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Technology assessment as policy advice

Introduction

Technology assessment (TA) as technology research and policy advice has been under scrutiny, sometimes even pilloried, since its beginnings. From time to time, we also receive reports of its demise. A brief preliminary remark may be appropriate here.

Messages about the demise of this TA concept – often referred to as the classic concept – can be heard in very different discussion contexts. One of these is the criticism of TA as an expert event, often with the implication that a democratic process of technology assessment by laypeople should be organized (instead). Embedded in overarching debates about extended opportunities for citizens to co-determine and shape environmental and technology-specific planning and decision-making processes in politics and administration, citizens' forums, consensus conferences, sometimes also planning cells (and citizens' expert opinions) are discussed as contrasting with "elitist" TA and as a medium for the "democratization of expertise" (Saretzki 1997). It is not always entirely clear whether this conceptual discussion is taking place with the intention and result of supplementing or replacing expert advice.

Criticism of expertise and its cognitive and social limits has highlighted many of its deficits, and the loss of trust in experts has evident and justifiable causes. However, I have yet to see any convincing arguments as to how democratized expertise could *substitute* the problem identification and problem-solving skills of experts in an equivalent way.

It would therefore probably make more sense to install and test new "forms of problem-related cooperation between different knowledge carriers and certain groups of affected parties, interested parties, and decision-makers" (Saretzki 1997, p. 306). As a result, the field of policy advice would be characterized by different but complementary communication relationships between science, politics, business, and citizens (and thereby also between expert and lay understanding). However, it will hardly be possible to do without the reflexive and strategic skills of experts – also for the formulation of scientific, technical, and social goals and paths in the globalized risk society. However, traditional expertise must face criticism and questions.

Since the first hesitant steps toward establishing its practice – and especially with regard to its institutionalized forms – TA has been accompanied by the question of its implementation and "effectiveness" (Petermann 1991, p. 151ff.), including the accusation of lack of impact. The question of the "implementation" of expertise in political action is legitimate, and the question of inconsequential research is rightly raised. However, it would be desirable to recall some of the internal structural features of scientific policy advice and its essential framework conditions when discussing it.

In the following, I will highlight such structural and framework conditions of TA as policy advice and at the same time address some myths and misunderstandings that obstruct or impede the view and understanding of TA (and policy advice in general) and its possibilities. I do this in three steps:

- Firstly, I would like to remind you that policy advice, especially when it takes place in close communication processes, can only be adequately understood in terms of its possibilities if it is understood as a social process. In this process, two professions cooperate with each other. They do this not only rationally, but also irrationally, not only factually, but also emotionally (Bonus 1982). As two different professions with different perspectives and prerequisites relate to the same subject in the counseling process, it must be taken into account that counseling is always also a social competition – "competitive cooperation." This is not least about prestige, status, and power. "Implementation problems" (and possibly lack of consequences) are already inherent here.
- Secondly, it must be taken into account that the object to which the process of "self-consultation" is directed with practical intent is a highly presuppositional section of social reality. It is not without reason that research into the characterization of innovation and diffusion resorts to terms such as chaotic, invents attributes such as "Tolstoyan" and takes refuge in images of "rat race dynamics" and "crazy companies" (Ausubel 1991). If one reviews even a fraction of the research on the genesis and use of technologies or on innovation and diffusion processes, it should be clear how misguided the idea of precise "control knowledge" is, which could be used to shape such processes in a targeted manner and according to universally agreed criteria.
- Thirdly, the fact that the addressee of TA (as policy advice), state policy, is neither the sole actor in the shaping of development processes, nor is it homogeneous as an actor, must be addressed. In addition, its capacity to act and its creative competencies suffer from the fact that state policy is fragmented both vertically (municipalities, federal states, federal government,

European Union (EU)) and horizontally (departments, committees). In view of the reality of a multi-level political-administrative system (Zürn 1996), an image that focuses on the unitarist nation state as a central center of state control is a travesty. It is far more accurate to imagine a state that is a *player in* the technology policy arena together with a large number of other economic and social players.

The discussion of these three aspects of the "consequences" of TA as policy advice should, I hope, at least help to put some hasty diagnoses of implementation blockages, unsuitability for use, or lack of impact into perspective and to arrive at a realistic assessment of the possibilities of TA.

1. Counseling as a process (The difficult dialogue)

The dialogue between science and politics has long aroused the interest of external observers or prompted participants to write partly scientific, partly anecdotal reports of their experiences. Scientists in particular describe and analyze their encounters with people from the political profession – sometimes as if they were immersed in another culture and were confronted (like a traveler or ethnologist) with foreign customs and traditions (Hoffmann-Riem 1988). The diverse experiences have one small common denominator: Cooperation between science and politics is not without its pitfalls.

A first misunderstanding would therefore be to understand scientific policy advice (only) as cooperation based on trust and perceived as helpful.

In an idealized and exaggerated view, science and politics are different worlds. Hence the talk of "communities," "ethnosociologies," and "linguistic communities," whose respective logics of action and rationalities (Petermann 1988, p. 418) are not always compatible with one another. From the wealth of field reports and the empirical and empirically enriched research on policy advice, we can gain a picture of the relationship conflicts between science and politics.

Their collaboration often resembles a complicated love affair full of disappointed expectations. It is therefore not surprising that an experienced observer of the consulting scene has come to the conclusion that scientists and politicians often "prefer to operate in an atmosphere of polite and mutual contempt," and do so with a "distance that roughly corresponds to the social distance between competing tribes" (Horowitz 1976, p. 48; see also von Thienen 1990). Much of what we believe we can diagnose as implementation blockages is probably due to these personal and system-related communication problems.

A second misinterpretation of scientific policy advice is based on the assumption that scientific rationality is superior to political rationality.

Even the – transitive – concept of consulting implies (unlike the reflexive form of "consulting with") the premise of a specific asymmetry in the relationship (von Thienen 1990, p. 173ff.), so that the distribution of roles between politics and science is quite clearly pre-structured. The "shaper of society," writes G. Weisser, referring to politicians, "desires interpretative help in fundamental decisions and instruction on the basic types of shaping social life that are historically available for selection" (1961, p. 96). In such a perspective of an "asymmetrical advisory relationship," the advisor is

> [...] a confident of the decision maker, helping to bring order and perspective to the other voices and helping him/her to weight the different alternatives and their likely consequences (Zetterberg 1962, p. 187).

Accordingly, sources of this kind contain images of the function of science as a "signpost" or "lighthouse." However, the metaphor of the orienting map and the paths marked therein for the consulting product is also not uncommon.

In this perspective, scientific information is often characterized, if not "already by the property of being true," then at least by being "the product of an institution that has privileged ways of establishing the truth" (von Thienen 1990, p. 174). Furthermore, this idea has the consequence that the (probably widespread) selective use by the recipients of advice is classified as an "exploitation" of the "legitimation potential" of science "under false pretenses" (Schneider 1989, p. 318).

This illuminates an interesting aspect of the apparently entrenched myth of the science-practice relationship: Science provides objective facts and rational problem-solving knowledge – or even "truth" (Wildavsky 1979). If anything other than direct and unadulterated use is made of it, this is the result of tactical power and other calculations, the triumph of the instrumental rationality of politics over the substantial rationality of science. However, the assumptions underlying this relationship of superiority and inferiority are not necessarily convincing. After all, is scientific knowledge really so superior to common knowledge (ordinary knowledge)? Is scientific knowledge unambiguous or at least consensual? Rather no, if we bear in mind the trench warfare between disciplines when it comes to complex problems ("wicked problems"). Is scientific knowledge capable of increasingly resolving ignorance? Here too: Rather no. Rather, it is likely to be the case that as knowledge increases, ignorance also increases, or the "impossibility to know" (Beck 1997, p. 60) becomes clear. And finally, all expert and reviewer duels embedded in technology controversies show not only cognitive (data dissent) but

also evaluative dissent, especially on the question of "what should be" and the desired purposes.

In view of recognizable cognitive and normative deficits in scientific knowledge in the face of complicated problems, the conclusion of a different kind of rationality of science (including its indispensable specific problem-solving potential) would at best be correct – but the assumption of its greater dignity would be wrong. However, this is often taken as a basis in the discourse on the consequences and impact of consulting – disappointment and incomprehension in the face of non-use or only partial use are therefore common, but by no means justified, assessments.

The expectation of direct, short-term, and complete adoption of scientific information by politicians is closely linked to the assumption of greater rationality.

This "model" of the impact of advice, which is often taken as a basis by critics, should be discussed in terms of whether the norm of "successful" policy advice it expresses is justified. Based on the available experience, such an idea (both empirically and normatively) appears to be a misguided measure of use and even more so of benefit. This is supported by the findings of several decades of "utilization research" (Beck/Bonß 1984; Wingens 1988). According to the sum of the insights gained, the relationship between information and politics is "complex," "chaotic," and "non-linear" (Bimber 1996, p. 4).

The impact of advisory expertise is complex and extremely difficult to understand. We should therefore start by moving away from the idea that knowledge is "applied" as it is delivered. A different and better understanding emerges if a concept of the "use" of scientific knowledge in a specific practical context is taken as a basis instead. This opens up a view of the fact that the actual transfer of consultancy results into practice is carried out by *their* actors.

> Use is therefore not "application," but an active co-production and re-production of the results, which thereby lose the character of "results" and are created in the context of action, language, expectations, and interests of the respective practical context according to immanent rules regarding their practical relevance (Beck 1991, p. 175).

The idea that scientific knowledge is used by the addressees in the sense of "identical reproduction" (Luhmann) is therefore unrealistic. Rather, the knowledge acquired goes through stages of selection and transformation. In the course of processing and editing by politicians, it is taken apart, so to speak, reassembled, and combined with other knowledge. Experience shows that such "deconstruction and reconstruction" of provided expertise (Jasanoff 1987) is by no means counterproductive or illegitimate from the outset.

Delivered knowledge can also become "invisible" in various ways. The basic messages, the data material, the strategic options are reformulated, incorporated into other linguistic contexts and thus experience a kind of rebirth in programs, regulations, laws, or in the rhetorical arsenal of practice (Weiss 1992, p. 15), or also in their world views and patterns of interpretation (Murswieck 1994, p. 105). This recurrence of the results of consultation can occur not only with a time lag but also in other local and social contexts (Beck 1991, p. 175). For example, policy advice can have an impact through its reception in public opinion and the media, and it can also happen that actors other than those directly advised make use of the results. All these consequences are also effects.

Finally, a trivial and actually self-evident fact should be remembered: Every advisory process takes place in a network of other advisory processes and in "competition" with them.

In 1984, for example, the Federal Republic of Germany counted 528 committees made up of 7,000 people for the federal government. These included such interesting bodies as the Poplar Commission[1] and the Cosmetics Commission. For the year 1992, an attempt was made to at least estimate the scope of the government's advisory system, and this more poorly than well. If we add up the departmental advisory bodies and the government's own research institutions, we arrive at 348 bodies and institutions, which together cost DM[2] 3.84 billion. If we also include federal and state institutions ("Blue List"), we arrive at a total of 430 bodies and institutions and approx. DM[2] 4.16 billion in costs. To this must be added the costs of so-called ad hoc consultation amounting to DM[2] 65 million (Murswiek 1994, p. 108ff.).

From the above, a trivial – but often neglected – circumstance with consequences for policy-advising TA becomes clear: It is surrounded by "competition" at the level of scientific policy advice (not to mention the influence of the interest-driven recommendations of associations and lobbyists). TA as policy advice is therefore not a singular, context-free process. The political apparatus does not stand still while busy TA experts are at work, nor does the opulent network of other policy advice processes rest. When making snap diagnoses about TA without consequences, it is therefore worth remembering from time to time that it is only *one* voice in a large and diverse choir.

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1 *Editors' note*: The International Commission on Poplars and Other Fast-Growing Trees Sustaining People and the Environment is one of the oldest, firmly established organizations of the FAO (Organization for Food and Agriculture) of the United Nations.

2 Deutsche Mark, Former German currency

The results of science are hardly suitable for changing practical knowledge, everyday knowledge, in a short space of time. However, what can take place – in a process of "consulting with one another" – is what is referred to in the literature as "policy learning" (Sabatier 1988): A gradual and successive influencing of basic assumptions, perceptions, and habits of thought of decision-makers and, as a result, possibly a modification of state policy content and policy styles (Sabatier 1987, 1988).

2. Technology development as an evolutionary process

TA as policy advice has a practical purpose. So-called "control knowledge" is provided for a "control subject" with regard to a "control object." This object (and the subject of TA) is the development and use of technologies or their innovation and diffusion in a social context. Whether "control knowledge" related to this can become effective has a lot to do with whether and to what extent the "control object" is accessible to an intended influence at all. Let us therefore ask what the object of control in question is all about.

From the diverse observations of technical change by the scientific augurs of the various disciplines and their various factions, one can initially gain the impression that formerly clear terms and models are no longer adequate. Known and familiar distinctions between individual technologies are disappearing, product and process innovations can no longer be precisely separated, nor can development phases such as research, development, demonstration, prototype, etc. In particular, linear development models ("from basic research to diffusion") or other simple concepts such as the "trickling-down model" are increasingly being discarded. Instead, the search is on for concepts, theories, and models that reflect the multiple determinism of innovations well, prove themselves in empirical studies, and possibly provide starting points for active and targeted design through evidence of causalities or determinants. Relevant influencing factors of technology genesis or determined variables of innovation and diffusion processes are therefore abundantly traded. However, they cannot be determined from their colorful and confusingly diverse empiricism with sufficient precision, and beyond individual cases, to be transferable to other constellations and suitable for description, analysis, and explanation on the one hand, and targeted design and control on the other.

It is therefore not surprising that the sciences are not making much progress toward a theory of technology or (technical) innovation – "in search of a useful

theory of innovation" (Bollmann 1990, p. 168) – or that they offer a picture of competing explicative paradigms (Sundbo 1995). Provisional and highly generalized insights into clusters of innovations (Ausubel 1991, p. 15) or trajectories (Dosi 1982), into "waves" or "cycles" of innovation processes (Sterman 1987) do succeed. For example, it has been established "that innovations are not even distributed over time, but are clustered around certain dates." At the same time, however, it must be conceded that "nothing definitive can be said regarding causality between these innovation peaks and economic or socio-political activity" (Shaw 1987, p. 241; see also Dror 1988, p. 69f.).

Contrary to what is suggested by the idea of a linear process, e.g., in a well-structured three-step process of invention, innovation, and diffusion, innovation is better understood as a networked, interactive process. There is feedback between the individual phases, then spillovers between different markets (Erdmann 1993, p. 211), and finally interactions between companies and factors external to the companies, for which the term "selection environment" has been coined (Nelson/Winter 1982, p. 262ff.).

One form of interaction is the exchange of experience between innovator and user (Silverberg 1991, p. 69). There seems to be general agreement that innovation processes are problem-solving- and learning processes and that information and knowledge play a key role here – even if they are scarce, unevenly distributed, and uncertain. Not least for this reason, technical change has rightly been characterized as "inherently inefficient" and accompanied by "duplication and waste" (Nelson 1987). Nevertheless, companies as innovators search, decide, and act, and do so in competition with each other – which not only knows success, heroic inventors, and winners but also "deaths," "lunatics," and "losers" (Ausubel 1991, p. 17). At a higher level of abstraction, innovation competition can therefore be understood as "a self-organizing system of non-linearly networked actors," "in which the relevant developments are a result of unintended (social) repercussions of intentional human actions" (Erdmann 1993, p. 7).

The fact that such "collective evolutionary processes" (Silverberg 1991) are basically overdetermined in their technical, economic, and social implications for an analytical understanding of underlying causalities is illustrated by the fact that the semantic field and the scientific rhetoric of innovation research is extensively characterized by linguistic, pictorial borrowings from other disciplines. We read about mutation and selection, along with variation, fermentation, or even retention (Weyer et al. 1997, p. 27ff.). Now and again, we find terms such as infection, metabolism, and growth or epidemic spread (Erdmann 1993, p. 26; Dreher 1997, p. 38ff.). As in the evolutionary processes of nature – as such and

other metaphors suggest – individual lines of technology prevail over others. And it is no coincidence that terms such as "inherently stochastic" or "erratic" (Shaw 1987, p. 241), "non-linear," "haphazard," dynamic, natural, cumulative, etc. are used to characterize innovation and diffusion processes (Rip 1995, p. 418).

From the camp of social science technology research, we hear different messages in terms of terminology. However, their core statements signal a comparable characterization of their object of observation and knowledge:

- Technical systems are embedded in social, political, economic, and cultural structures ("embeddedness"/"connectedness") and their genesis and consequences are shaped by these "contexts" ("socio-economic orientation complexes"). They cannot therefore be viewed in isolation.
- Technologies are the result of human ideas and actions ("socio-technical process") and are therefore "socially constructed" and consciously shaped ("socially shaped"). In this respect, technological change must be understood as a "social process" (OECD 1988, p. 11), not as an endogenous factor.
- Of particular importance for technology genesis processes is the fact that possible development alternatives are blocked relatively early on due to design and construction decisions by developers and engineers (combined with strategic management decisions) and that certain choices and design options are no longer permitted within the selected technology line ("closure"). Once technology lines have been established, they also block attempts at political control that do not take into account the resulting narrowed corridors of action ("stubbornness of technology").
- Similarly, it is argued that when technologies, especially large-scale technological systems, have reached a certain "degree of maturity," design attempts (and alternatives) have little chance of success ("momentum" of technology/"entrenchment"). "Control at this stage, however, becomes increasingly difficult, since any changes are extremely costly due to the amount of technologically financial, institutional and cultural investments already made" (Aichholzer/Schienstock 1994, p. 14).
- Finally, numerous case studies from the history of technology are used to show that a large number of actors and networks of actors with different strategies and interests are involved in technical and social change processes. At company, social, and political level, "strategic games" and negotiations take place between those involved with the aim of asserting their own ideas of technology and use (competitively or cooperatively) (cf., e.g., Weyer et al. 1997).

So what can we say about the subject matter of TA? Research has now provided a wealth of empirical evidence in individual cases and individual conceptually interesting approaches or paradigms, with the help of which the evolution of innovations can be roughly and ex-post (!) deciphered despite theoretical inadequacies and practical deficits (Edquist 1994, p. 48f.). However, all track readers together – regardless of whether they are neoclassical or belong to the school of evolutionary economics – always discover the same characteristics that distinguish the innovation and diffusion process in highly developed economies:

- The processes in question are open future processes, not deterministic but stochastic.
- Although the actors involved (also) act intentionally, the results of these (diverse) actions are the result of unintended social repercussions and consequences.
- The knowledge of both the innovation participants and the "observers" is limited, and planning, assessments, and decisions remain fundamentally uncertain and risky.
- Because information is scarce and knowledge is uncertain, intentional actions and controlling interventions are also fundamentally limited in their possibilities.

Any hopeful prospects for activist and committed policy advice are therefore dimmed considerably if we take note of the wealth of research results. And it darkens further when we turn to another subarea, namely the question of the "control subject."

3. The state as a disenchanted center

In modern industrial societies at the end of this millennium, there is no central controlling authority. Even the state no longer has this role. Modern society has neither a center nor a top. In the literature, this is associated with dwindling opportunities for "active reform policy," the "crisis of regulative policy" or "regulative law" (Grimm 1990), implementation blockades in political programs, and restrictions on social controllability as a whole (Grimm/Hagenah 1994; Mayntz 1996).

In order to understand the limited role of state policy *today*, a little reminiscing about the 1970s and 1980s is helpful. In retrospect, both decades can be seen as a time of secular change, on the one hand in the state's problematic budget,

and on the other – as a reaction to this – in the structures and instruments of the state. For the Western industrialized nations (but not only for them), the "brief dream of perpetual prosperity" (Lutz 1989) was abruptly extinguished by the mid-1970s at the latest. Inflation and stagflation problems as well as rising national budget debt brought other genuine problem symptoms into even sharper focus. These included, especially in Europe, the "crisis of the welfare state," new social movements, an increasingly unpredictable electorate, a change in secular values and attitudes, a problematic acceptance of technology, and new policy issues such as the environmental problem in particular. One result and at the same time a component of these problem constellations was a significant decline in the state's problem-solving competence and its ability to control, which had previously hardly been questioned.

Nowadays, the assessments are confusingly ambivalent (Zürn 1996, p. 28ff.). On the one hand – especially in the course of the globalization debate – few things are as readily invoked as the decline of nation-state politics. On the other hand, scope for action of no small importance continues to be identified (Eßer et al. 1996). Detailed case studies in the areas of economic, industrial, research, and technology policy also reveal new possibilities for shaping (national) policy.

But where and how, between the two poles of a depraved actor and new active statehood, is the role of the state to be located today? First of all, there is broad agreement that a *change in the form* of statehood has taken place.

> We are not dealing with a decline, but with a change in the form of the exercise of state power, through which the spectrum of coexisting forms of regulation has broadened (Mayntz 1996, p. 163).

On the one hand, this includes tendencies toward the (complete or partial) delegation of state tasks to intermediary organizations or private individuals. Secondly, so-called "network-like forms of government" are identified as new forms of cooperation between the state and society. Supporters of this appraisal operate with the thesis that network-like forms of cooperation between private and state actors have replaced the classic hierarchical political mode with direct control of society through money and law in many areas.

Although the state remains formally hierarchically organized, in fact,

> [...] the formulation and implementation of state policies proves to be the result of multilateral negotiations between a large number of state and non-state actors rather than the one-sided, hierarchical control intervention of a monolithic state (Scharpf 1992, p. 51).

Such appraisals of relatively new "horizontal policy coordination" in "joint decision systems" or "policy networks" (Marin/Mayntz 1991) of private, intermediary, and state actors hide long-established, but also relatively new forms of statehood such as privatization, delegation, corporatism, subsidiarity, self-administration, etc.

The transformation of the state into a "cooperative," "interactive," or "learning" state (Martinsen/Simonis 1995; Voigt 1995) is due, among other things, to the complexity of its environment and the significant increase in the number of problems the state faces since the 1970s. Because society is complex and contingent and because problem solving has become more difficult, the state is dependent on society and the competence and information available there in order to fulfill its tasks. Cooperation with social actors is the necessary consequence.

In this respect, the changed appearance of the state that has long been noted by political science is an adequate reflection of reality. This process includes changes:

- from a reactive to an anticipatory policy,
- from regulatory control to partnership-based cooperation,
- from centralized instruction to decentralized coordination,
- from standardization to conviction,
- from sovereign means of coercion to multilateral cooperation and negotiated solutions (Jänicke/Weidner 1995; Ritter 1979).

Some typical patterns of cooperation between state and society can be seen in the following cases and demonstrate the diversity of forms of governance between autonomous self-regulation by society on the one hand, and hierarchical state control on the other:

- The state delegates almost entirely the shaping tasks to which it itself is potentially entitled. This can be seen in examples such as collective bargaining autonomy, the chamber system, and self-administration in the healthcare sector.
- The state sets a framework and establishes certain testing mechanisms, but largely keeps a low profile. The result is "social self-regulation" – as in the case of technical standardization by industry associations and institutions (Voelzkow 1996).
- The state establishes advisory and/or decision-making bodies made up of representatives from science, industry, and society (sometimes also from politics and administration). Such "negotiation systems" for the purpose of consultation and the development of regulations (in the form of standards,

limit values, guidelines, etc.) are, for example, the Nuclear Safety Standards Commission, the Reactor Safety Commission, or the Radiation Protection Commission.
- The state delegates tasks to social bodies of "self-administration" and cooperates with the bodies responsible for self-administration (such as the Science Council) in specific committees. In doing so, it reserves the right to finance the activities.

Environmental policy and science, research, and technology policy are sectoral policies in which forms of the cooperative government have already advanced relatively far.

- The role and activities of the self-governing organizations of science, the DFG[3] and the MPG[4], which have to a certain extent made the funding of basic research their "domain with a claim to sole representation" (Braun 1993, p. 259), stand for a model of (self-)control by "intermediary organizations." With regard to research and technology policy in Germany, it can be stated that not only the large, but also many smaller-scale funding programs are negotiated in discussions between representatives of state- and scientific institutions and sometimes with the involvement of industry representatives. The literature contains numerous examples of such "discourses" in which the framework conditions, project topics, potential contractors, etc. for such programs are determined by the state together with social groups and also controlled in the course of the process (Martinsen/Simonis 1995, p. 388ff.). The state acts as a moderator here, which certainly includes the opportunity to implement its ideas. At the European level, comparable cooperation and consultation processes can be observed for EU research funding (Sturm 1995, p. 266).

  A large number of relevant analyses confirm the plausibility of the thesis that the state has developed into an "interactive state" with a now very differentiated technology policy with a focus on "soft" control media (Kubicec/Seeger 1993, p. 13ff.; Martinsen/Simonis 1995, p. 381ff.).
- In environmental policy, including environmental administration, the principle of cooperation is not just a noble maxim. In practice, the environmental policy decision-making system is characterized by agreements between the state administration and industry (in preparation of legislation, representa-

3 *Editors' note*: Deutsche Forschungsgemeinschaft (German Science Foundation).
4 *Editors' note*: Max-Planck Gesellschaft (Max-Planck Society).

tion of legislation, and enforcement of legislation). However, this should not distract from the fact that there was and is sufficient empirical evidence that, in addition to "negotiation" as a mode of intervention, "regulatory command-and-control policy" is still valid as a policy pattern (Jänicke/Weidner 1995, p. 20f.).

The joint handling of problems by the state and society is particularly evident in committees that act in an advisory capacity, but also prepare decisions (Hagenah 1996, p. 141ff.). These are institutions in which representatives from politics and science, and in some cases also from industry, work together. They are concerned with central issues of public safety and health, and certainly also – in connection with this – with questions of economic efficiency. One of the aims is to define binding technical standards, safety requirements, and threshold and limit values. The recommendations or rules drawn up are of an indicative and in some cases binding nature for authorities and industry. In such "societal negotiation systems" (Hampel 1991), areas to be regulated by the legislator, or by politicians in general, are actually shaped together with those directly affected and interested parties (i.e., the state relinquishes direct and hierarchical control options). It draws on the expertise of science and industry, and creates framework conditions and procedures that are not only efficient, but should also comply with democratic and constitutional principles in their internal structure. In environmental policy in particular, the state has increasingly become a state that "cooperates" and "negotiates" with social groups.

All in all, before singing a definitive sang off to the state, we should pause and take a closer look. The state is still present and is by no means just a passive "supervisory state" (Willke 1992), but an active player, not just a moderator, but often a decision-maker. Assessments such as those of a "new architecture of the state" (Grande 1993), the increased use of non-hierarchical forms of regulation and cooperative control (Sturm 1995), and a changed understanding of the role of the state as an authority for the common good and responsibility for the future are probably realistic. To quote Renate Mayntz: "There can be no question of a resigned withdrawal of the state" (Mayntz 1996, p. 163; see also Jänicke/Weidner 1995, p. 21ff.). And this probably also means that it is still far from being obsolete as a TA addressee.

4. Summary and outlook

As early as the 1980s, the Organisation for Economic Co-operation and Development (OECD) pointed out the need for a changed, appropriate understanding of technology and innovation as a "social process," not least based on findings from innovation, diffusion, and technology research.

- It has emphasized the importance of the *social context* for technological developments – both for analysis and for practical design (OECD 1988, p. 117). This insight into the interconnectedness of technology with society and its embedding in society has now led to calls for a systems approach in technology policy (Meyer-Krahmer 1993, p. 41), i.e., for an "integrative, overall restructuring policy." Accordingly, there is a demand for "a broadening of government policy into the socio-institutional sphere" (Roobeek 1990, p. 233). On the one hand, this means keeping an eye on the various levels of the innovation process (companies, sectors, social structures) in their context and, on the other, promoting the "innovation system" as a whole rather than individual technologies and individual companies. This is roughly the realization of the appropriateness of a policy approach that indirectly controls technologies in and through their context (Aichholzer/Schienstock 1994, p. 21) ("decentralized context control").
- The OECD has called for a "*communicative turnaround*" in technology policy – communication with the recipients of funding, the players in the innovation system, and the committed and interested social groups. Accordingly, the so-called soft control media of politics have now increasingly come into focus: Incentives, voluntary commitments, guiding principles, persuasion. If the thesis that decisions are increasingly being made in "policy networks" is correct, the communicative component must be intensified anyway.
- There is an overarching need to *network different sectoral policies* – in the sense of coordinating their "signals," or a comprehensive approach, to a socially oriented technology policy (Badham/Naschold 1994). "No longer should technology policy be separated from other policy fields. Rather should it be seen as an integrated element of social and welfare policy, education and science policy, environmental policy and healthcare, housing and transport, etc" (Roobeek 1990, p. 233; see also Smits et al. 1995, p. 278).

All three aspects are about nothing less than the validity of politics as a specialist for the general. The definition and discussion of goals, needs, strategies, and guiding principles are essential for fulfilling this role. Equally important are the

methods of communicating them, because if only the *efficiency* of political work is increased without thinking about its communication, the *evidence* of what politics wants and does suffers.

Context orientation, communication, as well as *participation* and *networking* of politics internally and externally – the TA concept can be directly linked to these maxims and is ideally suited to the analytical, communicative, and political challenges inherent in these aspects. Because:

- TA as policy advice has always attempted to take account of *the contextual nature and multidimensionality* of its subject matter through a comprehensive approach to analysis and evaluation (comprehensiveness): The complexity and social embedding of technical innovations is to be taken into account by analyzing the various sectors relevant to their preconditions and consequences, such as law, politics, economics, ecology, social structures, and culture.
- As an analytical and advisory process, TA is participation-oriented and communicatively open toward stakeholders, but also toward those affected, not least in the development of policy options. This dimension of TA takes account – in its context – of the "communicative turn" in technology policy, which was only claimed much later by the OECD, i.e., the maxim of discussing objectives and measures with the addressees of political programs as well as with the affected and interested citizens.
- The "*policy component*" of TA takes account of the need for *sectoral networking* of specialist policies and the ability to connect with the interests and patterns of action of the actors in the innovation system. According to the claim, this has always been a cross-system approach. The charm of TA in the practical dimension is therefore to address sectoral/departmental options in their mutual relationship and, if appropriate, to bundle them into an overall political strategy. Also in this respect, TA is compatible with a research and technology policy "based on a systems approach" (Meyer-Krahmer 1993, p. 41).

For these reasons, TA can also do justice to the necessarily changed concepts of modern technology policy and the challenges of increased citizen participation in political and administrative decision-making processes. It is therefore not advisable to issue a death certificate too quickly.

Literature

Aichholzer, Georg; Schienstock, Gerd (eds.) (1994): Technology Policy. Towards an Integration of Social and Ecological Concerns. Berlin, New York: De Gruyter. https://doi.org/10.1515/9783110846256

Ausubel, Jesse H. (1991): Rat-race dynamics and crazy companies: The diffusion of technologies and social behavior. In: Technological Forecasting and Social Change 39 (1–2), Special Issue – From Democracy to Chain Saws: New Perspective on Innovation Diffusion. Amsterdam: Elsevier, pp. 11–22. https://doi.org/10.1016/0040-1625(91)90025-B

Beck, Ulrich (1991): Wie streichle ich mein Stachelschwein? Zur Verwendung von Sozialwissenschaften in Politik und Praxis. In: Politik der Risikogesellschaft. Essays und Analysen. Frankfurt am Main: Suhrkamp, pp. 172–179.

Beck, Ulrich (1997): Weltrisikogesellschaft, ökologische Krise und Technologiepolitik. In: Massing, Peter (ed.): Gesellschaft neu verstehen: Aktuelle Gesellschaftstheorien und Zeitdiagnosen. Schwalbach: Wochenschau-Verlag, pp. 55–76.

Beck, Ulrich; Bonß, Wolfgang (1984): Soziologie und Modernisierung: Zur Ortsbestimmung der Verwendungsforschung. In: Soziale Welt 35 (4), pp. 381–406.

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

Bollmann, Petra (1990): Technischer Fortschritt und wirtschaftlicher Wandel. Heidelberg: Physica-Verlag. https://doi.org/10.1007/978-3-642-52386-1

Bonus, Holger (1982): Information und Emotion in der Politikberatung – Zur politischen Umsetzung eines wirtschaftstheoretischen Konzepts. In: Zeitschrift für die gesamte Staatswissenschaft/Journal of Institutional and Theoretical Economics 138 (1), pp. 1–21.

Braun, Dietmar (1993): Politische Steuerungsfähigkeit in intermediären Systemen am Beispiel der Forschungsförderung. In: Politische Vierteljahresschrift 34 (2), pp. 249–271.

Dosi, Giovanni (1982): Technological paradigms and technological trajectories. In: Research Policy 11 (3), pp. 147–162. https://doi.org/10.1016/0048-7333(82)90016-6

Dreher, Carsten (1997): Technologiepolitik und Technikdiffusion: Auswahl und Einsatz von Förderinstrumenten am Beispiel der Fertigungstechnik. Baden-Baden: Nomos.

Dror, Israel (1988): Forecasting technologies within their socioeconomic framework. In: Technological Forecasting and Social Change 34 (1), pp. 69–80. https://doi.org/10.1016/0040-1625(88)90024-8

Edquist, Charles (1994): Technology Policy. In: Aichholzer, Georg; Schienstock, Gerd (eds.): Towards an Integration of Social and Ecological Concerns. Berlin: De Gruyter, pp. 67–94. https://doi.org/10.1515/9783110846256.67

Erdmann, Georg (1993): Elemente einer evolutorischen Innovationstheorie. 1st ed., Tübingen: Mohr Siebeck. https://doi.org/10.1628/978-3-16-162858-0

Esser, Klaus (1996): Globaler Wettbewerb und nationaler Handlungsspielraum: Neue Anforderungen an Wirtschaft, Staat und Gesellschaft. München, Köln, London: Weltforum-Verlag.

Grande, Edgar (1993): Die neue Architektur des Staates: Aufbau und Transformation nationalstaatlicher Handlungskapazität – untersucht am Beispiel der Forschungs- und Technologiepolitik. In: Verhandlungsdemokratie, Interessenvermittlung, Regierbarkeit. Festschrift für Gerhard Lehmbruch. Opladen: Westdeutscher Verlag, pp. 51–71.

Grimm, Dieter (1990): Wachsende Staatsaufgaben – sinkende Steuerungsfähigkeit des Rechts. Baden-Baden: Nomos.

Grimm, Dieter; Hagenah, Evelyn (eds.) (1994): Staatsaufgaben. 1st ed., Baden-Baden: Nomos.

Hagenah, Evelyn (1996): Prozeduraler Umweltschutz: Zur Leistungsfähigkeit eines rechtlichen Regelungsinstruments. 1st ed., Baden-Baden: Nomos.

Hampel, Frank (1991): Politikberatung in der Bundesrepublik: Überlegungen am Beispiel von Enquete-Kommissionen. In: Zeitschrift für Parlamentsfragen 22 (1), pp. 111–133.

Hoffmann-Riem, Wolfgang (1988): Schleichwege zur Nicht-Entscheidung: Fallanalyse zum Scheitern der Enquete-Kommission "Neue Informations- und Kommunikationstechniken". In: Politische Vierteljahresschrift 29 (1), pp. 58–84.

Horowitz, Irving L. (1976): Wissenschaftliche Gemeinschaft und politisches System. Beziehungskonflikte zwischen Sozialwissenschaftlern und politischen Praktikern. In: Badura, Bernhard (ed.): Seminar: Angewandte Sozialforschung. Frankfurt am Main: Suhrkamp.

Jänicke, Martin; Weidner, Helmut; Wissenschaftszentrum Berlin für Sozialforschung (eds.) (1995): Successful environmental policy: A critical evaluation of 24 cases. Berlin: Edition Sigma.

Jasanoff, Sheila S. (1987): Contested Boundaries in Policy-Relevant Science. In: Social Studies of Science 17 (2), pp. 195–230.

Kubicek, Herbert; Seeger, Peter (eds.) (1993): Perspektive Techniksteuerung: Interdisziplinäre Sichtweisen eines Schlüsselproblems entwickelter Industriegesellschaften. Berlin: Edition Sigma.

Lutz, Burkart (1989): Der kurze Traum immerwährender Prosperität: Eine Neuinterpretation der industriell-kapitalistischen Entwicklung im Europa des 20. Jahrhunderts. Frankfurt am Main, New York: Campus.

Marin, Bernd; Mayntz, Renate (eds.) (1991): Policy networks: Empirical evidence and theoretical considerations. Frankfurt am Main, New York: Campus.

Martinsen, Renate (1995): Paradigmenwechsel in der Technologiepolitik? Wiesbaden: VS Verlag für Sozialwissenschaften.

Mayntz, Renate (1996): Politische Steuerung: Aufstieg, Niedergang und Transformation einer Theorie. In: Beyme, Klaus von; Offe, Claus (eds.): Politische Theorien in der Ära der Transformation. Wiesbaden: VS Verlag für Sozialwissenschaften, pp. 148–168. https://doi.org/10.1007/978-3-322-86620-2_6

Meyer-Krahmer, Frieder (ed.) (1993): Innovationsökonomie und Technologiepolitik: Forschungsansätze und politische Konsequenzen. Heidelberg: Physica-Verlag.

Murswieck, Axel; Mayntz, Renate; Deutsche Vereinigung für Politische Wissenschaft (eds.) (1994): Regieren und Politikberatung. Opladen: Leske + Budrich.

Nelson, Richard R. (1987): Understanding technical change as an evolutionary process. Amsterdam, New York: North-Holland.

Nelson, Richard R.; Winter, Sidney G. (1982): An evolutionary theory of economic change. Cambridge, MA: Belknap Press/Harvard University Press.

OECD (1988): New technologies in the 1990s: A socioeconomic strategy. Paris: Organisation for Economic Co-operation and Development.

Petermann, Thomas (1988): Technology Assessment (Technikfolgen-Abschätzung) als Politikberatung: Über die Angst des Parlamentariers beim Umgang mit der Wissenschaft. In: Politik, Philosophie, Praxis. Festschrift für Wilhelm Hennis zum 65. Geburtstag. Stuttgart: Klett-Cotta, pp. 412–425.

Petermann, Thomas (1991): Technikfolgen-Abschätzung als Technikforschung und Politikberatung. Frankfurt am Main, New York: Campus.

Rip, Arie (1995): Introduction of new technology: Making use of recent insights from sociology and economics of technology. In: Technology Analysis & Strategic Management 7 (4), pp. 417–432. https://doi.org/10.1080/09537329508524223

Ritter, Ernst-Hasso (1979): Der kooperative Staat: Bemerkungen zum Verhältnis von Staat und Wirtschaft. In: Archiv des öffentlichen Rechts 104 (3), pp. 389–413.

Roobeek, Annemieke J. (1990): Beyond the technology race: An analysis of technology policy in seven industrial countries. Amsterdam: Elsevier.

Sabatier, Paul A. (1987): Knowledge, policy-oriented learning, and policy change: An advocacy coalition framework. In: Knowledge 8 (4), pp. 649–692.

Sabatier, Paul A. (1988): An advocacy coalition framework of policy change and the role of policy-oriented learning therein. In: Policy Sciences 21 (2), pp. 129–168. https://doi.org/10.1007/BF00136406

Saretzki, Thomas (1997): Demokratisierung von Expertise? Zur politischen Dynamik der Wissensgesellschaft. In: Klein, Ansgar; Schmalz-Bruns, Rainer (eds.): Politische Beteiligung und Bürgerengagement in Deutschland. Möglichkeiten und Grenzen. Baden-Baden: Nomos, pp. 277–313.

Scharpf, Fritz W. (1992): Koordination durch Verhandlungssysteme: Analytische Konzepte und institutionelle Lösungen. In: Benz, Ulrich; Scharpf, Fritz W.; Zintl, Reinhard (eds.): Horizontale Politikverflechtung: Zur Theorie von Verhandlungssystemen. Frankfurt am Main, New York: Campus, pp. 51–96.

Schneider, Wolfgang L. (1989): Kooperation als strategischer Prozeß. Administrative Auftragsforschung im Spannungsfeld zwischen professionellem Interesse und politischer Instrumentalisierung. In: Beck, Ulrich; Bonß, Wolfgang (eds.): Weder Sozialtechnologie noch Aufklärung? Analysen zur Verwendung sozialwissenschaftlichen Wissens. Frankfurt am Main: Suhrkamp, pp. 302–331.

Shaw, Bradley T. (1987): Technology and military criteria: Broadening the theory of innovation. In: Technological Forecasting and Social Change 31 (3), pp. 239–256. https://doi.org/10.1016/0040-1625(87)90013-8

Silverberg, Gerald (1991): Adoption and diffusion of technology as a collective evolutionary process. In: Technological Forecasting and Social Change 39 (1–2), Special Issue – From Democracy to Chain Saws: New Perspective on Innovation Diffusion. Amsterdam: Elsevier, pp. 67–80. https://doi.org/10.1016/0040-1625(91)90029-F

Smits, Ruud; Leyten, A. Jos M.; Hertog, Pim (1995): Technology Assessment and Technology Policy in Europe: New Concepts, New Goals, New Infrastructures. In: Policy Sciences 28 (3), pp. 271–299.

Sterman, John D. (1987): The Economic Long Wave: Theory and Evidence. In: Vasko, Tibor (ed.): The Long-Wave Debate. Heidelberg: Springer.

Sturm, Roland (1995): Kooperative Steuerung auf dem Gebiet der Technologiepolitik. In: Voigt, Roland (ed.): Der kooperative Staat: Krisenbewältigung durch Verhandlung? Baden-Baden: Nomos, pp. 257–271.

Sundbo, Jon (1995): Three paradigms in innovation theory. In: Science and Public Policy 22 (6), pp. 399–410. https://doi.org/10.1093/spp/22.6.399

Thienen, Volker von (1990): Beratungswelt und Methode. Parlamentarische Politikberatung in der Perspektive unterschiedlicher Methoden der empirischen Sozialforschung. In: Drawer, Carsten; Bruckhoff, Daniel; Schmidt, Marvin (eds.): Das wohlberatene Parlament. Orte und Prozesse der Politikberatung. Berlin: Edition Sigma, pp. 171–215.

Voelzkow, Helmut (1996): Private Regierungen in der Technik steuerung: Eine sozialwissenschaftliche Analyse der technischen Normung. Frankfurt am Main, New York: Campus.

Voigt, Rüdiger (ed.) (1995): Der kooperative Staat: Krisenbewältigung durch Verhandlung? 1st ed., Baden-Baden: Nomos.

Weiss, Carol H. (1992): Organizations for policy analysis: Helping government think. Los Angeles, CA: Sage Publications.

Weisser, Gerhard (1961): Probleme beratender Sozialwissenschaft. In: Greiß, Franz; Meyer, Fritz W. (eds.): Wirtschaft, Gesellschaft und Kultur. Festgabe für Alfred Müller-Armack. Berlin: Duncker & Humblot.

Weyer, Johannes (ed.) (1997): Technik, die Gesellschaft schafft: Soziale Netzwerke als Ort der Technikgenese. Berlin: Edition Sigma.

Wildavsky, Aaron (1979): Speaking truth to power: The art and craft of policy analysis. Boston, MA: Little, Brown and Company.

Willke, Helmut (1992): Ironie des Staates: Grundlinien einer Staatstheorie polyzentrischer Gesellschaft. 1st ed., Frankfurt am Main: Suhrkamp.

Wingens, Matthias (1988): Soziologisches Wissen und politische Praxis: neuere theoretische Entwicklungen der Verwendungsforschung. Frankfurt am Main, New York: Campus.

Zetterberg, Hans L. (1962): Social Theory and Social Practice. New York: The Bedminster Press.

Zürn, Michael (1996): Über den Staat und die Demokratie im europäischen Mehrebenensystem. In: Politische Vierteljahresschrift 37 (1), pp. 27–55.