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›Tackling the Grand Challenges‹ Reflections on the Responsive Structure of Science

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Abstract

The goal of this paper is to analyze recent science policy discourses on ›grand challenges‹ and to compare them with traditional 20th century discourses on the relationship between science and society. In the first part, the history and the content of the ›grand challenges‹ discourse is outlined and the question is put forward whether this new discourse is more than old wine in new bottles. In the second part, conceptualizations of the relationship between science and society are presented in the form of eight ideal type discourses. Each discourse stands for a certain way of conceiving the science/society-interface. In the third part, the ›grand challenges‹ discourse is compared to these traditional discourses. It will be demonstrated that it is problematic to take the new discourse as face value. Rather, so the conclusion, it is necessary to systematically examine what the implicit assumptions in all these discourses are, and whether there is a way of avoiding the blind spots that are reproduced in the ›grand challenges‹ discourse as well as in its predecessors.

1. The ›Grand Challenges‹ Discourse

In recent years national and supranational science policy has been increasingly focussed on so called ›grand challenges‹. This concept has an interesting history. Some authors trace it back to David Hilbert's famous list of 23 unsolved mathematical problems, put forth in 1900 (Omenn 2006, P. 1696). These problems have bothered mathematicians for a century, thus the quest for their solutions triggered a lot of research within the discipline. As is well known from philosophers and historians of science such as Popper or Kuhn, problem solving lies at the heart of every scientific enterprise: There is no interesting research without interesting problems, thus ›grand challenges‹ are what makes science thrive. However, Popper talked about ›problems‹, Kuhn about ›puzzles‹, and both were aware of that the ›normal‹ problems dealt with by scientists were often and necessarily small and specialized. ›Grand challenges‹ therefore mean something different. The label as such emerged not until the 1980s in fields such as computational science (Wilson 1988) and artificial intelligence (Reddy 1988), and was picked up by different disciplines and research fields in the 1990s, mostly pointing to long term research agendas and emerging fields of interest. It is striking that the label from then on was increasingly associated with broad questions of societal relevance instead of inner-scientific puzzles. For example, in the early 2000s the concept gained prominence in connection with the ›global health‹ initiative, patronized by the Gates Foundation and the NIH (Varmus 2003). In this context, a grand challenge was defined as »a call for a specific scientific or technological innovation that would remove a critical barrier to solving an important health problem in the developing world with a high likelihood of global impact and feasibility« (Varmus 2003, p. 398). On the basis of more than 1000 proposals from scientists from all over the world, the initiative finally presented a list of 14 »Grand Challenges in Global Health«.

In the last decade, the label has been increasingly used in connection with global societal and ecological problems. Today, talk about ›grand challenges‹ is more or less synonymous with talk about ›societal challenges‹. Given the current discussion of the proposed EU framework programme for research and innovation from 2014 to 2020 with its estimated € 80 billion budget, it becomes obvious how important the idea has become. Besides the goals of »excellent science« and »industrial leadership« the EU commission strongly emphasizes as third key objective the tackling of »societal challenges«. This last point means that the new research agenda shall address »major concerns shared by citizens in Europe and elsewhere« (European Commission 2011, p. 5). More to the point, funding within the framework programme will be focussed on the following challenges, broadly circumscribed by the issues of health, food supply, energy, transport, sustainability, and security: (a) »Health, demographic change and wellbeing«, (b) »Food security, sustainable agriculture, marine and maritime research and the bio-economy«, (c) »Secure, clean and efficient energy«, (d) »Smart, green and integrated transport«, (e) »Climate action, resource efficiency and raw materials«, and (f) »Inclusive, innovative and secure societies«.

The discursive framing of the »Horizon 2020«-Agenda demonstrates once more that and how EU science policy is in search for new semantics. On the one hand, what used to be called ›basic research‹ has been redefined as ›frontier research‹ (Harris and Martin 2005; Nowotny 2010) and was successfully institutionalized in the European Research Council (ERC). On the other hand, what used to be called ›applied research‹ nowadays is embedded in the impressive rhetorics of ›grand societal challenges‹. Obviously, the old fashioned distinction of basic and applied research, as well as the notorious ›linear model of innovation‹ (Stokes 1997; Godin 2006) have been redressed in a much more fancy semantics. But is this really a new policy or just old wine in new bottles?

Such lists with either inner-scientific or societal grand challenges have become very popular and thereby developed their own dynamic (see for more examples: Omenn 2006). However, it is surprising that these lists are, at least in the European context, not as diverse and manifold as one would expect. For example, the Ministry of Innovation, Science and Research of the German Bundesstaat North Rhine-Westphalia recently launched a new science policy strategy (»Fortschritt NRW«), with the central message that the regional science policy has to set priorities in regard to the »grand societal challenges of our time« (MIWF 2013, p. 2). Surprisingly, the list of problems presented by the ministry is nearly exactly the same like the one of the European Commission, but without any reference to it. From a sociological perspective the question arises why it is that exactly these problems and not others have become central issues for science policy. Of course, somehow the list is formulated in a way that it covers more or less every topic one can think of, nevertheless it focusses certain aspects. For example, issues of poverty, education or unemployment are neglected. Also, other issues that are evidently of extreme importance in a global scale, are not in the focus, for example hunger, human rights, political and religious conflicts, environmental degradation (desertification, air and water pollution). It seems to be an interesting aspect of the semantics of ›grand challenges‹ that they are on the one hand intuitively plausible and convincing, so that on the other hand we do not ask further where they come from.

We don't know very much about how we actually came to our big problems, we don't know how and by whom the agenda we are confronted with was set.

To summarize, the ›grand challenges‹ discourse has two dimensions. First, it epitomizes a certain idea about the goal of scientific progress and about the role science plays in modern societies. Second, it defines what problems are urgent at the present. Taken together, the discourse aims at a science policy that pushes science to tackle these problems. Science is expected to be responsive to societal demands and science policy is expected to ensure that science actually takes this responsibility. What is important to note here is that there seems to be an implicit suspicion that science in itself is not responsive enough, so that a certain pressure from outside has to be exerted. In other words, the discourse builds on an implicit model of a non-responsive ›ivory tower‹ science system. The question whether this a realistic picture of science does usually not emerge. Also, given that the ivory tower accusation is an old hat, we have to ask again whether what we've got here is more than old wine in new bottles. To evaluate the potential of the ›grand challenges‹ discourse, it therefore makes sense to take a look at the more traditional conceptions of the science/society-interface and to ask afterwards what it is exactly that distinguishes the new discourse from older science policy discourses.

2 Discourses on the Relationship between Science and Society

What is presented in the following is a working list with possible models or conceptualizations of the relationship between science and society, based on the current state of research in science and technology studies. Of course such a list can never be complete, nevertheless it enables us to compare specific discourses in the light of other discourses of similar relevance. Therefore, the list points to the contingency of the respective discourses and helps to avoid narrowing the perspective to certain popular models. It is important to note that these discourses are present not only in science studies literature, but in different social contexts, not least in science policy. In a way they link science studies and society, i.e. models that are used more or less implicitly in science policy contexts can often be traced back to explicit models in science studies.

2.1 Higher and Professional Education

Although trivial at first sight, one of the most important linkages between science and society is the structure of higher and professional education. This linkage is emphatically stressed by the classic discourses on the idea of the university, especially in the Humboldtian principle of ›unity of research and teaching‹ (Boulton and Lucas 2008). The importance of this science/society-link is obvious given the fact that a significant share of the population in industrialized countries spends some years in a university before leaving for a non-academic career. Thus what is at issue here is a basic form of knowledge transfer via education. However, this transfer is linear and ›one way‹ insofar the students first visit the university and apply their knowledge afterwards in different societal contexts. Of course today most universities offer also continuing education for people with occupational experience, but usually this does not imply that the students can bring forth questions and problems from outside. Thus on the one hand the classic notion of the the university as a supplier of knowledge somehow runs counter the idea that academia responds directly to societal needs. On the other hand there has been much effort in the last decades to establish practically oriented study programmes. Many higher education reforms actually aim at closer linkages between the university and its societal, especially industrial environments. Today it is of crucial importance for universities to make plausible that their students will be well equipped for practical occupations after their studies. Interestingly, science studies do not reflect very much about this basic mechanism that couples science and society, probably because this issue is seen as a matter of higher education studies, not as a matter of science policy. For example, empirical research on knowledge and technology transfer in the context of ›entrepreneurial universities‹ focusses on the role of technology transfer offices, on commercialization via patents, or scientists cooperating with industry, but usually not on the millions of people that leave the universities every year and are intrinsically motivated to engage with society, whereas only a small portion of these graduates aims at inner academic careers.

2.2 Consulting and Expertise

Another classic interface of science and society can be subsumed under the category of consulting and expertise. The model here is that of a knowledge and technology transfer via experts that translate abstract scientific knowledge into practical expertise. Here science turns out to be immediately responsive, since there are clients asking (and paying!) for advice. There are various forms of interactive constellations between consultants and clients. First of all one has to point to the classic professions such as law or medicine, which can be defined as »exclusive occupational groups applying somewhat abstract knowledge to particular cases« (Abbott 1988, p. 8). In these cases, academic knowledge is both applied to and affected by everyday professional practices. Others forms of consulting and expertise are not as well institutionalized, but nevertheless crucial for most spheres of modern societies. Politics today depends in most of its subfields on scientific, not least on social scientific policy advice (Prewitt, Schwandt and Straf 2012). Also, starting in the late 18th century, modern industries have been more and more dependent on technical expertise by engineers and natural scientists. Furthermore, in the 20th century management consulting has become essential for the development of firms and companies, a field where economists, psychologists and sociologists translate their disciplinary insights into practice. In the legal system there is need not only for judicial expertise but also for all kinds of expert opinions for court cases, thus here again, different scientific disciplines are directly responsive to practical problems. The same goes for medical expertise, and, ever more urgent in regard to the development of the enormous potential of the life sciences, for ethical expertise.

Looking at the science studies literature, consulting and expertise has become a central topic of the field, especially in the last decade. In a programmatic essay, Harry Collins and Robert Evans (2002) proclaim a »third wave of science studies«. Whereas the first wave, that is the positivist history and sociology of science, aimed at explaining the success of the scientific endeavour in its search for truth, the second wave, that is the sociology of scientific knowledge (SSK), deconstructed the idea of objective knowledge and truth. The third wave, in contrast, no longer bothers about ›truth‹ and concentrates instead on the socially grounded categories of ›expertise‹ and ›experience‹. Thus Collins and Evans propose the new label Studies of Expertise and Experience (SEE). However, it is striking that most contributions to this field concentrate on matters of policy advice (e.g. Maasen and Weingart 2005; Grundmann and Stehr 2012). It seems that the intersection of science and politics is especially attractive for science studies scholars, probably because they suppose that this is the point of greatest ›impact‹. This is problematic insofar as the many other forms of consulting and expertise are not systematically taken into account when it comes to evaluating the responsiveness of science to societal needs.

2.3 Innovation and Entrepreneurship

The innovation discourse is probably the most influential science policy discourse in the second half of the 20th century. It basically conceptualizes the relationship of science and its societal environment as knowledge and technology transfer from science to the economy. In the 1950s, a linear model of innovation emerged that conceived of this transfer as a one dimensional flow from ›basic research‹ via ›applied research‹ and ›development‹ to ›production‹ (Stokes 1997; Godin 2006). This idea has dominated innovation discourses for decades. However, the actual term ›linear model‹ became popular not before the 1980s, and served from then on as a straw man, a foil against which more elaborated accounts of the innovation process could be launched (Edgerton 2004). In the meantime, numerous authors have criticized the linear model as too narrow; in reality, they state, the relationship between science and technological innovation is much more complex (e.g. Rosenberg 1991; Wengenroth 2000). And yes, of course it is. However, the question is whether it helps to refine the model by suggesting dialectical interdependencies and feedback loops. Actually, a certain kind of linearity and the idea of knowledge and technology transfer from science to the economy is still at the core of today's innovation discourses. For example, in the 2000s there has been abundant research on spin off companies and technology transfer offices (TTO). Behind this lies the idea that the knowledge transfer may be optimized by the right organizational arrangements. At the same time, empirical studies demonstrate that often these transfer strategies are not very successful (Knie, Simon and Flink 2010). In other words, such forms of mediated knowledge and technology transfer are certainly important, but may be overrated in their actual relevance.

Another important moment of innovation discourses ist the value of entrepreneurship, understood as a creative and innovative capacity of both individuals and organizations. In the older science studies literature, it is often assumed that academic scientists and traditional universities are dominated by a specific academic value structure that radically differs from the entrepreneurial ideal that is mostly associated with business and commerce. However, in the meantime several studies stress that the difference may not be that absolute. Beginning from the late 19th century there are numerous examples of scientists behaving in an entrepreneurial way and of universities building linkages to industry (Shapin 2008). Building on such insights, innovations discourses push the ideal of the ›entrepreneurial scientist‹ and of the ›entrepreneurial university‹ (Etzkowitz 1983; Clark 1998; Potter 2008; Lam 2010).

2.4 Public Understanding of Science

Starting in the 1980s, several initiatives aimed at improving the communication between science and the general public. Such initiatives were labeled as ›public understanding of science‹ (PUS).

In the beginning this concept implied a problematic notion of the public that later was criticized as »deficit model« (Wynne 1991; Ziman 1991): Lay people were conceived as hostile towards science because they don't know enough about it (»scientific illiteracy«). If only they knew more, so the expectation, they would become more science-friendly, and ultimately the relationship between science and society would become more fruitful. However, the idea that there is a positive correlation between individual knowledge about science and personal appreciation of science was not corroborated by empirical research (Bauer, Allum and Miller 2007). Thus, starting in the 1990s, the initial model of ›public understanding of science‹ was replaced by more dialogical models, the idea being now that the public is not only an audience, but should be actively engaged in issues of science and technology. In the 2000s, slogans such as ›public engagement with science and technology‹ (PEST) emerged, 1 and anthologies describing the state of the art of the field have titles such as ›science communication‹ (Bauer and Bucchi 2007) or ›public communication of science and technology‹ (Bucchi and Trench 2008). Nevertheless, many activities still are grounded in the trivial problem that experts have to communicate their knowledge to lay people. This is necessarily an asymmetrical constellation and in most cases, a two-way dialogue is wishful thinking. Thus in the discourse of PUS and PEST there is a lot of talk about science being responsive to the public, but in practice, it is still the public that has to listen. At the same time, the whole discourse builds (often implicitly) on the belief that most scientists have to be either motivated or even coerced to leave their ivory tower and talk to the public. To put it in a nutshell: In the beginning the discourse was about how to make to public listen, later it was about how to make scientists talk about their work and how to make scientists listen to what society says. Thus the discourse builds on the implicit model of a network of coercion, as if nobody would talk to each other if not reminded to do so.

2.5 Research Funding and Agenda Setting

The four discourses discussed so far have a common denominator: In some way or another they conceive of the science/society-interface basically as a transfer of knowledge from science to society – via education, via expertise, via entrepreneurship, or via public communication. The next four discourses differ from this insofar as they lay much more weight on the mechanisms by which society »speaks back« to science (Nowotny, Scott and Gibbons 2001, p. 54). Here we enter the fields of research funding, of science policy, and of science and technology governance.

The most basic mechanism by which society speaks to science is by way of money. Given this trivial insight, David Edgerton has recently proposed that science studies should more systematically »follow the money« to find out what kind of research at a given time in a given society is deemed relevant (Edgerton 2012). Thus money is not only crucial in regard to economically grounded innovation processes, but also indicates quite precisely what research is politically desired. Since the emergence of science policy as a central policy domain of modern nation states in the course of the 20th century, science necessarily has to listen both to what politics has to say and what the economy has to say, for the simple reason that it depends on resources that it could not organize itself. Analytically, one can distinguish two ideal typical models of science

1 In 2002, *Science* magazine commented this new notion under the headline »From PUS to PEST«.

policy. First, the science system may be maintained for its own sake, for example as cultural institution; here politics, in the name of the broader public, takes the role of a patron. Second, science may be supported because certain kinds of goods are expected, be they of economic or military value, or be they public goods. In this case, politics acts as a client, expecting certain services for the money invested. In this second case, policy makers tend to influence the research agenda, trying to motivate scientists (with more or less pressure) to do a certain kind of research: For example, to take to most prominent historical example, to build atomic weapons, or, to take a more recent example, to engage in nanotechnology. The important point here is that this goes again with an implicit ivory tower-model of how science works: The assumption of such agenda setting policies is that science in itself is not responsive to societal needs, but can be made responsive by way of financial constraints. Agenda setting discourses are therefore a prominent issue both in academic science studies and in science policy for some decades now. The same goes for foresight studies (Irvine and Martin 1984; Martin and Irvine 1989) and for more recent discussions on democratic and deliberative processes concerning the choice of research problems (see the notes below on the discourse on science, values, and democracy).

2.6 Responsibility and Accountability

Discourses about research funding, agenda setting and foresight revolve around the positive impact science has in terms of useful knowledge. However, the impact of science is a double-edged sword. New knowledge and technology brings not only progress, but has unintended consequences, side effects and risks. Responsibility discourses and accountability discourses represent two forms of dealing with this problem. The first aims at the moral stance of the scientist and his duty to reflect about the consequences of his work (Jonas 1979; Forge 2008). The second is more pragmatic and based on the idea that scientists should generally be accountable for their work. Since they as individuals may not foresee all the aspects and consequences of their research, they should at least make their work as ›transparent‹ as possible, thus enabling other observers to reflect and regulate the science system in regard to broader societal interests.

These discourses became prominent in the late 1960s and 1970s, when the negative consequences of scientific progress became obvious, for example in the form of environmental degradation or in the form of nuclear threat. The problem was discussed both within and outside academia, not least in science policy. As a result of these reflections, procedures of risk regulation and technology assessment were proposed and institutionalized as forms of conflict management and policy advice. These discourses are relevant not only because they paved the way for reflections about how society can speak to science, but also because they had an important function for science itself: They served as a legitimation strategy, since they enabled scientists to position themselves vis-à-vis society with the promise to take responsibility (Krohn and Küppers 1989, p. 118f.; Luhmann 1990, p. 715). In the ideal case, if scientists plausibly communicate that they know about their responsibility and that they are willing to account for what they do, this will result in trust. Here, again, the issue is about the responsiveness of science to societal expectations and anxieties. The interesting point with this constellation is that the responsiveness is on both sides: If the public or politics has the impression that science behaves irresponsible or is not willing to be accountable, it may respond by imposing stricter rules for scientific practice. That means that there is a genuine motivation for scientists to be proactively responsive to these issues, for it may have negative consequences for the freedom of research if they were not.

2.7 Transdisciplinarity and Participation

Although there is no single definition of the concept of transdisciplinarity, most commentators today define it basically as a kind of research that transgresses the boundaries between science and society. Furthermore, transdisciplinary science is usually seen as oriented on problems of general societal relevance. Thus, the concept is more radical than the older notion of interdisciplinarity, which aimed at overcoming the boundaries between disciplines, but which did not imply that the choice of problems is determined by extra-scientific considerations. Therefore, some authors have commented that it would be more appropriate to talk about ›trans-science‹ instead of ›trans-disciplinarity‹ (Bogner, Kastenhofer and Torgersen 2010, p. 13). Starting in the 1990s, the idea of transdisciplinarity has become a major issue in discourses about relationship between science and society. To understand its trajectory, it is helpful to compare it with the structure of innovation discourses. The latter are mainly concerned with the coupling of science, technology, and the economy, and they often focus on the technosciences and the life sciences. In contrast, transdisciplinarity discourses emphasize the relationship of science, politics and the democratic public. They focus on issues of ecology and sustainability, thereby including the ecological sciences, but also the social sciences and humanities, i.e. disciplines, that are not very relevant in innovation discourses. Prominent topics in transdisciplinary research are for example climate change, alternative energies, resource management, or food and agriculture. However, the concept of transdisciplinarity is not restricted to these issues, rather it has originally been proposed in a much more general sense concerning the whole idea of science and education (e.g. Jantsch 1972).

Nevertheless, starting in the late 1990s it became common usage to use transdisciplinarity mainly in regard to certain prominent societal and ecological problems. Hand in hand with this focus goes the ideal of public participation. Today, most authors assume that transdisciplinary research necessarily has participatory elements (Burger and Zierhofer 2007). The goal is, in other words, to systematically integrate as many civil society stakeholders as possible. They may take the role of ›practice partners‹ in local research projects, or they may be consulted and asked for their opinions within the framework of Citizen Conferences or other formal procedures. In strong versions of ›community based research‹ the idea is that these external partners have an equal position to that of the scientists (Pereira, Vaz and Tognetti 2006). In the literature, strong participation ideals are also debated under the heading of ›extended peer communities‹ (Funtowicz and Ravetz 1993). To summarize, following the transdisciplinarity discourses, it seems that public participation is increasingly understood as a constitutive element of scientific progress. Recently a new journal has been established that exclusively aims at how such participation works and can be managed. 2 What we’ve got here is a very strong variant of the idea that ›society

2 *DEMESCI – International Journal of Deliberative Mechanisms in Science*. On their webpage, the journal presents the following mission statement: »The Journal of Deliberative Mechanisms in Science (DEMESCI) is an international journal that publishes original works on the relationship between science and the rest of society. Specifically, the articles provide insight into areas like public participation in scientific decision-making. DEMESCI is oriented towards the academic world, stakeholders and all types of collectives interested in

speaks back to science‹: In ideal typical transdisciplinary research projects, stakeholders of the civil society do not only participate in setting research priorities, but also in actually performing the research. Of course it is another question whether this works in practice.

2.8 Science, Values and Democracy

Most of discourses discussed so far are an integral part not only of science and technology studies, but also of practical science policy. The final discourse presented here is different, since it conceptualizes the way society talks to and influences scientific practice on an abstract and theoretical level. It revolves around the classic postulate, prominently put forward by Max Weber, that science should be free from value judgements (Weber 1988; Albert and Topitsch 1979). As is well known, Weber distinguished sharply between the societal sphere of politics, where values were central, and the societal sphere of science, where values are legitimate only in regard to the choice of research problems, but not in respect to the choice of theories and methods. However, this postulate of value-neutrality has been highly controversial ever since. For example, Thomas Kuhn pointed out that theory choice is never fully determined by empirical data and therefore also influenced by values (Kuhn 1977). Such values can be epistemological and cognitive, thereby representing inner-scientific norms and paradigms, but they may in principle also be non-epistemic, thus representing social, ethical or economical concerns. The point here is that the problem of underdetermination of scientific theory goes hand in hand with the problem of value-ladenness of scientific knowledge. Hence the question of what role values actually play in scientific practice has occupied philosophers of science for some decades now (Laudan 1984; Proctor 1991; Lacey 1999; Longino 2002; Machamer and Wolters 2004; Carrier, Howard and Kourany 2008; Douglas 2009). This discourse is mainly maintained by the philosophical subfield of social epistemology. STS scholars have long taken note of these insights, and of course they couldn't agree more, since these postulates are a backup for many social constructivist accounts of science. However, STS scholars did not really participate in the discourse about different kinds of values, probably because it was too philosophical and theoretical. The philosophers, on the other hand, pushed their discourse further; in the 2000s, they began to reflect systematically about its political consequences. The result was the idea that if science is value-laden, then it can no longer withdraw from political issues, but rather has to actively engage with questions of democracy (Kitcher 2001; Fuller 2007; Brown and Menke 2008; Brown 2009). This is the point where the philosophical discourse merges into the discourses on research funding, agenda setting, transdisciplinarity and participation, since one basic point of scholars such as Philip Kitcher is that from a democratic viewpoint, the autonomy of science should be restricted to meet the societal needs of a given time. That is, science should continue to seek the truth, but it should at the same time concentrate on »significant truths« (Kitcher 2001, p. 65), or in other words, in »truths that matter« (Kitcher 2004, p. 54) – and what ›matters‹ depends on the deliberations of the democratic public.

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the boom especially during the last two decades of activities and methodologies related to the public participation in science and technology. In this respect, DEMESCI not only intends to come up with a better understanding of the application of these mechanisms in different contexts, but also to encourage their development and to maximize the impact both on the scientific community and the involved social groups and institutions.«

3 The Responsive Structure of Science

The eight discursive formations presented in the last section are ideal types, and the list does not, as already noted, claim to be complete. Nevertheless the list enables us to compare some of the most common ways of thinking about the relationship between science and society. The first four discourses were centered on different models of knowledge transfer, thereby respectively highlighting the interfaces of (1) education, (2) expertise, (3) entrepreneurship and (4) public communication. The common denominator of these models is that science speaks to society. In contrast, the second four discourses focussed different media by which society influences, more or less directly, the way of the scientific enterprise. The idea is that society speaks to science (5) via money, (6) via regulation, (7) via participation and (8) via values.

Looking again at the discourses on ›grand challenges‹, we can now ask whether they actually imply, if compared to the traditional ideal types, a new way of thinking about the relationship between science and society. Two aspects of the ›grand challenges‹ discourse were emphasized above: First that science is expected to be responsive to societal demands, and second that science policy is expected to ensure that science actually takes this responsibility. Both claims are to be found in several of the other discourses as well, thus at first sight there isn't much novelty in the new discourse. It seems that the new semantics basically refer to the innovation discourse on the one hand, and to the transdisciplinarity discourse on the other hand, thereby merging two discourses, while at the same time ignoring most of the other interfaces between science and society. Of course, one could argue that there is a strong agenda setting aspect in the semantics of ›grand challenges‹, but at the same time the agenda turns out to be closed already, since the problems are given in an essential sense, not as the result of democratic deliberation. At least, the ›grand challenges‹ discourse does not rely on the simple notions of knowledge and technology transfer only, it goes beyond the ›linear model‹ and does not stick to old concepts such as ›applied research‹ or ›strategic research‹. Nevertheless it picks out only two or three concepts of the science/society-interfaces as its primary focus, ignoring that there are many other ones. So the implicit assumptions and blind spots of 20th century science policy discourses are relocated, but not overcome.

What follows from this comparison? If we take the idea of ›grand challenges‹ serious, we must be careful not to restrict our view by implicit presuppositions. The eight ›traditional‹ discourses on the relationship between science and society and the new ›grand challenges‹ discourse in science policy have a common denominator that remains implicit in most discussions: They all build on the assumption, that scientists have to be motivated or even compelled to engage in societal relevant problems. Behind this lies again the ›ivory tower‹-image of science, i.e. the idea that scientists, if given free rein, would only delve in inner-scientific puzzles without any broader societal relevance. They would, in other words, not tackle the ›grand challenges‹. But is this really the case? Actually we don't know, since there is no systematic research on the responsivity of science. Rather, most empirical studies are framed by one of the given discourses, thereby relying on implicit premisses that exclude the possibility that scientists may be responsive to societal needs in ways that are not conceivable within the traditional thinking of STS and science policy. Let’s therefore assume, just as a thought experiment, that the real world of science is not as simply textured as portrayed in the common discourses. We can for this reason pick up and vary an old tenet of the sociology of science literature: As we all know, in the 1940s Robert Merton issued his ideas on the normative structure of science, thus stressing the autonomy of scientists vis-à-vis the political struggles of their time (Merton 1973). Today, 70 years later, we know very well about the ideological bias of this concept. But we have yet to learn what kind of structures are constitutive for the modern system of science. It is not enough to conceive of science as either autonomous or, as many STS scholars do, as quasi-political struggle for power and authority. Rather, the normative structure of science is in constant flux, and challenged by other values. Thus, we may think about whether there may be a complementary responsive structure of science, i.e. a set of norms and values that determines the ways science reacts proactively to problems in its societal and natural environments. Finally, given this conception, we can ask whether science policy discourses support and sustain this responsive structure, or whether they erode this structure by way of focussing the »pressure of practice« only (Carrier 2011). In other words: The science policy discourses are not irrelevant, in the opposite, they construct a certain social reality. The reality sketched by recent discourses on the potential of science to tackle the ›grand challenges‹ is at first promising, but it may be delusive. At second sight it may turn out that exactly the ›grand challenges‹ discourse makes the solutions more difficult because it restrains science and science policy to certain preconceived notions of the interaction with the wider society, thus curtailing the actual potential of a science system that may be more responsive than we think.

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