Science and Public Policy, 46(5), 2019, 702–709
doi: 10.1093/scipol/scz023
Advance Access Publication Date: 12 May 2019
Article

The inherently democratic nature of technology assessment

Armin Grunwald *

Institute for Technology Assessment and Systems Analysis (ITAS), Karlsruhe Institute of Technology (KIT), Karlstr. 11, 76133, Karlsruhe, Germany

*Corresponding author. E-mail: armin.grunwald@kit.edu

Abstract

Technology assessment (TA) emerged more than fifty years ago to provide information supply, decision support, and orientation for democratic processes and institutions in many democratic countries. This historical observation alone, however, does not justify speaking of an inherent relationship between TA and democracy. The latter requires taking a conceptual view. Arguments supporting the thesis of the inherently democratic nature of TA will be given based on pragmatist approaches developed by John Dewey and Jürgen Habermas. This perspective on TA has specific implications for the inclusion of the knowledge and perspectives of stakeholders, people affected and citizens involved in TA processes, as well as the necessity to develop or strengthen thinking in alternative options. Furthermore, it makes clear that in the current crisis of democracy in many countries, TA cannot take a distant and neutral position.

Key words: policy advice; technology assessment; pragmatist philosophy; technocracy; inclusion; participation.

1. Introduction and overview

Technology assessment (TA) emerged more than fifty years ago to provide information supply, decision support, and orientation for democratic processes and institutions (Grunwald 2019: 37ff). The Office of TA (OTA) at the US Congress was the first TA institution (Bimber 1996), and developed as a model for many others (Vig and Paschen 1999; Cruz-Castro and Sanz-Menendez 2004). Since that time, TA has developed further in many democratic countries, in particular to serve parliaments as the core institutions of democracy (Hennen and Nierling 2013; Scherz and Merz 2016) and to enable and enrich participatory processes, thus contributing to a more deliberative democracy (Joss and Bellucci 2002; Abels and Bora 2016) (cf. Section 3 of this article for a brief overview).

This empirical and historical observation alone, however, does not justify speaking of an inherent relationship between TA and democracy. If a dictator wants to install some new surveillance technology in order to control and suppress the people more efficiently, and if he or she commissions a study to investigate the possible unintended consequences of that technology, according to the state of the art of TA methodology—would we accept this as TA, or even as good TA in the case of sound TA methodology having been applied? Is TA value-neutral and should serve any political power? Or is TA built on a normative fundament, which would render it an *issue advocate* (Pielke 2007) in favor of democracy (Delvenne 2018)?

In this article, I will explain and defend the thesis of an inherent relationship between TA and democracy. First, this requires clarifying the concept and understanding of TA (Section 2). Second, a quick look at the history of TA clearly demonstrates its close relationship with democracy so far (Section 3). Third, to underpin the thesis of an inherently democratic nature for TA, arguments will be given based on pragmatist approaches to science and society developed by Dewey (1927, 1931) and taken up by Habermas (1970, 1992) (cf. also von Schomberg 1999; Saretzki 2015).

This perspective on TA has specific implications (Section 5): (1) the knowledge and perspectives of stakeholders, people affected and citizens have to be involved in TA processes. The entire cosmos of participation belongs to the core of TA rather than being a 'nice to have' feature. (2) The inclusion of different perspectives, values, and positions implies increasing complexity for TA's assessment processes, which makes it necessary to establish strategies for handling this complexity. (3) Rather than orientating decision-making to the ideal of scientific optimization, thinking in alternative options has to be developed or strengthened.

A more political implication is that instead being a distant observer, TA has to take a stand in the current crises of democracy in many countries. This also holds when TA goes beyond countries with a democratic tradition. On the global stage, TA is faced with different political and cultural traditions in many regions of the world. Hence, intercultural work and reflection are required in order to arrive at a global TA (Hahn and Ladikas 2018) without either losing its democratic roots or becoming paternalistic (Section 6).

2. Conceptual framework of TA

TA is an interdisciplinary field of scientific research and advice, which aims to provide knowledge and orientation for better-

informed and well-reflected decisions concerning new technologies and their consequences. It shall, according to TA literature, enrich technology governance by integrating any available knowledge on possible side effects at the early stage of decision-making processes, by supporting the evaluation of technologies against a broad set of societal values and ethical principles, by elaborating strategies to deal with the inevitable uncertainties, and by contributing to the constructive handling of societal conflicts.

The need for TA was expressed about fifty years ago in daily politics rather than by science (Bimber 1996). This origin story is different from many others at the interface between science, technology, and policy. The ozone hole, for example, was discovered by scientists who then alarmed policymakers (Parson 2004). Analogously, the necessity of climate protection policies was first expressed by climate researchers. In the case of TA, the increasing significance of science and technology for almost all areas of individual and collective life, in combination with the ambivalence of the technological advance in many respects, motivated a diagnosis of the need for orientation. In the meantime, additional demands such as the imperative of sustainable development (WCED 1987) occurred, which led to a complex portfolio of demands and needs for TA:

- Increasing influence of scientific and technological advances on all areas of society and individual life
- Occurrence of unintended side effects of scientific and technological advance, some of which showed dramatic extensions
- Emergence of technology conflicts, and legitimization problems for science and technology
- Threats of technocracy and challenges to realizing substantial democracy in many fields of technology governance
- The imperative of sustainable development and its consequences for the development, use and disposal of technology
- Emergence and power of visionary debates involving technology futures in public debate and political decision-making
- Far-ranging changes at the interface between science and society and the emergence of new epistemic regimes

Three focal branches of TA practice can be distinguished empirically, which address different targets and involve different actors in overall technology governance (Grunwald 2015, 2019):

1. TA was initially conceptualized as *policy advice* (Bimber 1996). The objective is to support policymakers in addressing the above-mentioned challenges by implementing political measures, such as adequate regulation, sensible research funding, and strategies toward sustainable development and responsible innovation. In this mode of operation, TA does not *directly* address technology but rather considers the *boundary conditions* of technology development and use to be shaped by the political system.
2. During the past few decades, citizens, consumers and users, civil society actors, stakeholders, the media, and the public increasingly demand to be engaged in technology governance, for example, for siting processes of waste disposal facilities, shaping energy infrastructures, and prioritizing the public research agenda. Participatory TA developed approaches to involve these groups in different roles at different stages of technology governance (Joss and Bellucci 2002; Abels and Bora 2016).
3. A third branch of TA is related directly to technology development and engineering. Departing from analyses of the genesis of technology within the framework of social constructivism (Bijker et al. 1987), the idea of *shaping technology* due to social expectations and values has motivated the development of approaches such as Constructive TA (CTA; Schot 1992), which aims to facilitate 'better technology in a better society' (Rip et al. 1995). This approach is among the roots of the current RRI movement (Owen et al. 2013; van den Hoven et al. 2014).

This TA 'trinity' (Grunwald 2019: 51) shows a broad variety of obviously heterogeneous TA practices. Therefore, the question of the existence of a conceptual core of TA beyond the diversity poses itself. In order to identify commonalities among the many and various TA activities, it is crucial to determine the overall *cognitive interest* of TA. The concept of the *cognitive interest* (*Erkenntnisinteresse*) was proposed by Habermas (1971). His observation was that the research process in the sciences is not only oriented to human curiosity but rather to more specific interests. This concept is an appropriate point of departure for identifying an umbrella perspective for TA. This cognitive interest was recently reconstructed as (Grunwald 2019: 88):

> supporting, strengthening and enhancing reflexivity in all epistemic and social fields of reasoning and decision-making on shaping the scientific and technological advance, on the usage of its outcomes and on dealing with the consequences to present and future society.

There is no doubt that TA in all of its practical manifestations is about enhancing the reflexivity of deliberation, debate, and decision-making processes in scientific and technological progress, on making use of its products and results, and on dealing responsibly and constructively with the consequences. However, enhancing reflexivity is a rather abstract notion and has to be made more specific. This can be done by introducing three conceptual dimensions of TA (Grunwald 2019: 92ff): providing and assessing prospective knowledge (anticipation), including different perspectives, values, and pieces of knowledge (inclusion), and systems thinking with reflections on relevance (complexity):

- *anticipation* addresses the dimension of time when facing an open future: enhancing reflexivity *over time*;
- *inclusion* addresses the manifold of different perspectives to be involved: enhancing reflexivity *across perspectives*;
- *complexity* management addresses the necessity of judgments on relevance: enhancing reflexivity *over relevance*.

These dimensions open up the field for developing and practicing concepts and methods in the different disciplines and fields of research, which contribute to TA in fulfilling its mission as a response to the demand portfolio (see at the top of this Section).

Figure 1 provides a quick view of the resulting overall picture of TA. It starts at the top with the societal needs and demands for orientation (cf. list at the top of this Section). TA, working in the dotted box according to the framework described, produces outcomes as responses to those needs and demands (at the bottom). These outcomes will have an impact in the real world by responding to the demands and needs, for example, by providing new insights for decision-making processes. In this way, TA is a research-based part of societal learning processes (Wynne 1995), contributing to dealing constructively and responsibly with the technological advance and its outcomes in a more reflexive manner (Grunwald 2019: 88).

3. Supporting democracy: elements of TA's history

TA has a strong tradition in providing scientific advice to democratic institutions (Section 3.1). In the recent decades, TA has increasingly

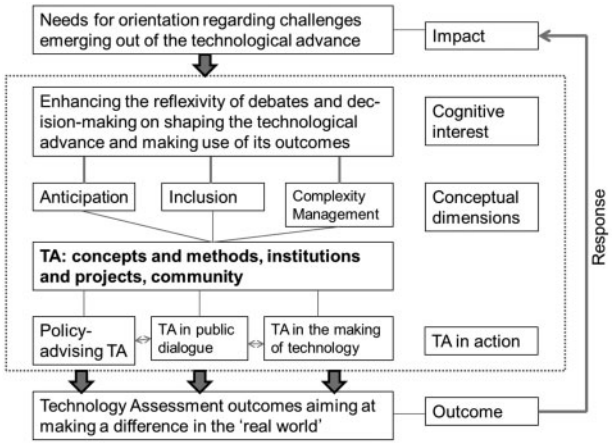

Figure 1. Framework of technology assessment.

Source: Grunwald 2019: 89.

developed and applied deliberative and participatory processes, contributing to a stronger democracy (Section 3.2).

3.1 TA serving democratic institutions

The birthplace of institutionalized TA was the US Congress (Bimber 1996). The origin of TA as rooted in the demands of politics has two sides: (1) a very special and (2) a more general side (Grunwald 2019: 40). First, the specific background to the invention of parliamentary TA in the US Congress consisted in concerns about the increasingly asymmetrical access to politically relevant expertise between the legislative and executive bodies in US federal government (Kunkle 1995; Bimber 1996). While the executive, thanks to the official apparatus at its command and enormous financial resources, had access to practically any amount of knowledge and advice, Congress lagged behind and had no independent sources of knowledge. This was considered to endanger the balance of power between the legislative and the executive forces, which is so important in US democracy. From this point of view, the political aim related to the establishment of parliamentary TA was to restore parity between the executive and the legislative forces: '[W]e recognize our responsibility to the people and the necessity for making some independent judgments . . . [but] we do not particularly have the facilities nor the resources that the executive department of government has' (George Miller, Democratic Party, quoted after Kunkle 1995). Against this background, the US congressional representative Emilio Daddario, a member of the Democratic Party, coined the term 'technology assessment' and heavily influenced its basic policy-advising approach (Kunkle 1995; Bimber 1996). Senator Edward Kennedy, an eminent politician of the Democratic Party for decades, was also among the founding fathers of TA.

The foundation of parliamentary TA was institutionalized by establishing the OTA, which was made possible by the Technology Assessment Act (United States Senate 1972) approved by both Houses of the Congress in 1972. It declares:

a. As technology continues to change and expand rapidly, its applications are
   1. large and growing in scale; and
   2. increasingly extensive, pervasive, and critical in their impact, beneficial and adverse, on the natural and social environment.
b. Therefore, it is essential that, to the fullest extent possible, the consequences of technological applications be anticipated, understood, and considered in determination of public policy on existing and emerging national problems.

Second, interestingly, the motivation of the US Congress here extends beyond the political context of restoring parity between the legislative and executive bodies. It also recalls the basic motivations of TA, such as the increasing significance of science and technology for many policy fields and the occurrence of unintended effects. The combination of these concerns with the issues of strengthening democracy is absolutely not self-evident, but motivated the original OTA concept of TA.

OTA became a model for parliamentary TA for many other countries (Vig and Paschen 1999), which is still the case today, particularly in Europe, despite OTA's crisis and closure in 1995 (Bimber 1996). In the meantime, parliamentary TA has developed various forms of institutionalization (Cruz-Castro and Sanz-Menendez 2004; Nentwich 2016). Its tasks include providing different types of advice, such as informing parliaments on emerging issues in scientific and technological progress, preparing them for future developments, exploring and analyzing opportunities and needs for action, developing alternative options for political measures in the fields of regulation, research funding and innovation policy, and bridging the gap between parliaments and public dialogue (PACITA 2012). Through these activities, parliamentary TA contributes to reflexive modernization (Delvenne et al. 2011).

Many European states and the European Parliament, inspired in part by the OTA, established their own TA agencies from the mid-1980s onward (PACITA 2012). Examples are the OTA at the German *Bundestag* (Grunwald 2006; Hennen et al. 2012), the Dutch Rathenau Instituut, and the Norwegian Board of Technology. The European TA institutions founded the EPTA (European Parliamentary Technology Assessment) network in 1990, later joined by countries, such as Japan, Mexico, and Chile. The US General Accountability Office (GAO), partially replacing the former OTA, also became an associate member.

A huge variety of different forms of scientific policy advice to executive bodies and governments have been established. New activities initiated by governmental bodies inform the executive about the possible effects of new technology and address the ambivalence of new science and technology in its very early stages of development. Examples are EHS studies (environment, health, safety) addressing possible unintended effects of new technology for the environment, human health, or safety issues; ELSI studies (ethical, legal, social implications) focusing on the societal side of the technological advance through ethics, law, and the social dimension; and finally projects on risk perception, risk communication, and risk management. In the parliamentary field, the frame of TA is used in spite of this wide diversity (e.g. Siune et al. 2009), but there is no common umbrella term in the area of scientific policy advice to governments and other executive bodies (OECD 2015). Though these advisory structures, projects, and activities are often not named as TA, a closer look soon shows that they fit well with the general characterization of TA (Section 2).

3.2 TA supporting deliberative democracy

Participation has developed into a key issue for TA (e.g. Renn 1999; Joss and Bellucci 2002; Zhao et al. 2015). Beginning in the 1970s with some front-runners (e.g. the citizens' jury approach), and fueled by the social movements of the 1980s, in particular by the peace and environmental movements, and supported by demands for a more deliberative democracy (Barber 1984), demands for the

participation and engagement of citizens increased considerably, both in many Western countries and beyond (Saretzki 2009). In particular, the Sustainable Development Goals (SDGs) approved by the United Nations (UN) in 2015 (UN 2015) include the ideal of inclusion and participation. According to these normative ideas, the assessment and evaluation of technology should be left neither to the scientific experts nor to the political decision-makers or to the economy (Habermas 1970). It is the task of participative TA to include societal groups—stakeholders, affected citizens, non-experts, and the public in general—in assessing technology and its consequences (Hennen 2012b).

In this manner, participative TA procedures are deemed to improve both the practical and political legitimacy of decisions about technology (Fischer 1990; Abels and Bora 2016). Participatory TA is informed and advised by science and experts but also involves people and groups external to science and politics. This involvement may take place in a variety of settings and with regard to different objectives (Joss and Bellucci 2002; Saretzki 2009). The idea of TA being deliberative and participatory is at the core of its conceptual dimension of *inclusion* (see above) and follows several objectives, depending on context (Grunwald 2019: 64):

- Participation as a value in itself (for reasons of deliberative democracy)
- Participation for improving TA's *process* quality (e.g. with respect to inclusion)
- Participation for improving TA's *product* quality (concerning its outcomes)
- Participation for strengthening long-term thinking (beyond the short term of daily politics)
- Participation for creating or improving acceptance (of certain measures)
- Participation for creating, fueling, and deepening public debate
- Participation for bridging decision-making in democratic institutions and public debate
- Participation for enriching agenda setting (for research policy toward a demand-pull approach)
- Participation for supporting transformation (e.g. with respect to a more sustainable future)

Beyond this variety of objectives and ends for participatory TA, a common expectation is that the participation of citizens and those affected should improve the knowledge base as well as the values fundament on which opinions are formed, judgements are based, and decisions are made (Hennen 2012a). Local knowledge, with which experts and decision-makers are often not familiar, should be used to achieve the broadest possible knowledge base and to substantiate decisions. Taking the interests and values of more (ideally *all*) of those affected into consideration in the decision-making process will improve the robustness of decisions and enhance their legitimacy (Gibbons et al. 1994; Hennen 2012a).

Participation is also a constitutive element in the CTA (Rip et al. 1995), which was motivated by the social constructivist movement (Bijker et al. 1987; Bijker and Law 1994). It aims at improved, and in particular more inclusive, processes of technology design and development. In contrast to policy-advising TA, CTA engages directly in the 'making' of technology by involving societal actors in development processes, including key economic players, stakeholders, and citizens. Thereby, CTA wants to promote the emergence of a learning society concerning its engagement with technology (Wynne 1995).

The terms *responsible development*, *responsible research*, and *responsible innovation* (RRI) have been used increasingly over recent years (Owen et al. 2013; van den Hoven et al. 2014). They can be regarded as umbrella terms for TA (in particular CTA), ethics, and foresight. The RRI framework (Stilgoe et al. 2013) includes the category of inclusiveness, which also implies a high priority for participatory processes. Hence, CTA and RRI both have a strong focus on democracy in the sense of *inclusion*, although unlike policy-advising TA they do not focus specifically on democratic institutions and processes (cf. Grunwald 2019: 167ff for this difference).

In order to summarize this point, it can be stated that participatory TA is one of the fields of practice of an emerging deliberative democracy (Bächtiger et al. 2018). But TA is also a means to strengthen this type of strong democracy (Barber 1984). TA is motivated to go in this direction through its conceptual dimension of inclusion (Section 2), which is rooted in normative theories of democracy (Section 4).

4. Normative roots of TA

The next step of the argument addresses the philosophical roots of the historic and empirical development of TA presented above. The early work of Jürgen Habermas on the relations between science, politics, and the public was very influential. Published in the 1960s, in parallel to the emergence of TA to serve the institutions of democracy, it had considerable influence on the conceptual development of TA (Saretzki 2015). In my reading, the work of Jürgen Habermas, which is strongly rooted in the ideas of the American philosopher John Dewey, has been crucially important for the conceptualization of TA, in particular of its obligation to inclusion.

Dewey's point of departure (Dewey 1927) is a liberal view of citizens in modern society, oriented to the idea of human rights, according to, for example, the constitution of the USA with its roots in the European Enlightenment. Dewey's basic observation is that indirect consequences of human action occur which might affect the rights and freedom of others. Dewey regards the regulation of these indirect consequences as the main business of politics, while the common awareness of these indirect consequences forms the public, according to his conception. In accordance with the normative fundament of liberalism and human rights, he introduces democracy as the combination of the regulation of indirect consequences and the normative expectation that ideally *everyone* should be involved in the regulatory process:

> . . . democracy is the regulation of the public interest arising from indirect consequences and related conflicting interests; it is combined with the idea that everyone should be involved and, in principle, regarded as a person capable of co-deciding about a regulation of such indirect consequences. (Dewey 1927: 147)

This introduction of politics, the public, and democracy is very attractive to TA because it can directly be coupled with the issue of unintended consequences of technology: while the use of technology benefits many persons, it might cause burden, risk, or even damage to others. The emission of greenhouse gases while going from A to B by car is a simple but illustrative example: while the direct (and intended) consequence of the journey will be to move a person from A to B, the indirect consequence is the loss of nonrenewable resources and a contribution to climate change, causing risks for other persons, other regions, and future generations. These unintended consequences of technology form a specific area of what Dewey denoted as indirect consequences in general. Their regulation is the task of politics, awareness of them creates a public around those issues, and a democratic way of regulation should include everyone.

This structural neighborhood explains the strong role for Dewey's approach in TA and related fields of scientific policy advice (Kowarsch 2016).

A public will emerge around such indirect effects as soon as some threshold of (perceived) importance or significance is passed. Dewey (1927: 64) identified three characteristics of such thresholds of significance. He stated that indirect consequences often motivate public concern if they are '(1) long-lasting and enduring, (2) extensive, that is, affecting many in a similar way, sometimes even repeatedly, and (3) serious and often irreparable' (Kowarsch 2016: 21). This list reads exactly like a list of characteristics of major unintended consequences related to the scientific-technological advance and the use of its outcomes. The book *Silent Spring* by Rachel Carson (1962), the Chernobyl disaster (1986), the first cloned sheep Dolly (1997), the first *in vitro* fertilized baby Louise Brown (1978) and the report 'Limits to Growth' (Meadows et al. 1972) can all be regarded as catalysts, which created public awareness of the respective issues, according to Dewey's criteria.

John Dewey was also aware of the significance of scientific advice for policymaking and public dialogue. He diagnosed scientific research and advice as being required to recognize and investigate these consequences, which defines role expectations toward TA:

> An intelligent public debate into indirect consequences – as public concerns – and their regulation is needed, which requires support from scientific experts as well as transparency in public affairs. (Dewey 1927: 167)

Jürgen Habermas developed Dewey's approach at the occasion of the debate on technocracy in the 1960s. He adopted Dewey's model of democracy as one of the roots of his own thoughts (Habermas 1970) and expanded it toward the model of a deliberative democracy (Habermas 1992). Deliberation should, in principle, be *inclusive*, taking Dewey's postulate seriously that *everybody* should be involved in public dialogue on regulating indirect consequences (Grunwald 2019: 151ff).

Habermas' 'pragmatist' approach of the relation between science, the public, and politics is twofold (Saretzki 2015). First, similarly to Dewey (1927), and Jonas's 'Imperative of Responsibility' (1979), he states that scientific expertise and advice are needed to systematically oversee the consequences and implications of decisions. Therefore, experts and decision-makers should meet in appropriate formats, which lead to the necessity of scientific policy advice. However, without any further clarification, the idea of scientific policy advice would also be compatible with a technocratic type of advice. Networks of experts could consult policymakers in closed spaces without public transparency and could heavily influence political decision-making, and at an extreme could even determine their results.

In order to prevent such possibilities, Habermas postulated that the advice provided by experts to policymakers should be transparent to an imagined 'audience of citizens'. While *de facto* participation of everybody, as postulated by Dewey (see above), is obviously impossible for many practical reasons, Habermas suggested a regulative idea: policy advice should happen under the imagined eyes of citizens. Scientific experts and policymakers should discuss their issues in a dome of glass, metaphorically speaking. Experts should advise policymakers 'as if' the public were involved and 'as if' it could listen to the experts and could intervene in the communication between experts and policymakers. This 'as if' model of scientific policy advice again reminds us of Dewey: any advice concerning the regulation of indirect consequences (to recall Dewey's notation) should be created and provided 'as if' everybody could intervene in the game at any time.

The pragmatist model directly leads to the cognitive interest of TA, in particular to the conceptual dimension of *inclusion* (Section 2). This basic argumentation, developed by John Dewey and Jürgen Habermas, was adopted and developed by scholars in different fields (Kowarsch 2016) and in particular in TA (Saretzki 2015). It has also been taken as point of departure for postulating and developing participatory approaches (Renn 1999; Skorupinski and Ott 2000; Saretzki 2009) and is among the major background narratives of TA in general. In the recent decades, the theoretical 'as if' model of Habermas has been transcended toward the establishment of many forms of real and practical public dialogues in participatory TA (Joss and Bellucci 2002; Abels and Bora 2016).

This consideration reveals that the strong democratic tradition of TA in its practice (Section 3) is rooted in normative conceptions of humans and of the way humans should regulate their affairs. The cognitive interest of TA (Section 2) is based on these roots and puts TA into intimate neighborhood with democracy. TA in a dictatorship would be a poor version, lacking the conceptual dimension of *inclusion*, which must be a constitutive issue in the entire TA process (Fig. 1; cf. Grunwald 2019: section 4.3). Therefore, TA is not value-neutral (Delvenne 2018), but is bound to values of human rights, the rights of citizens, division of power, and other crucial issues of a democratic and inclusive society.

5. Some implications

The model of TA introduced above involves a certain view on the relations between citizens, politics, science, and policy advice. Taking the model seriously has many implications for TA's practice (and probably also for many other fields of scientific policy advice).

1. *Reflection and improvement*: The Dewey–Habermas model is highly ambitious in normative respects. The postulate for the inclusion of everybody in pubic deliberation, the strong role of argumentative deliberation, and the normative view of humans going back to Immanuel Kant are often in contradiction with empirical data of how humans behave factually, and how decision-makers act strategically. Criticism of normative models frequently calls them simply *unrealistic* (Posner 2004). However, human reasoning addresses not only questions of how the world functions but also ideas of how it *should* function (MacIntyre 1981). This twofold view on the world, here on issues of TA, opens up the possibility of uncovering gaps between the Is and the Ought (Reber 2016). The recognition of Is/Ought differences can then be transformed into motivations for reflection, critique, learning, action, and improvement of the current situation. Regarding the normative ideal as the Ought and understanding, the Is/Ought difference as a motivation for learning and change is key for any oriented development. This constellation leads to a strong obligation for TA to continuously reflect on its own approaches, practices, and methods, and to think about improvements in the directions oriented by the normative fundament. This can be regarded as the self-application of TA's cognitive interest to its own practice.
2. *Strengthening inclusion*: The message of the Dewey–Habermas model is that inclusion is not only an issue for functional arguments in modern democracy. Rather, inclusion is necessary for normative reasons and as a value in itself (Grunwald 2019: 64ff). This observation implies that TA has to foster its

engagement with inclusive methods and approaches. TA then is not a user of participatory methods but an *issue advocate* (Pielke 2007; cf. also point 5 below) in terms of broader inclusion, which includes the obligation to work toward the respective empowerment of citizens and stakeholders.

3. *Increasing complexity*: While many actors in politics and public debate claim that complexity must be reduced and that things must be made as simple as possible, TA usually adds further complexity. Often, TA comes up with new issues and items to be taken into account *in addition* to what was originally under discussion. Its inclusive approach renders simplistic views on new technology or transformation processes inadequate (Stirling 2010). Enhancing reflexivity through TA implies that more time, resources, and effort will be required for reasoning, deliberation, and decision-making. Obviously, TA has to work on approaches and methods regarding how to deal constructively and responsibly with this increased complexity (Grunwald 2019: 194ff).
4. *Thinking in alternatives:* Scientific policy advice often closes down spaces of decision-making and recommends implementing one solution, which is regarded as the best or optimal one (Collingridge and Reeve 1986; Stirling 2008). In this approach, policy advisors from science and engineering assume, either implicitly or explicitly, that 'science knows best' in determining societal futures in areas, such as energy supply, self-driving cars, or the digitization of work. The expectation with regard to politics is then to implement the assumed 'one best solution'. However, TA's conceptual dimension of inclusion (Fig. 1) renders this impossible. An objectively optimal option cannot exist because its determination would necessarily involve normative issues, such as values, political positions, images of humans and society, understandings of justice, and so forth (Grunwald 2003; Wynne 2016). Hence, denoting a specific solution to the problem under consideration as the optimal one exceeds the mandate and expertise of science. Rather, science can provide policymakers and society with a spectrum of alternative options based on the same scientific and technological expertise, but orientated to different values, interests, norms, visions of the future, and political positions. Consequently, *thinking in alternatives* is the appropriate mode of operation of TA, so that it should operate in the mode of an *honest broker* (Pielke 2007) in assessing new technology and issues of transformation: 'Policy alternatives come from experts. It is the role of experts in such a system to clarify the implications of their knowledge for action and to provide such implications in the form of policy alternatives to decision makers who can then select among different possible courses of action' (Pielke 2010: 5). The selection among the alternatives has to be left to the democratic decision-making procedures reflecting public debate.
5. *Supporting and developing democracy*: The normative fundament of TA excludes the idea that TA could be just a neutral and distant observer of democracy (Delvenne 2018). In particular, in times of crisis of democracy, TA has to take a stand, in order to defend and strengthen democracy but also to develop it further (cf. point 2 above). It is not accidental that most of the populist movements of the recent ten years do not sympathize with TA. TA is not neutral at the level of the political regime but must instead be an *issue advocate* (Pielke 2007) in favor of (in particular deliberative) democracy.

Hence, we can observe the coexistence of different roles for TA at different levels. TA must be an *issue advocate* in debates and struggles about the *procedural* system of public decision-making due to its obligations to democracy (Section 4). Simultaneously, and due to the same obligation, but in particular to its conceptual dimension of inclusion, TA has to be an *honest broker* concerning the *substantial* assessments of specific technologies and transformational strategies.

6. Perspective: toward a global TA

TA has its origins in Western culture and has developed mostly in industrialized countries. In addition, for large parts of TA's history, its practice has been closely related to national decision-making processes and regimes, for example, in the field of parliamentary TA (Section 3). However, technology development and innovation strategies today are often in the hands of global actors in science and engineering and in the economy (Hahn 2019). Far-reaching challenges such as climate change and worldwide digitization need TAs and transformational strategies on the global level, beyond the sphere of nation-states. However, the step from a national toward a transnational and even global TA is ambitious. Technologies are perceived differently in different cultures, technology governance differs according to political traditions, and the institutional setting for TA can be vary from case to case (cf. Hahn and Ladikas 2018 including case studies e.g. from China, India, and Australia). Therefore, the simple transfer of TA ideals originating in Western culture to other parts of the world will not work. Even direct transfer from European countries with a long tradition of parliamentary TA to other European countries without that tradition is impossible (PACITA 2012). Instead, new institutional approaches have to be explored for new settings and traditions. Therefore, global TA needs not only specific efforts toward creating an infrastructure for TA at the global level but also procedures and communication activities to achieve a common understanding of technology, innovation, and TA both across geographical regions of the world and across cultures.

An example was provided in the framework of the SDGs of the UN (cf. UN 2015). It is obvious that developing and implementing technology for reaching sustainability goals needs at least some kind of TA at the global level. The possible consequences of technologies, independent of whether these already exist or still have to be developed, must be assessed with respect to the assumed implications for the SDGs (Grunwald 2019: 220ff). This assessment needs to be reflexive and has to involve the dimensions of anticipation, inclusion, and complexity management (Fig. 1). Hence, TA-like assessment processes are needed. The Technology Facilitation Mechanism (TFM) postulated by the UN (2015) could provide an opportunity to establish global assessment processes on technology. These could then be used to create practical experience and to start learning processes. Therefore, the TA community should engage in giving substance to this mechanism.

As presented above, any global TA has to deal with the challenge of doing TA in a multicultural environment. Different regions of the world are rooted in different cultural traditions, and have disparate historical experiences and perspectives on how to meet the challenges TA is faced with (see above). They perhaps even perceive these challenges and resulting motivations for TA in a different way, in particular involving different perspectives on ethics (Ladikas et al. 2015), but also on wide-ranging conceptualizations of humans, technology, and nature (Hahn and Ladikas 2018).

In particular, when looking beyond the Western world, things become much more complex for TA with respect to different

understandings of democracy and alternative images of the relations between individuals and the collective (Hahn 2019). Additionally, disparate historical experiences will play a role, for example, concerning European colonialism and the catastrophes of the 20th century. Looking, for example, to countries such as Brazil, Russia, South Africa, India, and South Korea gives an impression of the wide diversity of cultures involved. At this point, TA's conceptual dimension of inclusion (Fig. 1) leads to a broadened understanding and an extended range of meaning: global TA also has to include perspectives from different cultures. Hence, intercultural work is required in global TA in several respects, ranging from linguistic, cultural, and religious issues to historical experiences, and current perceptions of the global situation and the respective cultural contexts.

But beyond the issue of cultural diversity, it is important to note that democracy has a core set of values and related procedures, which distinguishes it from other political systems. If these values were to be violated or if the procedures were to be undermined, for example, when populist movements obtain a majority, then TA would run into serious problems. TA could still work in its conceptual dimension of anticipation, but realizing inclusion would probably become impossible, leading to a conflict with TA's own conceptual foundation (Fig. 1). Therefore, TA cannot be neutral with respect to the governance system it serves, but has to work in favor of democracy. Otherwise, TA would render itself inconsistent.

Therefore, establishing global TA across different cultural contexts but also in different government and governance regimes is a significant challenge to future work. The deep-lying democratic fundament of TA emphasized in this article should serve as an orientation, in particular with regard to its conceptual dimension of *inclusion*.

References

Abels, G., and Bora, A. (2016) 'Ethics and Public Participation in Technology Assessment', DOI: 10.13140/RG.2.2.35586.89282 accessed 22 November 2018.

Bächtiger, A., Dryzek, J., Mansbridge, J. et al., eds (2018) *The Oxford Handbook of Deliberative Democracy*. Oxford: Oxford University Press.

Barber, B. (1984) *Strong Democracy. Participatory Politics for a New Age*. Berkeley, CA: University of California Press.

Bijker, W., Hughes, T., and Pinch, T., eds (1987) *The Social Construction of Technological Systems. New Directions in the Sociology and History of Technological Systems*. Cambridge, MA: MIT Press.

——, and Law, J., eds. (1994) *Shaping Technology/Building Society*. Cambridge, MA: MIT Press.

Bimber, B. (1996) *The Politics of Expertise in Congress: The Rise and Fall of the Office of Technology Assessment*. New York: State University of New York Press.

Collingridge, D., and Reeve, C. (1986) *Science Speaks to Power: the Role of Experts in Policymaking*. London: Frances Pinter.

Cruz-Castro, L., and Sanz-Menendez, L. (2004) 'Politics and Institutions: European Parliamentary Technology Assessment', *Technological Forecasting and Social Change*, 27: 79–96.

Decker, M., and Ladikas, M., eds (2004) *Bridges Between Science, Society and Policy. Technology Assessment – Methods and Impacts*. Berlin: Springer.

Delvenne, P. (2018) 'Breaking the Myth of Neutrality: Contemporary Politics and Normativities in and of Technology Assessment'. Presentation at the TA18 Conference at Vienna, <https://orbi.uliege.be/handle/2268/226117> accessed 22 November 2018.

——, Fallon, C., and Brunet, S. (2011) 'Parliamentary Technology Assessment as Indications of Reflexive Modernization', *Technology in Society*, 33: 36–43.

Dewey, J. (1931) 'Science and Society', in Dewey J. (ed.) *The Later Works 1925–1953*, Vol. 6, pp. 53–63. Carbondale, Illinois: Southern Illinois University Press.

—— (1927) *The Public and Its Problems*. New York.

Fischer, F. (1990) *Technocracy and the Politics of Expertise*. London: Sage Publications.

Gibbons, M. et al. (1994) *The New Production of Knowledge*. London: Sage.

Grunwald, A. (2003) 'Technology Assessment at the German Bundestag: 'Expertising' Democracy for 'Democratising' Expertise', *Science and Public Policy*, 30: 193–8.

—— (2006) 'Scientific Independence as a Constitutive Part of Parliamentary Technology Assessment', *Science and Public Policy*, 33/2: 103–13.

——, (2015) 'Technology Assessment and Design for Values', in J. Hoven et al. (eds) *Handbook of Ethics, Values, and Technological Design*, pp. 67–86. Dordrecht, Netherlands: Springer.

—— (2019) *Technology Assessment in Practice and Theory*. London: Routlege.

Habermas, J. (1970) *Toward a Rational Society*. London: Heinemann.

—— (1971) *Knowledge and Human Interest*. Boston: Beacon Press.

—— (1992) *Between Facts and Norms: Contributions to a Discourse Theory of Law and Democracy*. Boston: Beacon Press.

Hahn, J. (2019) 'Towards a Global Technology Assessment – Insights from Cases in Germany, China, India and Beyond', PhD thesis, Karlsruhe Institute of Technology.

——, and Ladikas, M., eds (2018) *Towards a Global Technology Assessment*. Karlsruhe: KIT Scientific Publishing.

Hennen, L. (2012a) 'Why Do We Still Need Participatory Technology Assessment?', *Poiesis & Praxis*, 9: 27–41.

—— (2012b) 'Parliamentary Technology Assessment in Europe and the Role of Public Participation', in K. O'Doherty and E. Einsiedel (eds) *Public Engagement and Emerging Technologies - Proceedings of the Conference in Banff, Canada, 10/2010, pp*. 27–44. Vancouver, Canada: UBC Press.

——, and Nierling, L. (2013) *A Cross-European Comparative Analysis of Barriers and Opportunities for Establishing Technology Assessment as a Means of Policy Advice*. Karlsruhe: KIT Scientific Working Papers 9.

——, ——, and Hebakova, L. (2012) 'Parliamentary TA in Germany', in J. Ganzevles and R. van Est (eds) *TA Practices in Europe*, pp. 100–20. Brussels: European Commission.

Joss, S., and Bellucci, S., eds (2002) *Participatory Technology Assessment – European Perspectives*. London: Westminster University Press.

Kowarsch, M. (2016) *A Pragmatist Orientation for the Social Sciences in Climate Policy*. Berlin: Springer.

Kunkle, G. C. (1995) 'New Challenge or the Past Revisited? The Office of Technology Assessment in Historical Context', *Technology in Society*, 17: 175–96.

Ladikas, M., Chaturvedi, S., Zhao, S., Stemerding, D. eds (2015) *Science and Technology Governance and Ethics: A Global Perspective from Europe, India And China*. Heidelberg u.a.: Springer Open.

MacIntyre, A. (1981) *After Virtue: A Study in Moral Philosophy*. Notre Dame, IN: University of Notre Dame Press.

Meadows, D. et al. (1972) *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind*. New York: Universe Books.

Nentwich, M. (2016) *Parliamentary Assessment Institutions and Practices*, ITA Manu:scripts ITA-16-02. Vienna: Institute of Technology Assessment.

OECD (2015) 'Scientific Advice for Policy Making: The Role and Responsibility of Expert Bodies and Individual Scientists'. OECD Science, Technology and Industry Policy Papers, No. 21, OECD Publishing, Paris <http://dx.doi.org/10.1787/5js33l1jcpwb-en> accessed 22 November 2018.

Owen, R., Bessant, J., Heintz, M., eds (2013) *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*. London: Wiley.

PACITA (2012) 'TA Practices in Europe. Report of the PACITA Project' <www.pacitaproject.eu/wp-content/uploads/2013/01/TA-Practices-in-Europe-final.pdf> accessed 22 November 2018.

Parson, E. (2004) *Protecting the Ozone Layer: Science and Strategy*. Oxford: Oxford University Press.

Pielke, R. (2007) *The Honest Broker: Making Sense of Science in Policy and Politics*. Cambridge University Press.

—— (2010) 'Expert Advice and the Vast Sea of Knowledge', in A. Bogner, K. Kastenhofer, and H. Torgersen (eds) *Inter- und Transdisziplinarität im Wandel?*. Baden-Baden: NOMOS.

Posner, R. A. (2004) 'John Dewey and the Intersection of Democracy and Law', in Elias L. Khalil (ed.) *Dewey, Pragmatism, and Economic Methodology*. pp. 167–186. London: Routledge.

Reber, B. (2016) *Precautionary Principle, Pluralism, Deliberation. Science and Ethics*. London: Wiley-ISTE.

Renn, O. (1999) 'Participative Technology Assessment: Meeting the Challenges of Uncertainty and Ambivalence', *Futures Research Quarterly*, 15: 81–97.

Rip, A., Misa, T., and Schot, J., eds (1995) *Managing Technology in Society*. London.

Saretzki, T. (2009) 'From Bargaining to Arguing, from Strategic to Communicative Action? Analytical Distinctions and Methodological Problems in Empirical Studies of Deliberative Policy Processes', *Critical Policy Studies*, 3: 153–83.

—— (2015) 'Habermas, Critical Theory and Public Policy', in F. Fischer, D. Torgerson, A. Durnová et al. (eds) *Handbook of Critical Policy Studies*, pp. 67–91. Cheltenham: Edward Elgar.

Scherz, C., and Merz, C. (2016) 'Parliamentary TA: Lessons to Be Learned from the Established', in A. B. Moniz and K. Okuwada (eds) *Technoloy Assessment in Japan and Europe, pp*. 57–74. Karlsruhe: KIT Scientific Publishing.

Schot, J. (1992) 'Constructive Technology Assessment and Technology Dynamics: The Case of Clean Technologies', *In: Science, Technology and Human Values*, 17: 36–56.

Siune, K. et al. (2009) 'Challenging Futures of Science in Society'. Report of the MASIS Expert Group. Brussels: European Commission.

Skorupinski, B., and Ott, K. (2000) *Ethik und Technikfolgenabschätzung*. Zürich: ETH.

Stilgoe, J., Owen, R., and Macnaghten, P. (2013) 'Developing a Framework for Responsible Innovation', *Research Policy Policy*, 42: 1568–80.

Stirling, A. (2008) 'Opening Up and Closing Down: Power, Participation, and Pluralism in the Social Appraisal of Technology', *Science, Technology and Human Values*, 33: 262–94.

—— (2010) 'Keep It Complex', *Nature*, 468: 1029–31.

UN – United Nations (2015) 'Sustainable Development Goals', <www.un.org/sustainabledevelopment/sustainable-development-goals/> accessed 22 November 2018.

United States Senate (1972) 'Technology Assessment Act of 1972'. Report of the Committee on Rules and Administration, 13 September 1972. Washington, DC.

van den Hoven, J. et al., eds (2014) *Responsible Innovation 1. Innovative Solutions for Global Issues*. Dordrecht: Springer.

Vig, N., and Paschen, H., eds (1999) *Parliaments and Technology Assessment. The Development of Technology Assessment in Europe*. Albany: State University of New York Press.

von Schomberg, R., ed (1999) *Democratizing Technology. Theory and Practice of a Deliberative Technology Policy*. Hengelo.

WCED – World Commission on Environment and Development (1987) *Our Common Future*.

Wynne, B. (1995) 'Technology Assessment and Reflexive Social Learning: Observations from the Risk Field', in A. Rip, T. Misa, and J. Schot (eds) *Managing Technology in Society*, pp. 19–36. London.

—— (2016) 'Ghosts of the Machine: Publics, Meanings and Social Science in a Time of Expert Dogma and Denial', in J. Chilvers, and M. Kearnes (eds) *Remaking Participation: Science, Environment and Emergent Publics*, pp. 99–120. London: Routledge.

Zhao, Y. et al. (2015) 'Public Engagement in the Governance of Science and Technology', in M. Ladikas et al. (eds) *Science and Technology Governance and Ethics: A Global Perspective from Europe, India and China*, pp. 39–51. Heidelberg u.a.: Springer Open.