homeland Security Committee, which prevented him from organizing another set of hearings.[14]

Behind the scenes, Kerr continued to work towards establishing the ODNI's bioscience reform efforts. Initially, Kerr had considered two approaches: (1) focus on increasing the biological science competence within the intelligence community's analysts, and (2) create an outside bioscience advisory group. He chose to focus his efforts on the second approach.

Throughout 2006, Kerr met with various members of the U.S. intelligence community to obtain suggestions for how to structure this new advisory group. In talking with Dr. Peter Jutro, Deputy Director for Science and Policy at the National Homeland Security Research Center, U.S. Environmental Protection Agency, Kerr learned Measurements of Earth Data for Environmental Analysis (MEDEA), a novel external science advisory group set up by the intelligence community.[15] MEDEA was established in 1993 to bring both academic and intelligence knowledge to bear on understanding the science behind global environmental concerns (Gore/Belt 1997; Carter 1996). Approximately 70 scientists were recruited from academia, the private sector, and relevant government agencies to serve on MEDEA.[16]

MEDEA scientists worked to compile a list of critical environmental issues and

[14] Telephone interview with former Linder staff, 24 August 2007.

[15] Interview with U.S. intelligence official, Arlington, VA, 24 July 2007.

[16] The name MEDEA, chosen by CIA official Linda Zall, came from a Greek mythological character who helped Jason and the Argonauts steal the Golden Fleece (Beardsley 1995).

the intelligence information needed to address them. With their security clearances, these scientists were then given highly classified briefings on U.S. intelligence technology to help them determine what kinds of archived classified data might be useful for environmental research. The briefings also helped inform the scientists as to how existing classified satellites and other technological systems could be targeted to collect new environmental data.[17] With this MEDEA model in mind, Kerr began structuring the ODNI's new biological sciences advisory group.

5 Evolution of the BSEG

In November 2006, the NCPC established the Biological Sciences Experts Group by official charter within the ODNI (see Office of the Director of National Intelligence 2006). An Executive Secretariat — with its own dedicated, classified budget — was created in the ODNI to provide support and management of the BSEG's operations. In addition, a steering group consisting of various representatives of the intelligence community was established to advise Kerr on BSEG taskings.

The BSEG consists of a cadre of external life science and bioweapons experts from universities, companies, and non-government organizations. These experts provide technical advice and counsel to the intelligence community on specific scientific and technical issues relevant to assessing the bioweapons threat.[18] These experts serve as independent consultants to the NCPC, appointed through the National Intelligence Council Associates program and paid for their time (plus per diem and travel expenses) to attend meetings.[19] Although contracts are renewed on an annual basis, BSEG consultants are expected to serve at least three to four years.

The BSEG consists of a group of 50 scientists (Prentice 2011). Because there are a variety of subspecialties within the life sciences (and related technologies), it is expected that the larger BSEG network will grow in the future to allow the intelligence community access to a greater pool of technical expertise as the need arises. Thus, it is expected that the BSEG will change and grow, depending on intelligence community needs.[20] New BSEG members can be proposed by members of the BSEG and the intelligence community. As with other advisors to the intelligence community, BSEG mem-

[17] Through negotiations with MEDEA, the intelligence community agreed to periodically image selected sites of environmental significance. Interestingly, MEDEA has served as an advocacy group in favor of further declassification of intelligence data for scientific research. For example, MEDEA scientists successfully lobbied to declassify over 800,000 images produced by Corona, Argon, and Lanyard photoreconnaissance satellites (Richelson 1998).

[18] The BSEG Charter explicitly states the following technical areas are of current interest: microbiology, molecular biology, synthetic biology, forensic sciences (e.g., microbial forensics), biochemistry, medicine, pharmacology, pathology (e.g., plant/human/animal), immunology, public health, epidemiology, veterinary medicine, food safety/security/production, agricultural sciences, pharmaceutical, biosecurity/biosafety, counterproliferation/ counterterrorism issues, former or current state bioweapons programs, former or current biological terrorist programs (Office of the Director of National Intelligence 2006).

[19] The National Intelligence Council (NIC) Associates Program was designed to enhance cooperation between academia and the Intelligence Community. Its associates are chosen from the ranks of academia, the corporate world, or think tanks. Prior to the formation of the BSEG, the NIC associates typically have followed a particular region or transnational topic for at least ten years, are U.S. citizens, and have traveled extensively. In the past, associates were asked to bring their historical understanding to bear on a wide spectrum of intelligence issues. See U.S. National Intelligence Council, "NIC Associates," available at < http://www.dni.gov/nic/NIC_associates.html >.

[20] Interview with U.S. intelligence official, Arlington, VA, 22 March 2007.

bership is confidential; individual member names are publicly released only with that member's permission.[21] To help recruit new members and raise awareness of the importance of bioscience expertise to the intelligence community, Kerr, Brill, and related NCPC staff have given public talks to large scientific and policy audiences and visited several universities across the United States (Brill et al. 2006; Kerr 2006; Prentice 2011).

The BSEG is separate from any particular U.S. intelligence agency, although it was established to be able to advise all U.S. intelligence agencies on biological issues. Thus, any one of these sixteen agencies may suggest to the NCPC specific topics or issues for research and analysis by BSEG experts. From these submissions, Kerr, as Senior Biological Advisor for the NCPC, could prioritize specific topics or issues for tasking to specific BSEG members (either to individuals or larger groups). As the charter stipulates, the types of issues that the BSEG may be assigned include: (1) supporting intelligence customers in the design of scientific/technical experimental protocols, intelligence analyses, or collection methodologies against biological threat agents (BTA), biological warfare agents, and/or state and non-state actors which do or may pose a threat to the United States; (2) advising on strategies to improve the execution or interpretation of results of experimental protocols, analysis, and collection against the aforementioned agents and/or actors; (3) undertaking technical assessments/performance review of the intelligence community's scientific/technical programs, analytical products, and collection methodologies against the aforementioned agents and/or actors; and (4) addressing any other issues as requested by the NCPC or intelligence community departments or agencies (Office of the Director of National Intelligence 2006).

To illustrate the types of activities that BSEG members may be involved in, if the intelligence community has captured a toxin recipe from al Qaeda and would like to determine whether it poses a threat, BSEG members could be involved in: providing technical advice on how to design an experiment to replicate the toxin recipe; helping the intelligence community interpret the results from the experiment; or serving as an independent reviewer of the finished experiment.[22] In addition, one policy official with an understanding of BSEG work has stated that the "BSEG has value in pointing analysts to open sources related to science and technology and what is going on in an open, vibrant and globalized S&T base."[23]

Unlike some intelligence activities, the name and existence of the BSEG is not classified. Yet most of BSEG's work is highly classified (e.g., specific code word classification, use of facilities that can work with special compartmentalized information). Currently, BSEG members are not required to undergo a polygraph examination, but this could change, depending on the types of projects proposed by the intelligence community. It is anticipated, however, that any necessary polygraphs would be done on a volunteer basis.[24] Although intelligence community members may be called on to work with specific BSEG members, the charter specifically states that BSEG members will serve only in an advisory capacity — they will not produce final

[21] Some BSEG members have expressed concern about identifying their association with U.S. intelligence to their national and other international scientific colleagues and collaborators; others, however, proudly list their membership on their academic CVs and in other public/policy forums.

[22] Interview with U.S. intelligence official, Arlington, VA, 22 March 2007.

[23] Personal communication with anonymous U.S. policy official.

[24] Interview with U.S. intelligence official, Arlington, VA, 22 March 2007.

intelligence products nor engage in collection activities (Office of the Director of National Intelligence 2006). To date, the BSEG has held regular meetings every few months, including briefings to BSEG members by intelligence community representatives, as well as talks by additional government and non-government speakers.

In addition to providing specific project advice, the BSEG can also provide commentary on emerging technologies of concern. One U.S. intelligence official has stated that the BSEG could maintain an annual "Top 10 Tech Watch" list, which would advise the intelligence community on what cutting-edge biotechnologies are emerging or changes in existing biotechnologies that may pose security threats.[25] This Top 10 list would then be given to intelligence analysts and collectors to help inform them in their open source and clandestine collection efforts in identifying whether states, terrorists, or lone-wolf "bio-hackers" were pursuing these technologies, as well as to help the intelligence community design new countermeasures or collection devices against such threats.

The BSEG is still evolving. As one BSEG member has commented to me, the group as it exists now is merely a collection of independent consultants who come together for regular meetings.[26] Thus, no cohesive identity, governance structure, or means of carrying out its assessments has been set. Therefore, opportunities exist for trying to re-shape how this group is informing bioweapons threat assessments. For example, at one BSEG meeting, a guest speaker was invited to discuss his archival research on former U.S. and U.K. bioweapons programs and how this historical knowledge can inform contemporary biodefense preparedness efforts. One BSEG member stated, however, that this type of presentation is atypical, as meetings typically focus on technical presentations with technical experts.

6 The logics and practices of BSEG

"Well, the use of preconceptions to guide inquiry is actually — is perfectly rational. In fact, it's a condition of rationality. You can't approach things with a tabula rasa. You have to start somewhere. The Commission gives a very good example of the use of preconceptions, sensible use of preconceptions, when it emphasizes the danger of bioterrorism. That's a preconception in the sense that we don't have any concrete information about the intentions or capabilities of our enemies with respect to bioterrorism. But we do know the logic of the situation, given what we think they want to do to us and given the means that are available in scientific knowledge and technical facilities, this is something to worry about" (Silberman 2005).

– Laurence Silberman, Co-chair of the WMD Commission Report

Silberman's words powerfully illustrate how preconceptions and narratives about biotechnology and terrorism are embodied in and work through particular kinds of people and institutions to shape public attention, policy prescriptions, and governmental responses to bioweapons threats. The establishment of the BSEG is the logical culmination of a security narrative that frames current and future bioweapons threats as a predominantly material and technical concern and privileges technical expertise to address those concerns. In looking at the history of the BSEG's formation, one can see how particular kinds of actors (e.g., WMD Commission, scientists, intelligence and policy officials) have worked to define the bio-intelligence problem as a lack of bioscience expertise and technical data, and have thus structured a variety

[25] Interview with U.S. intelligence official, Arlington, VA, 22 March 2007; see Brill (2006).

[26] Telephone interview with BSEG member, 21 September 2007.

of methods and activities to attract policy attention to this particular definition of the problem. As described earlier, activities designed to articulate and reinforce these claims have included: enrollment of high-profile scientists, government hearings, government and non-governmental reports, articles and editorials in high profile science and policy journals, and high-level policy briefings. Although the actors advocating this framing of the problem are sincerely concerned about bioweapons threats and U.S. preparedness against those threats, their narrowly focused policy prescriptions leave out important sets of non-technical knowledge and expertise critical to producing more accurate bioweapons assessments.[27]

Secrecy has also played an important role in shaping the public and policy discourse on the bioweapons assessment problem. For example, although the WMD Commission report included declassified information on al Qaeda's bioweapons efforts (as well as statements about threats from advances in biotechnology), other important contextual information about these issues remained (and continue to remain) classified. For example, there is little public information as to how the WMD Commission structured and formulated its assessments; most of its meetings were closed to the public. Although the report highlights the growing threat of bioterrorism, cryptic clauses in the report about the continued ambiguity of existing intelligence data go unexplained. And the classified nature of the BSEG's ongoing work also work to minimize public scrutiny over its activities. As a result, most of what we know about the BSEG and its work is dependent upon rare public and private statements. 2010 FOIA requests to release the BSEG's annual report were denied by the Office of the Director of National Intelligence, even though the denial was not based on classification concerns, but on what seem to be privacy issues (Aftergood 2010).

These half-secret/half-open activities constituting bioweapons threat assessments can be described as working under what John Cloud has called the "Shuttered Box" model of knowledge production,[28] which allows one to see how specific actors in recent bioweapons assessment policy discussions possess dual access to the classified and unclassified domains where discussions on the bioweapons threat and the bioweapons assessment problem are conducted. The way in which reports and related activities are constructed by these actors serve as shutters that "allow successful passage of people, money, ideas, technologies, and data back and forth between the disparate domains, but without ever providing direct sight or communication between the realms" (cf. Cloud 2001: 240). In the BSEG case, certain kinds of people and knowledge are allowed to pass through these shutters — those that support a particular kind of technical narrative and policy solutions about biotechnology and the bioweapons threat.

Cloud also writes that the shuttered box also "transforms or disguises the identities of the elements passing through it" (Cloud 2001: 240). The secrecy that structures the BSEG obscures the identities of its members, which are, however, important for understanding the kind of knowledge

[27] Having spent time in and out of the policy community, I have developed long-term professional connections and relationships with these individuals. From my judgments, these individuals do believe the problems are primarily technical, and that is the basis for their policy prescriptions.

[28] As Cloud explains, the Shuttered Box is an adapted metaphor of the "black box," where a technology or machinery was sealed or otherwise inaccessible, such that its contents and workings could not be seen. In a Shuttered Box model, however, areas of exchange can exist (Cloud 2001: 240).

that the group produces. An intelligence analyst who attends BSEG meetings has noted that many of its members have overlapping membership with other technical advisory committees, such as the Defense Intelligence Agency's Bio-Chem 20/20.[29] As a result, this analyst observes that instead of having alternative sets of outside expertise coming to bear on intelligence, there is a redundancy of perspectives about bioweapons threats represented behind the scenes — mostly those focused on a technovisionary of an increasing bioweapons threat with advances in biotechnology.[30]

Historian of science Michael Dennis noted that "one gets a certain type of knowledge from a particular social organization, in this case a secret organization or research that is secret. … This knowledge is different than what might be produced in a more open space … secret knowledge produced a different map of intellectual geography, a different sense of the horizons of possibility" (cf. Dennis 1999: 13-14). Dennis concludes that secrecy works to constrain and condition the imagination in different ways. In the case of the BSEG, because the group consists of technical experts who are tasked to look at purely technical aspects of bioweapons threats, the intelligence community (and its policy customers) will continue to consider bioweapons threats from a primarily abstracted technical perspective, without a richer understanding of the potentially larger contextual factors that shape real bioweapons capabilities.

Yet, in moving beyond the specific case of the BSEG, one can see the larger effects that this purely technical narrative in structuring intelligence can have on U.S. biodefense policy. In the past, U.S. biodefense planning has been tightly coupled to intelligence assessments based on specific clandestine information on particular adversaries. Recently, however, some have questioned this logic by, for example, advancing the need for a forward-looking, "capabilities-" or "science"-based approach to biodefense.[31] Under this model, justification for U.S. biodefense activities would move away from a tight coupling to intelligence assessments on specific adversaries and instead be based on exploring the abstract technical feasibility of current and future bioweapons threats. Such an approach is seen as providing a more robust and rapid mechanism for developing countermeasures against a broad range of potential bioweapons attacks in light of poor intelligence information and the unpredictability of advances in biotechnology.[32] One should see, however, that this technical solution is only one of several possible ones for improving intelligence on bioweapons threats. For example, testimonies and policy prescriptions could have focused efforts and resources on how to better collect and analyze intelligence information on adversaries that would include a broader range of social and technical data sets, as well as wrestle with the more complex problem of how to integrate and understand technical data

[29] Although its composition has changed from time to time, Bio-Chem 20/20 has typically consisted of about 15-20 prominent technical experts in the life sciences and related bio-chemical technologies from government, academia, and private industry.

[30] Personal communication with U.S. intelligence analyst, Washington, DC, 18 August 2010.

[31] For an example, see Petro and Carus (2005). This capabilities-based approach to biodefense has been based on former Secretary of Defense Donald Rumsfeld's interest in a similar approach to military transformation, where technology has been envisioned as a critical centerpiece and force multiplier.

[32] In choosing to focus on a science-based approach to biodefense, Petro and Carus describe the problem of assessing adversary intentions because this information is seen as scarce, dated, incomplete, contradictory, or insufficient for prioritizing biodefense resources and activities.

situated within different individual, terrorist, and state-level contexts.

With the existing technical focus, much gets left out. Sociologist of science Stephen Hilgartner notes that "Quantitative metrics and indicators may express particular forms of objectivity, but they cannot escape the deep and often invisible politics of what is counted, how it is counted, why it is counted, and how the counts are used" (cf. Hilgartner 2007: 4). It is important to note that a focus on the technical dimensions of the threat comes at a cost: the marginalization of analyses examining the social context underpinning bioweapons development and use, which is reflected in the considerable resources and programs within U.S. biodefense that have been shifted to focus on "science"-based threat assessments, R&D for countermeasures, and surveillance and detection systems. These programs remain largely focused on finding technological solutions to counter potential bioweapons threats, rather than funding the harder work of trying to better understand the multi-faceted and messy ways in which adversaries choose, design, develop, and use technologies for harm.

The fractures in social and technical knowledge in U.S. intelligence assessments are not new — they have been pointed out by a range of academic, policy, and intelligence scholars and practitioners over the past twenty years. During the Cold War, scholars and analysts failed to understand the role of technological development and change in the U.S.-USSR arms race. In the late 1980s, sociologist Donald MacKenzie, in the then-emerging academic field of science and technology studies, published an important commentary in the prominent journal International Security, attributing such analytic errors to judgments that failed to take into account that "There is more to weaponry than high technology, more to the competition of the Soviet Union and the United States than weaponry" (cf. MacKenzie 1989: 161). MacKenzie also noted how analysts and policy officials at the time tended to assume unproblematically the primacy of strategic state goals in establishing and advancing a weapons program, with the relevant weapons technology assumed to follow in a predictable trajectory devoid of shaping by a range of contextual factors. In contrast, he argued that there needed to be more attention to how technological change is intimately shaped through a variety of internal and external social factors, and to the need for more detailed case studies and historical analyses of the development of weapons technologies in different national contexts. Yet, more than twenty years later, as the BSEG example illustrates, a narrow technical focus in weapons assessments remains (albeit with a unique framing and narrative constituting the problem), leaving out crucial factors that can modulate the development of biological weapons by state and non-state actors.

7 Coda: New interventions and experiments

The current technical approach to bioweapons intelligence assessments needs to be broadened to include more attention to contextual factors in bioweapons threats and responses. I have argued elsewhere that these assessments should consider biotechnology more as a sociotechnical assemblage, which takes into equal account both the social and the technical character of biotechnology (Vogel 2013). In this way, one would examine how the social component of biotechnology is co-constructed with the technical — how this assemblage infuses and shapes how materials and infrastructure are used. Thus, this approach would examine qualitative aspects of biotechnology as a way to ground and refine purely technical analyses that dominate to date, and would recognize that biotechnology knowledge is embedded within a larger sociotechnical assemblage that can modulate the manner in which biotechnology can be adopted by terrorists or proliferators. This approach would suggest that greater effort should be given to examining the social dimensions of the bioweapons threat and how it interacts with the technical.[33] Instead of working so hard to infuse the CIA or other intelligence agencies with scientists, more attention in bioweapons assessments should be given to including other non-technical sets of expertise, as well as pairing non-technical and technical analysts to work closely together. In this way, CIA analysts could better understand the more complex synthesis of the technical with the political, economic, social, and cultural dimensions of terrorist and state-level bioweapons programs.

Tracing the historical evolution of the BSEG illustrates that existing ways of assessing bioweapons threats are not a given, but were historically contingent. Thus, new interventions can be created to include more open, inclusive, and reflexive modes of technology assessment. For example, some effort could be given to restructuring the types of BSEG-resident expertise by including other advisors from the National Intelligence Council Associates Program (the BSEG's hiring mechanism) to participate in its meetings and reviews. Typically, these associates are subject-matter experts from academia or think tanks who have followed a particular region or transnational topic for at least ten years and are asked to apply their historical and contextual knowledge to better understand the various factors affecting an intelligence issue. Although the BSEG currently views the Associates Program as merely a contracting mechanism to bring in technical experts, this perspective loses sight of broader sets of valuable expertise for helping BSEG members, the intelligence community, and its customers better understand the broader social and technical dimensions of bioweapons threats.

In addition, a recent set of overlapping activities and circumstances indicate additional openings to include alternative modes of producing knowledge in intelligence assessments. In July 2008, the Office of the Director of National Intelligence issued Intelligence Community Directive Number 205 (ICD 205), "Analytic Outreach" (Office of the Director of National Intelligence 2008). This Directive charges intelligence analysts to "leverage outside expertise as part of their work." To do so, the analyst is expected to seek opportunities to engage openly with these outside experts, to "explore ideas and alternative perspectives, gain new insights, generate new knowledge, or obtain new information." The Directive recognizes the importance for analysts to move out of their classified domains to tap into valuable outside knowledge and expertise relevant to intelligence problems, and thereby challenge erroneous group-think that can occur in the closed worlds of intelligence. This directive could provide a new impetus to include multi-disciplinary and cross-functional groups of experts to advise the BSEG or related intelligence analytic entities.

Also, in 2011, the U.S. National Academy of Sciences published a report — Intelligence Analysis for Tomorrow: Advances from the Behavioral and Social Sciences — sponsored by the Office of the Director of National Intelligence, to synthesize and assess evidence from the behavioral and social sciences relevant to analytic methods and their potential application by the U.S. intelligence community. The report recommended that the intelligence community "embed IC analysts in academic research environments to

[33] My research on the pre- and post-war assessments of Iraq's bioweapons program suggests how a more contextualized approach, as partly designed and implemented by UN weapons inspectors and the Iraq Survey Group, could be carried out to reform intelligence assessments (Vogel 2013).

participate in research and to network with [social and behavioral] scientists who can be consulted later," and that "the intelligence community should expand opportunities for continuous learning that will enhance collaboration, innovation, and growth in the application of [social and behavioral science] analytical skills" (U.S. National Research Council 2011: 85, 88-89).

Although this report is not specifically geared to the issue of biological weapons intelligence assessments, its general conclusions about consulting outside social and behavioral science experts to better inform intelligence is relevant to strengthening the BSEG to include multi-disciplinary sets of expertise. The report also suggests mechanisms and opportunities for intelligence analysts to exit their classified domains to spend time in academic and non-government settings, to enhance their learning on intelligence matters. In addition, other intelligence practitioners and academic scholars have pointed to the need for increased interaction among intelligence analysts and other government and non-government analysts and officials to produce more accurate and holistic weapons assessments (Koblentz 2009; Kerr et al. 2006).

Moreover, in November 2011, I attended a one-day meeting entitled "The Role of Tacit Knowledge in Nuclear, Biological, and Chemical Weapons Proliferation," sponsored by a high-level official within the intelligence community. This meeting involved a collection of intelligence analysts and non-government experts. At this meeting, a broad-based discussion of tacit knowledge in the development of nuclear, chemical, and biological weapons was presented by a set of non-government experts. As a participant-observer, I found it interesting to hear and reflect on the comments that intelligence analysts and officials made during the presentations and discussions. Although some in the audience were aware of the tacit knowledge literature in the field of science and technology studies and its application to weapons issues (mostly academic speakers), it was clear that most of the intelligence attendees were not aware of this body of literature, how it could be applied to weapons proliferation, or more broadly, how to think about the social dimensions of science and technology. In their comments about science and technology, they seemed to be working with older and more simplistic information-driven or cognitive-based models instead of taking into account how scientific and technical work are socially shaped.

Observing firsthand the disconnects between academia and intelligence has further underscored what I see as a critical need for more substantive and extended discussions between academic scholars and intelligence practitioners on specific case studies that illustrate the mechanisms by which know-how and other social dimensions of technical work relate to bioweapons development. Furthermore, in November 2011 I participated in the annual Emerging Biodefense Threats and Information Sharing Strategies Symposium organized by the IC-Private Sector Program, sponsored by the Office of the Director of National Intelligence. In the symposium, there was much interest generated around discussions of further outlining academic scholarship on the social and organizational factors shaping biotechnology development. Both these meetings therefore indicate interest by some within the intelligence community to explore a more contextualized approach to assessing bioweapons-related technologies, given the time and opportunity to consider alternative perspectives.

In response to these activities and my research, I am in the process of launching a new scholarly intervention into U.S. intelligence. In informal collaboration with intelligence analysts, I am creating a new unclassified "study group" consisting of a small group of academic experts and intelligence analysts, which will explore the development and use of different framings and social science analytic methodologies for intelligence assessments on biological weapons threats. I use the concept of "study group" instead of "seminar" to highlight that close engagement between academic scholars and intelligence analysts and officials on these issues will be in a manner that facilitates a co-exploration of the social and technical dimensions of bioweapons technologies.

An initial focus for this group will be the facets of tacit knowledge (i.e., know-how) involved in the development of biological weapons. Through an examination of a range of case studies and examples, some questions the group will explore include:

- How does tacit knowledge (and other forms of weapons knowledge) get transferred between people (or teams of people)? How is it possible to discretely identify and measure this process?
- How are different forms of tacit knowledge combined, across different stages, for the development of a particular weapons technology? How might this process differ between nuclear and biological weapons technologies?
- What are the mechanisms and factors by which tacit knowledge becomes converted to codified knowledge in nuclear and biological examples? What might be useful indicators by which to assess such change?
- In what ways does secrecy affect the development of technical work in a weapons program? How can one probe these effects and better infer their implications for weapons development?
- What kinds of social engineering are required (e.g., pedagogy, exchanges, organization and management structures, etc.) for weapons to be developed and transmitted? What are their variations in the context of nuclear and biological technologies? How does such social engineering vary across cultures?
- What analytic tools are available to better assess how intent (state/non-state actor) shapes technical decision making in the development of weapons programs? How can one assess changes in intent over time, and the resulting impact on weapons programs?
- What other important factors, conditions, and time scales shape the development and transfer of nuclear and biological weapons technologies? How do these vary by cultural context?
- How is weapons development blocked? What particular local conditions and practices contribute to the failure to develop these technologies? What do studies of technological failure reveal about the social and technical factors that shape weapons development, and how to measure these factors?

The goals of these study groups are to introduce intelligence analysts to new, unclassified, multidisciplinary social science approaches to study bioweapons problems relevant to their work, and to provide opportunities for intelligence analysts to raise challenging questions and pressing issues to academic scholars, in order to further refine academic social science scholarship on these bioweapons-related issues. In addition, this project aims to create new knowledge within the social sciences about how intelligence analysts acquire, process, and respond to new information and analytic methodologies.

By bringing new social science analytic tools to bear on intelligence and policy problems and better integrating it with technical forms of information and expertise, the U.S. government stands to gain more robust approaches for probing and sorting through the messy, contingent character of science and technology in weapons development. This project will also challenge the conventional wisdom in policy and intelligence communities, that substantive discussions of analytic methods for biological threats can only occur in highly classified settings and solely relate to technical expertise and knowledge. Also, this work aims to add to academic scholarship by shedding light on the knowledge-making practices in U.S. intelligence and how social science concepts can be translated to work in specific policy-oriented contexts. Therefore, there is much benefit from bringing the academic and intelligence communities together in close conversation. In this way, this project is akin to experiments that other social science scholars have launched to bring new perspectives to the governance discourse on science and technology (Expert Group 2007; Nordmann 2009).

Starting such an engagement, however, is fraught with challenges. For example, at a recent focus group with a small collection of intelligence analysts and officials to discuss this new engagement initiative, one intelligence official emphasized to me the problem of classification. He stated that for academic ideas to be really useful and challenge intelligence analysts' assumptions, academics would need to talk to analysts about the details of a specific case.[34] In his mind, this poses obstacles related to academics not having the appropriate security clearances to have such a conversation; for example, intelligence analysts would be reluctant to have detailed, explicit discussions about how to better assess the bioweapons capabilities of al Qaeda or North Korea without some level of classification. Thus, concerns over secrecy remain a difficult issue to work through as this engagement goes forward.

More recently, however, I co-organized a workshop between U.S. and U.K. academics and intelligence analysts aimed to start a conversation on merging social science and technical understandings of emerging biotechnology threats.[35] Although the analysts in the room were reticent to make public remarks during the workshop, during coffee breaks, lunches, and dinners there were a number of interesting side-bar conversations and follow-on discussions between the academics and intelligence analysts on specific workshop presentations. Both the academics and the analysts indicated that informal means of information and expertise sharing did occur on specific biotechnology/ bioweapons issues. Therefore, I think this as an important starting point for establishing trust, dialogue, and value to holding more unclassified dialogues in the future.

Trying to assess the intentions and capabilities of a state or non-state actor bent on hiding its bioweapons activities will always be a notoriously difficult problem to solve. Thus, analytic shortcomings and failures (even on the path to intelligence reform) should not be unexpected. As former Deputy Director of National Intelligence for Analysis Thomas Fingar has argued, "intelligence is not omniscience" (Fingar 2009). However, both the difficulty and the stakes of assessing bioweapons threats highlight the need to examine and open up how bioweapons assessments are conducted, to identify gaps and new ways to approach data collection and analysis for these assessments and, in turn, mitigate error.

8 Acknowledgments

The author wishes to thank the Mellon Humanities Project, Interface of Humanities and Sciences/Technology Cluster for early support and feedback

[34] Anonymous U.S. intelligence official, Washington, DC, 8 March 2012.

[35] U.S.-UK Joint Workshop on Improving Intelligence Analysis for Emerging Biotechnology Threats, 12-14 September, London, sponsored by the UK Economic and Social Research Council's Genomics Forum.

on this work and the National Science Foundation for its support of this research. I also wish to thank Robert Kulik for his editorial assistance.

References

Aftergood, Stephen, 2010: ODNI Advisors on Bio Sciences Keep Low Profile. In: Secrecy News. 16 August 2010. <http://www.fas.org/sgp/news/2010/08/odni080910.pdf>

Allen, Charles, 2006a: Statement for the Record. In: Hearing, Bioscience and the Intelligence Community (Part II): Closing the Gap. Committee on Homeland Security, Subcommittee on Prevention of Nuclear and Biological Attack, U.S. House of Representatives. 4 May 2006. <http://www.gpo.gov/fdsys/pkg/CHRG-109hhrg35695/html/CHRG-109hhrg35695.htm>

Allen, Charles, 2006b: Oral testimony. In: Hearing, Bioscience and the Intelligence Community (Part II): Closing the Gap. Committee on Homeland Security, Subcommittee on Prevention of Nuclear and Biological Attack, U.S. House of Representatives. 4 May 2006. <http://findarticles.com/p/news-articles/political-transcript-wire/mi_8167/is_20060504/representative-john-linder-ga-holds/ai_n50588567/pg_2/>

Beardsley, Tim, 1995: Environmental Secrets. In: Scientific American 273, 28-30.

Gore, Al/Don Belt, 1997: An Arctic Breakthrough. In: National Geographic 191, 36-57.

Brill, Ken/Melanie Elder/Lawrence Kerr, 2007: Intelligence Reform, S&T, and the Counterproliferation Challenge. AAAS Center for Science, Technology, and Security Policy, Washington DC, 6 June 2007. <http://cstsp.aaas.org/content.html?contentid=927>

Brill, Kenneth, 2006: Statement for the Record. In: Hearing on Bioscience and the Intelligence Community (Part II): Closing the Gap. Committee on Homeland Security, Subcommittee on Prevention of Nuclear and Biological Attack, U.S. House of Representatives. 4 May 2006
. <http://www.gpo.gov/fdsys/pkg/CHRG-109hhrg35695/html/CHRG-109hhrg35695.htm>

Brown, Nik, 2003: Hope Against Hype. Accountability in Biopasts, Presents, and Futures. In: Science Studies 16, 3-21.

Bush, George W., 2004: President Bush Announces Formation of Independent Commission. White House Executive Order. <http://georgewbush-whitehouse.archives.gov/news/releases/2004/02/20040206-3.html>

Carlson, Robert, 2003: The Pace and Proliferation of Biological Technologies. In: Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science 1, 1-11.

Carter, Ashton, 1996: DOD News Briefing, 31 January 1996. U.S. Department of Defense. <http://www.defenselink.mil/trancripts/transcript.aspx?transcriptid=275>

Choffnes, Eileen R./Stanley M. Lemon/David A. Relman, 2006: A Brave New World in the Life Sciences. In: Bulletin of the Atomic Scientists 62, 26-33.

Chyba, Christopher F., 2006: Biotechnology and the Challenge to Arms Control. In: Arms Control Today 36, 11-17.

Cloud, John, 2001: Imaging the World in a Barrel: CORONA and the Clandestine Convergence of the Earth Sciences. In: Social Studies of Science 31, 231-251.

Dennis, Michael A., 1999: Secrecy and Science Revisited: From Politics to Historical Practice and Back. In: Judith Reppy (ed.), Secrecy and Knowledge Production, Occasional Paper #23. Ithaca: Cornell University Peace Studies Program, 1-16.

Duelfer, Charles, 2004: Comprehensive Report of the Special Advisor to the DCI on Iraq's WMD. <http://www.cia.gov/library/reports/general-reports-1/Iraq_wmd_2004/index.html>

Expert Group on Science and Governance to the Science, Economy and Society Directorate, Directorate-General for Research, European Commission, 2007: Taking European Knowledge Society Seriously. <http://ec.europa.eu/research/science-society/document_library/pdf_06/european-knowledge-society_en.pdf>

Findlay, Trevor, 2004: The lessons of UNSCOM and UNMOVIC. In: VERTIC Verification Yearbook 2004. London: VERTIC, 17-26. <http://www.vertic.org/media/Archived_Publications/Yearbooks/2004/VY04_Findlay.pdf>

Fingar, Thomas, 2009: Reducing Uncertainty: Intelligence and National Security Myths, Fears, and Expectations. Payne Lecture No. 1, Spogli Institute for International Studies, Stanford University, Stanford, CA. <http://iis-db.stanford.edu/evnts/5628/Payne_Lecture_No_1_Final--3-11-09.pdf>

Franz, David, 2005: Statement by Dr. David Franz. In: Hearing, Bioscience and the Intelligence Community. Committee on Homeland Security, Subcommittee on Prevention of Nuclear and Biological Attack, U.S. House of Representatives. 3 November 2005. <http://www.gpo.gov/fdsys/pkg/CHRG-109hhrg35695/html/CHRG-109hhrg35695.htm>

Gronvall, Gigi Kwik, 2005: Bioterrorism and the Life Sciences: Research and Policy Controversies. In: CSIS/HHMI Seminar Bioterrorism and the Life Sciences. Washington, DC, 15 April 2005. <http://www.csis.org/files/media/csis/events/050415_gronvall.pdf>

Hilgartner, Stephen, 2007: Making the Bioeconomy Measurable: Politics of an Emerging Anticipatory Machinery. In: Biosocieties 2, 381-389.

Institute of Medicine and National Research Council, 2006: Globalization, Biosecurity, and the Life Sciences. Washington, DC: The National Academies Press.

Kay, David, 2003: Statement on the Interim Progress Report on the Activities of the Iraq Survey Group, before the House Permanent Select Committee on Intelligence, The House Committee on Appropriations, Subcommittee on Defense, and the Senate Select Committee on Intelligence. 2 October 2003. <http://www.fas.org/irp/cia/product/dkay100203.html>

Kerr, Richard, et al., 2005: Collection and Analysis on Iraq: Issues for the U.S. Intelligence Community. In: Studies in Intelligence 49, 47-54.

Kerr, Richard, et al., 2006: A Holistic Vision for the Analytic Unit. In: Studies in Intelligence 50, 47– 56.

Koblentz, Gregory, 2009: Living Weapons: Biological Warfare and International Security. Ithaca: Cornell University Press.

Laipson, Eileen, 2005: The Robb-Silberman Report, Intelligence, and Nonproliferation. In: Arms Control Today 35, 20-23.

Leitenberg, Milton, 2005: Assessing the Biological Weapons and Bioterrorism Threat. Carlisle, PA: U.S. Army War College.

Lopez, George A./David Cortright, 2004: Containing Iraq: Sanctions Worked. In: Foreign Affairs 83, 90-103.

MacDougall, Alan, 2006: Statement for the Record, In: Hearing, Bioscience and the Intelligence Community (Part II): Closing the Gap. Committee on Homeland Security, Subcommittee on Prevention of Nuclear and Biological Attack, U.S. House of Representatives. 4 May 2006.

MacKenzie, Donald, 1989: Technology and the Arms Race. In: International Security 14, 161-175.

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

Office of the Director of National Intelligence, 2008: Intelligence Community Directive 205: Analytic Outreach. <http://www.dni.gov/electronic_reading_room/ICD_205.pdf>

Office of the Director of National Intelligence, National Counterproliferation Center, 2006: Biological Sciences Experts Group: Concept Paper. <http://www.fas.org/irp/eprint/bseg-concept.pdf>

Pease, Bruce, 2006a: Statement for the Record. In: Hearing, Bioscience and the Intelligence Community (Part II): Closing the Gap. Committee on Homeland Security, Subcommittee on Prevention of Nuclear and Biological Attack, U.S. House of Representatives.4 May 2006. <http://www.gpo.gov/fdsys/pkg/CHRG-109hhrg35695/html/CHRG-109hhrg35695.htm>

Peace, Bruce, 2006b: Oral Testimony. In: Hearing, Bioscience and the Intelligence Community (Part II): Closing the Gap. Committee on Homeland Security, Subcommittee on Prevention of Nuclear and Biological Attack, U.S. House of Representatives.4 May 2006. <http://findarticles.com/p/news-articles/political-transcript-wire/mi_8167/is_20060504/representative-john-linder-ga-holds/ai_n50588567/pg_2/>

Petro, James B./David Relman, 2003a: Understanding Threats to Scientific Openness. In: Science 302, 1898.

Petro, James B./David Relman, 2003b: Supporting on-line information. In: Science 302, 1898. <http://www.sciencemag.org/cgi/content/full/sci;302/5652/1898/DC1>

Petro, James B./Theodore R. Plasse/Jack A. McNulty, 2003: Biotechnology: Impact on Biological Warfare and Biodefense. In: Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science 1, 161-168.

Petro, James B., 2004: Intelligence Support to the Life Science Community: Mitigating Threats from Bioterrorism. In: Studies in Intelligence 48, 57-68.

Petro, James B./W. Seth Carus, 2005: Biological Threat Characterization Research: A Critical Component of National Biodefense. In: Biosecurity and Bioterrorism: Biodefense, Strategy, Practice, and Science 3, 295-308.

Prentice, Erik, 2011: U.S. Government Programs and Priorities — Part 2. In: Preserving National Security: The Growing Role of the Life Sciences. 3 March 2011. <http://www.upmc-biosecurity.org/website/events/201103-lifesci/videos.html>

Relman, David A., 2005: Statement of David A. Relman. In: Hearing, Bioscience and the Intelligence Community. Committee on Homeland Security, Subcommittee on Prevention of Nuclear and Biological Attack, U.S. House of Representatives. 3 November 2005. <http://www.gpo.gov/fdsys/pkg/CHRG-109hhrg35695/html/CHRG-109hhrg35695.htm>

Relman, David, 2006: Bioterrorism — Preparing to Fight the Next War. In: New England Journal of Medicine 354, 113-115.

Richelson, Jeffrey, 1998: Scientists in Black. In: Scientific American 278, 48-55.

Silberman, Laurence, 2005: U.S. Intelligence Reform and the WMD Commission Report. 4 May 2005. <http://www.aei.org/events/filter.all,eventID.1061/transcript.asp>

The Commission on the Intelligence Capabilities of the United States Regarding Weapons of Mass Destruction, 2005: Report to the President of the United States. <http://www.wmd.gov>

The White House, 2004: Executive Order 13328. 6 February 2004. <http://www.whitehouse.gov/news/releases/2004/02/20040206-10.html>

U.S. Central Intelligence Agency, 2003: The Darker Bioweapons Future. 3 November 2003. <http://www.fas.org/irp/cia/product/bw1103.pdf>

U.S. House of Representatives, 2005: Engineering Bio-Terror Agents: Lessons From the Offensive U.S. and Russian Biological Weapons Program. In: Hearing before the Subcommittee on Prevention of Nuclear and Biological Attack. Committee on Homeland Security, 109th Congress, 1st Session. 13 July 2005. <http://www.fas.org/irp/congress/2005_hr/bioterror.html>

U.S. National Research Council, 2011. Intelligence Analysis for Tomorrow: Advances from the Behavioral and Social Sciences. Washington, DC: U.S. National Academies Press.

U.S. National Intelligence Council, 2008: Global Trends 2025: A Transformed World. <http://www.dni.gov/nic/PDF_2025/2025_Global_Trends_Final_Report.pdf>.

Vogel, Kathleen M., 2008a: Framing Biosecurity: An Alternative to the Biotech Revolution Model? In: Science and Public Policy 35,45-54.

Vogel Kathleen M., 2008b: Iraqi Winnebagos of Death: Imagined and Realized Futures of U.S. Bioweapons Threat Assessments. In: Science and Public Policy 35, 561-573.

Vogel, Kathleen M., 2013: Phantom Menace or Looming Danger? A New Framework for Assessing Bioweapons Threats. Baltimore: Johns Hopkins University Press.

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

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

ISSN: 1861-3675

STI Studies

www.sti-studies.de

Comment

Visioneering Assessment
On the Construction of Tunnel Visions for Technovisionary Research and Policy

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Visioneering is a type of engineering. Introduced and described by Patrick McCray, it involves a lot more than dreaming up a futuristic vision. Visioneers are a combination of "futurist, engineer, and promoter." Aside from developing a "broad and comprehensive vision of how the future might be radically changed by technology," they articulate designs for the future with considerable technical know-how and sometimes in astounding detail, and they build a coalition of supporters that provides "valuable and hard-won space in which other scientists and engineers could mobilize, explore, and push the limits of the possible" (McCray 2012: 10-14).

Visioneering thus mobilizes skills, expertise, and resources to forge something much stronger than a narrative thread that more or less plausibly leads from the present to the future. What visioneering aims for is to exhibit a compelling causal link between a state A (technological work-in-progress) and a state B (a future so desirable as to mandate its realization) such that A will actually lead to B while B necessitates A.[1] By tunneling from A to B, visioneering effects among other things "the marginalisation and mainstreaming of narratives" (Coenen and Simakova, in this issue). And though the visioneers in McCray's book are rare and eccentric individuals like Eric Drexler or Gerard O'Neill, visioneering can also be viewed as a widespread collective activity that is done by expert committee, that enters into policy advice, technology assessment, or so-called ELSA research, and that leads to constructions of socio-technical scenarios or roadmaps. As such, visioneering is not just a kind of engineering but a powerful technology that secures the space in which science, technology, and society probe limits and our prospects of overcoming them. This technology literally comes first in that it heralds technological change, prepares the ground for research and development, and announces the accom-

[1] In Aristotelian terms, visioneering establishes A as the effective cause of B and B as the final cause of A. It thereby first seeks to identify an actual causal chain of events leading from A to B, and then offers B as a teleological end that is productive of this causal pathway as its means.

plishment of a future that is radically changed by this research and development. In contrast to the technological feats that come in its wake, the work of visioneering is already done, it happens right in front of our eyes, ready to be scrutinized. Accordingly, it is this technology that has to be assessed first, that is, before one starts considering future technological changes that are precariously premised on it.

Though the three papers by Kathleen Vogel, Arie Rip and Jan-Peter Voß, and Armin Grunwald appear rather heterogeneous at first, what they have in common is the fact that they go beyond Grunwald and Grin's proposal to include vision assessment in the toolbox of technology assessment (Grunwald/Grin 2000). Without using the term, all three papers address visioneering, how it works and how it needs to become explicitly recognized as a subject for STS engagement, as a matter of governance, and as a technology that requires technology assessment.

Kathleen Vogel (in this issue) shows this most pointedly when she conceives of a necessary intervention in the visioneering practice that she finds to be at work in a Biosafety Engineering Group (BSEG). She first exposes the preconceptions that efficiently link A to B and that thereby function as a precondition for rationality. These appear to be simple enough, indeed, as Vogel points out, too simplistic: In order to judge whether there is a bioweapons threat, all we need to know is that certain people are hostile and that there is a technical capability which these might be able to acquire. If these conditions are satisfied, the capability serves as a causal avenue from the current state A to a future state B of the bioweapons threat, while the attitude of hostility renders B so desirable that it all but necessitates A. This visioneering construction solidifies a kind of tunnel vision, but even so, those who are committed to it are unlikely to question it: Why should we bring in further considerations to enrich this threat scenario while simultaneously rendering it implausible?

At first sight, Vogel's account of the construction of tunnel vision towards a "what can be done, will be done" threat-scenario appears limited by the special conditions of paranoia and secrecy that apply to her case. It applies equally, however, to many "what can be done, will be done" hope-scenarios: In order to judge whether there is any prospect of vastly improved diagnostic capabilities, all we need to know is that people want to know ever more about their physiological states and that there are new technical capabilities which can be incorporated into products for the wellness market. Again, the capabilities are said to lead to the products, whereas the desirability of improved diagnostics all but guarantees that this causal pathway will be taken.

Somewhat simple-minded yet amazingly robust visioneered constructions such as these inspire technovisionary research, and this includes social science research as much as it does engineering practices. But STS scholarship must not be content merely to identify this mechanism. Vogel proposes a form of engagement that seeks to contribute complementary expertise which renders visioneering more difficult, yet better informed. There are after all many cultural, strategic and technological factors that determine whether or not a country will actually develop or deploy bioweapons. And the desirability of new diagnostic tools is likely to be constrained by the availability of pertinent therapies or by data-security concerns. Moreover, such STS interventions are necessary not only when experts are blinded by somewhat paranoid preconceptions. They are equally necessary, for example, where tunnel visions are engineered that link technical capabilities to the needs of an ageing population. Often enough, these needs are narrowly construed in terms of the presumed frailty, isolation and helplessness of older people. These constructions need to be complemented by geriatric, intergenerational, economic and philosophical perspectives that open up a set of wider considerations regarding the demands of a population of older, active and generally healthy people who want to be mobile in cities, who want to be helpful and productive, who want to be engaged in the arts and in politics and manage their lives.

The notion of the "ageing society" serves to legitimate technological research programs, but what programs it legitimates depends on how narrowly or widely the needs of the ageing society are conceived, and this in turn depends on the presumptions of those who put the "problem" of the ageing society on the public agenda. Such feedback loops figure centrally in Arie Rip and Jan-Peter Voß's discussion of "ageing research," "nanotechnology," and "sustainability science" as umbrella terms. These owe their designation as umbrella terms to the fact that they draw together and shelter a wide variety of actors who can gather, mobilize and become mobilized under such umbrellas (cf. Nordmann/ Schwarz 2010). This is not, however, what the authors mostly emphasize about these terms. Instead they consider them as terms that can be stretched to bridge the distance between A and B. And yet, though they refer to "umbrella terms" as a governance technology, they do so without showing how this technology has been engineered and without showing that the terms function as a governance technology because they effectively achieve a bridge between technological trajectories and desirable futures. In other words, Rip and Voß only hint at the ways in which their stretchable or pliable bridging terms are important elements in the tool set of visioneering (cf. Pörksen 2011; Wullweber 2008, 2010). If they were more explicit in this regard and considered the governance technology as a product of engineering, some of their observations and remarks would appear less puzzling and their account more compelling.

For example, their discussion of nanotechnology as a "grand challenge" for research is puzzling. At first sight, this appears to be a curious conflation – wouldn't it be more appropriate to conceive of nanotechnology not as a challenge but as the means to the end of meeting challenges that are defined as socially and perhaps globally relevant problems? And indeed, this is how research councils initially present the case for nanotechnology. Only as an effect of successful visioneering does it make sense to view nanotechnology itself as a grand challenge: Nano now designates the state A (technological work in progress: a technology push) as well as the state B (a society transformed by nanotechnology that constitutes a demand pull). Nanotechnology presents a grand challenge only when we see in it a promise so powerful and attractive that it demands to be realized, no matter what. This circular construction is a visioneering feat par excellence as "nanotechnology" now allows us to traverse back and forth across the bridge between the present and the future, between means and ends, between A and B. It is a significant feat in that it serves to institute innovation as an end in itself that can be justified without mentioning any particular societal problem or specific need.

Another puzzling claim figures centrally in their account, and again Rip and Voß take it for granted rather than exposing or explaining its strangeness. "Sustainability science" is offered as another umbrella term but one that has not been instituted as effectively as nanotechnology, even though sustainability science would appear to be required to pursue responsible research and development in the current day and age. Rip and Voß suggest that the struggles for the establishment of sustainability science are due to the existence of an alternative that goes by the name of earth systems science. But though there is some overlap between the two fields, it is a bit of a stretch to consider them rivals, if only because one seeks to describe the earth as a system whereas the other seeks to identify practices of managing the environment, locally and globally. Moreover, the need for a distinct sustainability science is not at all obvious when research and development becomes geared towards sustainability as a guiding principle for all fields of inquiry. In light of the general commitment to sustainability, it requires a special visioneering effort to establish sustainability science, that is, to establish the difference between innovation as a necessary means for the achievement of the most desirable end of sustainability (Brundlandt 1987), and the specific fortunes of an interdisciplinary research agenda dedicated to sustainability (Scholz 2011). Accordingly it is only against the backdrop of visioneering that Rip and Voß can identify the same process that is at work in rather dissimilar cases:

> "[N]anotechnology offers open-ended promises about what it might enable us to do, while sustainability science and global change research and earth system science reason back from global challenges to what scientific research should contribute. While the histories are different, the process is the same, with the two cases being at different phases: there are struggles linked to potential umbrella terms, a dominant term emerges and becomes established, at least for some time, as a conduit which allows protection of ongoing research as well orientation towards relevance to societal problems and challenges.
> [...] Thus there are two ways in which umbrella terms are a governance technology: they constitute an arena for struggles about definitions, access / exclusion and resources; and their eventual black-boxed use has effects precisely because the detailed struggles that went into them are eclipsed." (Rip/Voß, in this issue)

In their editorial, Christopher Coenen and Elena Simakova worry about the success of visioneering, be it the success of the intelligence community in defining security threats or the success of nanotechnology promoters in establishing technoscientific innovation as an end in itself for sustainable development. Is there any room left for "thinking in alternatives," they ask, or do we need to surrender "the ideal of a democratic shaping of science and technology" in light of "the proclaimed inevitability of the nano, transhumanist and similar futures"? "Fighting fire with fire," they suggest, might allow us to defend the democratic ideal and to open up spaces for imagining alternative trajectories of technological development. Kathleen Vogel proposed fighting fire with fire when she suggested that STS scholars engage the intelligence community in their visioneering efforts. More explicitly, Armin Grunwald (in this issue) opens a new chapter for technology assessment.

Though it may appear to be a subtle shift at first sight, one should not underestimate its significance: There is a kind of technology assessment that focuses not primarily on expected outcomes, consequences, side-effects or implications of an emerging technology but on its attendant visions. Here, the visions are seen as a given entailed by the funding programs and proposals for technological research. So-called vision assessment considers the peculiar qualities of these visions, questioning their plausibility, for example, or their implicit conceptions of the good life. A strong advocate of vision assessment himself, Grunwald moves on from there when, in effect, he calls for visioneering assessment. Now, he is no longer looking at visions as representations of an emerging technology but is shifting attention from the emerging technology to quite another technology, namely to the institution of the causal relations between A (technological work currently-in-progress) and B (a desirable future that will be produced by this technological development).[2] Visioneering assessment looks at the engineering process that has produced a compelling vision of a technological future.[3] It thereby not only determines whether we really have to take this compelling vision seriously, but also opens the black box of umbrella terms by exposing our struggles over visions of the future.

In particular, Grunwald suggests that the creation of technovisionary futures needs to be rendered transparent by employing an empirically grounded methodology that serves to counteract the apparent displacement of politics and the apparent absence of alternatives that require public deliberation. In particular, he recommends a research program dedicated to the biographies of techno-visionary futures, to their deconstruction and hermeneutic reconstruction. This research will result in an understanding of the elements that make up the various visioneering constructs – elements that range from appeals to history to normative conceptions of human-machine relations; from technological achievements as proofs of concept to ideas of what might, can, or should be possible in the near and distant future; from a diagnosis of unsolved problems in the present to anticipations of their technological solutions.

Missing from this list and only implied by Grunwald's proposal is research dedicated to past debates about techno-visionary futures. Often enough, the biography of a visioneering feat will reveal that it addresses familiar themes and dreams. Nanomedical visions hark back to those of "rational drug design," for example, and contemporary visions of synthetic biology, the hydrogen economy, or human enhancement can be traced back even further, sometimes to their premodern fairytale origins. This is of interest in its own right since it challenges contemporary visioneers to detail why they believe that the realization of a perennial dream is finally becoming a real possibility just now. While this qualifies as well as sharpens the techno-visionary futures under consideration, it does not yet open the space for "thinking in alternatives." This can be done however, when one steps away even further from the particular visioneering construction by considering not just its genealogy but also the reception of its previous incarnations. It is those who in the past rejected certain techno-visionary ideas who are most likely to point us to alternative conceptions of technological and human development. Instead of considering nanomedicine, for example, as yet another claim of transformative novelty, one might consider it as yet another chapter in the ongoing history of medical research strictly according to the natural science mode. This history has been accompanied throughout by alternative conceptions regarding the origins and treatments of disease, regarding medicine as an art, regarding limits of reductionism, regarding the nexus of biography and physiology, regarding public health and personalized medicine (Kohl/Nordmann 2010). These past debates are a resource not so much for the visioneers themselves but for democratic deliberation that cannot proceed freely

[2] What I am informally employing here is a definition of technology according to which it consists in the institution of causal relations or of ways of making things work together. According to this definition, a visioneering construction of policy expectations, coalitions of actors and funding schemes is a "technology" (that institutes effective and final causes as described in footnote 1) just as much as the physical institution of causal relations in a mechanical device.

[3] For a related proposal see von Schomberg et al. (2005) on foresight knowledge assessment. Since the quality of foresight knowledge cannot be determined by checking against the facts but only by considering its pedigree, what needs to be assessed is the process that produced this knowledge, including the people and the information that went into this process.

under visioneering assumptions of technological inevitability.[4]

References

Brundlandt, Gro Harlem, et al., 1987, *Report of the World Commission on Environment and Development: Our Common Future*, New York: United Nations.

Grin, John/Armin Grunwald (eds.), 2000: *Vision Assessment: Shaping Technology in 21st Century Society*. Berlin, et al.: Springer.

Kohl, Thorsten/Alfred Nordmann (rapporteurs), 2010: Ethical and Societal Aspects of Nanomedicine. In: *NanoMed: A Report on the Nanomedicine Economic, Regulatory, Ethical and Social Environment - NanoMed Round Table Extended Report*, Brussels: EC, 11-17.

McCray, Patrick, 2012: *The Visioneers: How a Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future*, Princeton: University of Princeton Press.

Nordmann, Alfred, 2010: Im Feuer schierer Sinnlichkeit oder: Lady Chatterleys Gegenargument. In: Coenen, Christopher, et al. (eds.), *Die Debatte über „Human Enhancement": Historische, philosophische und ethische Aspekte der technologischen Verbesserung des Menschen*. Bielefeld: transcript, 199-207.

Nordmann, Alfred/Astrid Schwarz, 2010: Lure of the 'Yes': The Seductive Power of Technoscience. In: Mario Kaiser et al. (eds.), *Governing Future Technologies: Nanotechnology and the Rise of an Assessment Regime*. Dordrecht, et al.: Springer, 255-277.

Pörksen, Uwe, 2011: *Plastikwörter: Die Sprache einer internationalen Diktatur*. Stuttgart: Klett-Cotta.

Scholz, Roland W., 2011: *Environmental Literacy in Science and Society: From Knowledge to Decisions*. New York: Cambridge University Press.

von Schomberg, Rene/Ângela Guimarães Pereira/Silvio Funtowicz, 2005: *Deliberating Foresight Knowledge for Policy and Foresight Knowledge Assessment*. Brussels: European Commission Directorate-General for Research.

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.

Wullweber, Joscha, 2010: *Hegemonie, Diskurs und Politische Ökonomie: Das Nanotechnologie-Projekt*. Baden-Baden: Nomos.

[4] And thus, even a novel like *Lady Chatterley's Lover* can contribute to debates about human enhancement and human flourishing, about nature and artifice, and the nontechnical construction of a "new woman" (Nordmann 2010).

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

ISSN: 1861-3675

STI Studies

www.sti-studies.de

Comment

Techno-visionary Science and the Governance of Intent

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It is fifty years ago that Martin Luther King spoke from the steps of the Lincoln Memorial in Washington D. C. and proclaimed 'I have a dream'. Speaking on the centenary anniversary of the Emancipation Proclamation, which freed millions of slaves in 1863, he lamented the slow progress that had been made towards racial equality in the United States. King's speech was one of vision and hope, but it was more than just a dream. It was also a call for action. "1963 is not an end" he cried "but a beginning…the whirlwinds of revolt will continue to shake the foundations of our nation until the bright day of justice emerges". He urged those in the crowd to "Go back to Mississippi, go back to Alabama, go back to Georgia, go back to Louisiana, go back to the slums and ghettos of our northern cities, knowing that somehow this situation can and will be changed". By making his speech he not only described his dream, but strived to influence the intentions and subsequent actions of others, in the hope that this dream would one day be realized.

Freedom of speech, freedom to question, to dream, hope, envision, even fantasize are fundamental human rights in democratic 'free' societies and have fuelled the advances in science and the arts that have been the hallmarks of civilization, as well as some of its darkest moments. This includes 'the right to freedom of thought, conscience and expression; freedom to hold opinions without interference and to seek, receive and impart information and ideas through any media and regardless of frontiers' and the freedom to 'to share in scientific advancement and its benefits'.[1] The fact that I am able to write my own thoughts here at all reflects these rights, and you are perfectly within your rights as the reader to then decry them as being of interest, of being worthless or however other way you wish to describe them.

Visionaries of techno-science are not excluded from such rights. Referring to works by Rip/Voss, Coenen and Simakova (this issue) describe techno-visionary sciences as being fields of research and development characterized by 'flows of scientific promises, reference to relevance and mobilization of resources and sponsorship'

[1] Universal Declaration of Human Rights. Available at: www.un.org/en/documents/udhr/index.shtml

that 'exhibit strong and contentious ideological features, shaped by visions of progress and revolutionary implications'. These visions involve 'statements about what is to come situated in a larger world of an imagined future', where expectations maintain 'an explicit conceptual link to time and an implicit link to tacitly – held knowledges' (Selin 2007: 198). As Grunwald (this issue) writes, they are promoted by 'mostly scientists, science writers and science managers', but also can include industry, policy and civil society organizations. Their visions do not necessarily imply likelihood, plausibility, credibility, authority, or legitimacy. Anyone can, and should be allowed to, have a dream.

Freedom of thought, vision and speech are one thing, intent however is quite another matter. Intention suggests that a decision to act, with one or more intended (and desired) outcomes, is being seriously considered or planned. The actions that result can have direct or indirect consequences, both good and bad. Such intentions can be motivated by the visions and dreams, however fanciful, held by oneself, or be influenced by the visions of others, whether they are Martin Luther King, dictators, religious leaders, or visionaries of techno-science who, as Grunwald goes on to write, "can have a particularly great influence on evolving scientific agendas" e.g. the intentions and subsequent actions of funding agencies and the outcomes that result.

The outcomes of one's intended actions may or may not transgress the acceptable norms of society and the values in which these are anchored. Intent, influenced by one's own visions or those of others, must therefore lend itself to ethical examination for moral agents who exert free will. If not the subsequent consequences may render oneself, or others, accountable, either legally in a court of law or morally to society. If, for example, in one of my own University lectures I influence the intentions of my students to engage in racial hatred, by persuading, encouraging, instigating, pressuring, or threatening I could be found to be committing a statutory offence of incitement. I must reflect on my own intention to lecture in this way in the context of existing moral, legal and social norms, before I act. If I then decide to continue to act in this way, with knowledge of these norms, I am being reckless. If I act and then claim ignorance of such norms I am negligent – I should have known. In both cases I am culpable and you would rightly expect me to be brought to account. Thankfully this is a situation I have never had, or intend, to face.

As Kathleen Vogel (this issue) documents, in instances where there is intention to act in breach of legal or moral norms, this may prompt a 'necessary intervention', before action and consequences occur.[2] One could envisage my doctoral student, on becoming aware of my intentions, sabotaging my presentation before I give my lecture, or changing the lecture venue without my knowledge. Intervention can be framed as a legitimate and responsible response, for example when the intention is to use biotechnology to develop or enhance weapons capability that poses a threat to nation states or their interests. Intent here should be controlled. Vogel's argument is that in such cases understanding contexts of use is critical, that a purely technical assessment (e.g., of technological capability) is insufficient, and that the social sciences have a legitimate role to play in broadening technology assessment processes to help understand, and anticipate, the intentions and underlying motivations of

[2] The film Minority Report (in which a special police department ('PreCrime') uses foreknowledge provided by three psychics known as 'precogs' to apprehend individuals before they commit crimes) provides an interesting fictional viewpoint on the concepts of foresight and necessary intervention.

actors who might use biotechnology for malicious ends, to protect people from its misuse. The 'problem of intent has social dimensions', she asserts (I might also add political and cultural dimensions) that necessitate evaluation of 'a broader array of social factors that can shape bioweapons development', supported by 'analytic tools… that better assess how intent (state, non state actor) shapes technical decision making in the development of weapons programs' and how changes in intent over time might evolve.

A simplistic logic here (and not one that Vogel posits) might be that the intention to use biotechnologies for the purpose of developing weapons is morally (and legally) unacceptable, and that intervention to control this is therefore justified once such intentions are clearly understood and there is sufficient evidence to suggest that the risk of such intention translating into action – personal, collective – represents a clear and present danger: or even before this moment. Clearly the legitimacy of such intervention not only depends on the quality of the evidence regarding, for example, technical weapons capability,[3] but also one's socio-political-cultural position: but this only serves to highlight Vogel's argument. It also reminds us that (as Langdon Winner (1980) famously noted) the constitution of technologies is as much political and social as it is technical, and in some instances may perhaps be 'unavoidably linked to particular institutionalized patterns of power and authority' (Winner 1980: 134) (see also Jorges 1999 for further discussion).

In law, intention can be described as being either direct or oblique. Both are problematic in the context of techno-visionary science. Direct intent occurs when a defendant embarks on a course of conduct to bring about a result, which then occurs. A scientist might use biotechnology to develop weapons with the specific intention of using them in acts of terrorism against civilians. Oblique intent occurs where the defendant embarks on a course of action to bring about a desired result, knowing that the consequence of his actions will also bring about another result. The scientist might use biotechnology to develop weapons to be used to target military installations, knowing that these installations are located in built up areas where civilian casualties will inevitably occur. He knows that his actions will result in the death of civilians, even though that may not be part of his desire and motivations to use biotechnology to develop weapons capability. In either instance he is culpable as he knows, at least with a good deal of certainty, that civilian deaths will happen as a result of his intended actions.

In such cases one might argue that the governance of intent is legitimate and indeed necessary. There may be an imperative to act, for example under a principle of a 'responsibility to protect'.[4] Unfortunately (and indeed fortunately) such cases of intentional dual use are hardly the norm for techno-visionary sciences. It is true to say that some areas of contemporary, techno-visionary sciences, such as 'sustainability science', seem at first glance to be defined by their purpose. Research into solar radiation management (SRM) geoengineering, for example, has the explicit purpose of understanding whether it could be feasible to intentionally manipulate the Earth's climate by increasing albedo (for example by envisioned techniques such

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[3] "The document discloses that his (Saddam Hussein) military planning allows for some of the WMD to be ready within 45 minutes of an order to use them'' *Iraq's Weapons of Mass Destruction: The Assessment of the British Government*: Foreword, Prime Minister Tony Blair. www.archive2.official-documents.co.uk/document/reps/iraq/iraqdossier.pdf

[4] http://www.un.org/en/preventgenocide/adviser/responsibility.shtml

as stratospheric deployment of particles), thereby mitigating global warming. However this purpose belies a plethora of intentions and underlying motivations. The 'visionary' may intend to widely promote and publicize this field of techno-science motivated by his own belief in its potential use for humanitarian, environmental, commercial, military or any number of other reasons. The research funder may have intentions of funding SRM research motivated by the desire, or mandate, to improve national scientific competitiveness, or as Rip/Voss (this issue) write, simply to 'spend funding in an interesting and useful way' (noting that 'the research funder' is not one individual person but a collective of individuals harbouring a range of intentions and motivations). The scientist researching such techniques on the other hand may have intentions to objectively and dispassionately produce understanding and knowledge, motivated by her own love of science and discovery. She may have no assumption that such knowledge will translate into application and use: indeed she may hope that the techniques she is researching will never have to be used, that this is not her intention. She may hesitate to 'trespass into future' (Selin 2007: 214) and diverse, potential 'contexts of use' may not be part of the narrative of intent: whether and how her scientific findings will be used, and by whom, is a decision for others, but one she may hope she can support by providing objective and robust scientific evidence. Her intentions might alternatively be motivated by, at least in part, the potential for commercialization, where she might benefit through patent protection. She may be prepared to colonize the future in light of her own agenda(s).

But this is mere speculation. In reality such intentions are often tacit, implicit and poorly articulated, or articulated only at a general level (e.g., within the strategies and delivery plans of research funders) that insufficiently engages with the specifics of the techno-visionary science itself and its social and political constitution. Intention to undertake 'geoengineering' research (or research under other umbrella terms such as 'sustainability science') becomes open to various, and sometimes wildly different, framings. Whether research in such areas as solar radiation management should be done at all becomes contested, since it may be viewed by some as being symbolic of intent, framed as an emerging national policy commitment where deployment is perceived as being a realistic, and even inevitable outcome, and where research signals the beginning of a new end of history.

So, even in such instances where the purpose(s) of techno-visionary science seems at first glance clear, the plurality of intentions and their attendant motivations cannot be assumed. It is not a simple case of terrorists intending to misuse biotechnology, if this is indeed simple – which it is not. As intent becomes entangled and contested – ethically, socially and politically –, how it is framed becomes key (Stilgoe 2011). And many areas of technoscience are far from clear in terms of how their purpose is framed, let alone motivations and intent. Some, such as nanotechnology, ICT and synthetic biology, which may act as what Rip/Voss (this issue) describe as 'umbrella terms' might in part be framed within a narrative of more general, enabling technoscience with no specific purpose, serving as interpretively flexible, and politically malleable, labels. Some, again in the same areas, may be targeted at 'grand societal challenges' (e.g. Lund Declaration 2009) which include targets such as life–long health and wellbeing and the 'War on Cancer' as their purpose. Rip /Voss describe these as strategic science, linking 'basic research to societal problems and challenges' – and in which there is 'packaging of social questions, opportunities, and scientific developments … labeled so as to carry rhetorical force' and which serve to mobilize resources, and stabilize and institutionalize fields of techno-science; some again might have only a very broad purpose(s) that may include a vague narrative involving the realization of economic or social impact, sometimes at the requirement of funders eager to demonstrate the public value of the research they fund. In all these narratives, space for, and articulation of (the potentially diverse) framings of motivation and intent infrequently appear (particularly during what Rip/Voss describe as the critical dynamic of research priority setting by funders) and are hard to discern from such homogenizing umbrella terms as 'nanotechnology'. This is in spite of observations that, as Rip/Voss conclude, 'actors in the world of science and science policy will use actual and potential umbrella terms for their own purposes', that 'actors … construct future expectations which may run in parallel with and contest each other, occupying different time frames and carrying different interests' (Brown et al 2005: 5) and that 'different actors use future claims to assert their politics' (Selin 2007: 197).

This problem is compounded by a landscape of social norms and values, and of techno-scientific visions, that is in constant flux. The technical, social and political constitution of techno-science is not an immovable feast. This is a messy world of (often unpredictable) use, re-purposing and recombinant innovation with impacts and consequences that can extend across borders, and across generations (Jonas 1984). The sea in which techno-visionary science charts an uncertain course is shrouded in the fog of ignorance, alternate framings, contestation, with paucity of knowledge and limited capacity for foresight: technically, socially, politically. In such an ever-changing seascape, linking techno-scientific visions through tacit and plural intentions to eventual outcomes is a challenge, one that some might argue is only worth investing time in where serious concerns of misuse are at stake.

The issue is that new techno-scientific domains are 'complex … and mutually constituted by networked actors' (Selin 2007: 207) with consequences and impacts that manifest over time as a result of emergent, ecosystem-level phenomena. Visions of techno-science cannot be discussed as if they are already upon us (Nordmann 2007). Their future consequences are not easily directly attributable to the intentions and actions of specific individuals. The ascription of direct or oblique intent is therefore difficult. The case and rationale for intervention, and its nature and timing, are often unclear and contested. This presents an interesting variant on Collingridge's control dilemma (Collingridge 1980). With limited foresight, and under such conditions of unpredictability and technical, social, political and cultural complexity, the response might be that the techno-visionary science governance challenge is best addressed by a quasi-Hayekian, laissez faire approach of choice by the market. Here the independent republic of science as Michael Polanyi (1962) described it is sovereign and the governance of intent has limited place.

But of course, there are various forms of governance which include intent in their remit, to varying degrees: codes of conduct for research integrity aimed at deterring those who harbour intentions to falsify data or plagiarize; formal processes of ethical review of research proposals where the intention is to involve people, animals or genetic material, underpinned by principles such as informed consent. Bioethics includes techno- science within its brief.[5] More broadly however, principles of scientific autonomy generally hold, and moral divisions of labor be-

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[5] www.nuffieldbioethics.org/sites/default/files/Emerging_biotechnologies_full_report_web_0.pdf

tween the undertaking of techno-science, and appraisal and response regarding its wider social, political and moral dimensions and consequences are clearly divided, subjecting scientists to what Bernard Williams (1981) described as moral luck. In this republic, science advances 'only by essentially unpredictable steps, pursuing problems of its own, and the practical benefits' (and I add risks) 'of these advances will be incidental and hence doubly unpredictable' (Polanyi 1962). The alternative, to more broadly govern intent, may seem like a form of Orwellian thought police or totalitarian state intervention that Polanyi had witnessed in the Soviet Union just prior to making his famous statements.

The progressive development and implementation of regulation to govern the introduction of technologies in society has reflected the limitations of governance by the market. Here, (through various forms of testing and assessment) impacts that are known to be harmful, for example to health or environment can be limited. David Collingridge, and many others since, have described the limitations of this evidence–based approach, including path dependency and technological lock-in. And the point is that regulation is directed at products at the point of market introduction (or after it) and not the motivations and intentions of visionary enactors far further upstream.

Market choice and regulation continue to play limited roles in the governance of purpose and intent for techno-visionary sciences. However, the ethical and moral dimensions, and dilemmas, posed by science and technology – including underlying motivations, intentions and purposes – have long preoccupied scientists, from nuclear fission, through genetic modification to the current deliberations concerning climate engineering. Various forms of multi-level governance have also emerged to fill the void, as a sort of third way. Rip/Voss (this issue) argue that umbrella terms are a 'de facto governance technology'. Grunwald describes how technology assessment of nanotechnology in 2004 by the Office of Technology Assessment at the German Bundestag performed a kind of 'boundary work' on nanofuturism. In the UK, in the same year, the Royal Society and Royal Academy of Engineering's report on nanosciences and nanotechnologies (Royal Society/Royal Academy of Engineering 2004) performed a similar function, exorcising visions of 'nanobots' and 'grey goo' which were considered to be a 'distraction' from the real issues, and focussing attention through expert analysis, and a measure of public and stakeholder deliberation, on (far less exotic) engineered nanoparticles: this framed the ensuing research program at the research councils that largely stands to date.[6] A similar report by the Royal Society in 2009 (Royal Society 2009) addressed the topic of geoengineering and its attendant scientific visions.

Other approaches have also emerged in the science and technology studies literature, including anticipatory governance, constructive, real-time and participatory technology assessment (see Coenen and Simakova, this issue), upstream engagement, midstream modulation, and (most recently) responsible research and innovation (Owen et al 2012; 2013). Some of these approaches place emphasis not just on governing the wider risks and impacts of techno-science and how to proceed under conditions of ignorance and uncertainty, but also on purposes, visions, motivations and intentions. They emphasize the need for socio-technical integration, inter- and trans-disciplinarity based on principles that include the need for continuous anticipation, reflection and deliberation

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[6] Or as Nordmann (2007: 34) asserts, scarce ethical resources 'must not be squandered on incredible futures, especially when they distract from on-going developments that demand our attention'.

which materially influences, or modulates, the direction and trajectory of techno-science itself.

These approaches seek, in various ways, to empower social agency in technological choice (Stirling 2008), whilst simultaneously enlarging the role responsibilities of scientists, and science funders (Mitcham 2003; Douglas 2003). But this does not equate to controlling intent. Governance is more about enabling (personally, institutionally, politically) the opening up of such visions, purposes and intentions to processes of anticipation, reflection and broadly configured deliberation, to develop what Michel Callon and others describe as hybrid fora (Callon et al 2009), and to facilitate mechanisms of responsiveness at many levels, from the laboratory floor to the development of research policy. Grunwald provides useful insights into some elements of what that might involve: seeking to understand the 'biographies' of futuristic visions (created and disseminated by authors, teams, scientists and science managers, or those emerging from within scientific communities), their historical roots and the resonances they may subsequently generate; undertaking epistemological deconstruction of techno-visionary futures; subjecting visions to prospective hermeneutical analysis to better understand their content and meaning, what is at issue, which rights might be compromised, which images of humankind, nature and technology are being formed and which designs for society are implied; and reframing participation to support such 'hermeneutical work'.

Governance in this context is less about control and more about developing capacity (Guston 2013). Cognizant of the lure of speculative ethics (Nordmann 2007) it should support what Grunwald suggests should be transparent, democratic debate about the 'different visionary futures put forward by different actors' and how these subsequently become translated. He suggests this can be supported by social science and science and technology studies research into the 'biography of visions, epistemological effort and explorative hermeneutics', where, as Coenen and Simakova (this issue) argue the 'vagueness' of meanings and their ambiguity can provide a legitimate location for enquiry. This might provide useful insights into 'who uses visions when and for what purpose' and 'the means to consider alternatives – historical, current and future' (see also Stirling 2008). This I suggest should be an honest, substantive and open process in which the social and political context of visions and intentions (and the ongoing process of their translation and appropriation) are opened up, resisting instrumental conditioning. Grunwald suggests this can 'prepare the groundwork for anticipatory governance'. Understanding, reflecting on and inclusively deliberating on techno-scientific visions, and the underlying intentions and motivations, forms the basis of such preparatory work, and governance should aim to enable, facilitate and develop capacity to do this, particularly to inform, support and legitimize decisions in, for example, research policy, and especially at the critical, 'clinch' points of research priority setting described by Rip/Voss.

These considerations place critical emphasis on two prospective framings of responsibility that are less about accountability – drawing causal lines between consequences and intentions – and more about care and collective responsiveness that I and others have described in more detail elsewhere (Jonas 1984; Richardson 1999; Pellizzoni 2004; Groves 2006; Adam/Groves 2011; Grinbaum/Groves 2013; Owen et al 2013). Non-consequentialist and prospective framings of responsibility such as these can accommodate consideration of purposes, motivations and intent while allowing for ambiguity, contingency, indeterminacy, uncertainty and ignorance. In a complex, uncertain world where discourses and representations of the future may be easily constructed for many reasons and by many people, where visions are transient, ever changing and ephemeral, where expectations can wildly oscillate between paradise and catastrophe, where, as Rip/Voss write, governance shifts from attempts to achieve a (common) goal to modulate processes so as to achieve one's own goals, where power politics, ignorance, uncertainty and unpredictability predominate, and where the links between diverse intentions and multiple consequences cannot easily be foreseen, this may be the best we can dream of.

References

Adam, Barbara/Chris Groves, 2011: Futures tended: care and future-oriented responsibility. In: *Bulletin of Science Technology Society* 31(1), 17–27.

Brown, Nik/Brian Rappert/Andrew Webster, 2000: *Contested futures: a sociology of prospective techno-science*. Cambridge, MA: MIT Press.

Callon, Michel/Pierre Lascoumes/Yannick Barthe, 2009: *Acting in An Uncertain World: An Essay on Technical Democracy*. Cambridge, MA, London: MIT Press.

Collingridge, David, 1980: *The Social Control of Technology*. London: Francis Pinter Ltd.

Douglas, Heather E., 2003: The moral responsibilities of scientists (tensions between autonomy and responsibility). In: *American Philosophical Quarterly* 40, 59–68.

Grinbaum, Alexei/ Chris Groves, 2013: What is the 'responsible' in responsable innovation? Chapter 7. In: Richard Owen/John Bessant/Maggy Heintz (eds.), *Responsible Innovation*. London: John Wiley, 119-142.

Groves, Chris, 2006: Technological futures and Non-reciprocal responsibility. In: *The International Journal of the Humanities* 4 (2), 57–61.

Guston, David H., 2013: "Daddy, Can I Have a Puddle Gator?": *Creativity, Anticipation, and Responsible Innovation*. Chapter 5. In: Richard Owen/John Bessant/Maggy Heintz (eds.), Responsible Innovation. London: John Wiley, 109-118.

Joerges, Bernward, 1999: Do Politics Have Artefacts? In: *Social Studies of Science* 29(2), 411.

Jonas, Hans, 1984: *The Imperative of Responsibility*. Chicago: University of Chicago Press.

Lund Declaration, 2009, *Conference: New Worlds – New Solutions. Research and Innovation as a Basis for Developing Europe in a Global Context*, Lund, Sweden, 7–8 July 2009. <http://www.se2009.eu/polopoly_fs/1.8460!menu/standard/file/lund_declaration_final_version_9_july.pdf>

Mitcham, Carl, 2003: Co-responsibility for research integrity. In: *Science and Engineering Ethics* 9, 273–290.

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

Owen, Richard/Phil M. Macnaghten/Jack Stilgoe, 2012: Responsible research and innovation: from science in society to science for society, with society. In: *Science and Public Policy* 39 (6), 751-760.

Owen, Richard, et al., 2013: A Framework for Responsible Innovation. Chapter 2. In: Richard Owen/John Bessant/Maggy Heintz (eds.), *Responsible Innovation*. London: John Wiley, 27-50.

Pellizzoni, Luigi, 2004: Responsibility and environmental governance. In: *Environmental Politics* 13(3), 541–565.

Polanyi, Michael, 1962: The Republic of Science: Its Political and Economic Theory. In: *Minerva* 1, 54–74.

Richardson, Henry S., 1999: Institutionally divided moral responsibility. In: Ellen Frankel Paul/Fred D. Miller/Jeffrey Paul (eds.), Responsibility. Cambridge University Press, Cambridge, 218–249.

Royal Society and Royal Academy of Engineering, 2004: *Nanosciences and Nanotechnologies: opportunities and uncertainties*. <http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/publications/2004/9693.pdf>

Royal Society, 2009: *Geoengineering the Climate: Science, Governance and Uncertainty*. <http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/publications/2009/8693.pdf>

Selin, Cynthia, 2007: Expectations and the emergence of nanotechnology. In: *Science, Technology and Human Values* 32, 196-220.

Stilgoe, Jack, 2011: A question of intent. In: *Nature Climate Change* 1, 325-326.

Stirling, Andrew, 2008: "Opening up" and "closing down": power, participation, and pluralism in the social appraisal of technology. In: *Science Technology and Human Values* 33, 262–294.

Williams, Bernard, 1981: *Moral Luck*. Cambridge: Cambridge University Press.

Winner, Langdon, 1980: Do Artifacts Have Politics? In: Daedalus, Vol. 109, No. 1. Reprinted in: Donald A. MacKenzie/Judy Wajcman (eds.), *The Social Shaping of Technology*, London: Open University Press, 1985; second edition 1999.