Imaginaries of innovation

Turning technology development into a public issue

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Abstract

New technologies will have a big impact on our public life-world, suggesting that it is necessary to have a public debate on innovation. Such a debate is missing: instead of having a debate on the process of technology development, only expected effects of new technologies are discussed. This is undesirable as innovation processes recruit implicit normative assumptions that should opened up for public scrutiny. This paper aims to outline conditions and possibilities for organizing such public debates on innovation. It will do so by depicting innovations as wilful metamorphoses which materialize worldviews and expectations entertained by technology developers. Existing technology assessment organizations could instigate discussions on the desirability and credibility of these worldviews and expectations, so to further democratize the process of technology development.

1. Introduction

New technologies such as big data, the integration of different types of infrastructures, genetic engineering, nanotechnology, synthetic biology, and so on, will affect every aspect of social life. This suggests that, if we aspire democratic ideals, innovation processes that give rise to such technologies should be subjected to public scrutiny, so that they lead to the development of technologies that are responsive to societal demand. However, discussions on such new technologies predominantly appear to focus on the desirability or acceptability of possible outcomes of innovation, neglecting the processes that give rise to these innovations. While there is attention for the responsibilities and capabilities of technology developers to 'bring society into innovation' (Fisher and Maricle 2014; Owen et al. 2012), innovation cannot be said to be a 'public' issue in itself, with which I mean that it is taken on as a topic of collective concern that is to be discussed within a public debate. This means that it become hard, if not impossible to establish what the contribution of technologies is to the 'good life' shared by all (Brey 2017).

This paper addresses the question how to turn innovation into a topic public debate. In this, I will take a broad approach towards technology, including artefacts, skills and procedures (Rip and Kemp 1998), especially focusing on technologies with a wide-reaching societal impact. Innovation as the process of that gives rise to such technology, forwarding a somewhat one-sided depiction of the multi-facetted phenomenon of technological innovation (cf. Godin 2008). Like technology and innovation, there are many conceptualizations of the notion of public debate. Here a take on the public debate will be followed that originates from political theory, involving the way in which a social collective discusses the topics and problems that are considered to affect it, in order to come with an assessment. This account of the public debate will be expanded upon in sections 2 and 5.

The argument in this paper is broken down as follows. Section 2 proposes that we need to connect the social imaginary of a 'public' with the sociotechnical imaginaries of technology developers. In section 3, the tendency to deal with technology and society as two separate domains is presented, while section 4 illustrates the lack of realism in current debates on future technologies. These characteristics give rise to a democratic deficit (section 5), which is to be overcome by a focus on the decisions that give rise to the development of technologies. In line with this goal, sections 6 and 7 will present innovations as the effectuations of mental and discursive imaginations of a future social and moral order, with which it becomes possible to scrutinize the promises and normative assumptions and expectations of technology developers. This can be done in the shape of an 'innovation agenda' that is presented in section 8. Section 9 will discuss how this agenda can be furthered by existing technology assessment organizations. The concluding section will present a number of reflections and caveats about the claims made in this paper.

2. Connecting social and sociotechnical imaginaries

To understand the relation between innovation and publicness, I will firstly take up the notion of *imaginaries*, used by Charles Taylor (2002: 106) to describe the way in which people "imagine their social existence, how they fit together with others, how things go on between them and their fellows, the expectations which are normally met, and the deeper normative notions and images which underlie these expectations". Of these imaginaries, Taylor distinguishes the idea of the 'public' as an defining aspect of collective self-understanding in modernity (also see Pesch 2019). The social imaginary of the public can be seen as a prerequisite for democracy, as it allows individuals to consider themselves to be part of a

greater whole and it allows the belief that they contribute to decisions pertaining to the collective by partaking in deliberative processes and elections – as such giving shape to the 'good life'. Without having the social imaginary of the public, the contemporary version of democracy would not be possible.

Taking Taylor as their inspiration, Jasanoff and Kim introduce another imaginary, namely that of a 'sociotechnical imaginary', which is given as a "collectively imagined [form] of social life and social order reflected in the design and fulfillment of nation-specific scientific and/or technological projects" (Jasanoff and Kim 2009: 120). Sociotechnical imaginaries pertain to the mental models that are recruited by technology developers and decision-makers involved in innovation processes (also see Jasanoff 2015). Sociotechnical imaginaries differ from mere social imaginaries in the way that they present a temporal connotation: they are fundamentally forward-looking, imagining a *future* collective order that figures both as the context in which new technologies will be implemented and as the future that is permitted by these new technologies. As such, the future social order is not only conceived but also *enacted* in sociotechnical imaginaries. While the imaginary of the public is inclusive, at least from an normative perspective, the imaginary of a distinct sphere of technology fundamentally excludes technological 'insiders' from 'outsiders', at the same time it also legitimizes this exclusion (cf. Van de Poel 2000). A limited number of actors are given an authoritative position in the creation of future sociotechnical life-worlds, without having been required to pass any form of democratic consultation (cf. Habermas 2010; Jasanoff 2016; Sand 2019).

This raises the question what kind of entrance points may be found that allow for democratization of technology development, in the sense that there is a public debate which demands innovation processes to become directly responsive to collective assessments. This paper will address this question by exploring how public and of sociotechnical imaginaries can be related to each other (also see Nowotny 2014; Pellizzoni 2017; Welsh and Wynne 2013). The starting point is that the legitimacy and desirability of sociotechnical imaginaries need to become a concern of the collective that imagines itself to be a public. This idea also builds on recent work in so-called hermeneutic technology assessment which aims to assess sociotechnical future visions on their democratic and ethical qualities (Grunwald 2014; Lösch et al. 2016; Sand and Schneider 2017). Here, the contribution lies in the connection between public and sociotechnical imaginaries, which allows for more concrete directions on how to develop such a debate.

3. The separation of innovation and society

A first reason that explains why innovation does not become part of a public debate is that there appears to be a conventional image that assumes technology and society to be separate domains (Latour 1990; Pesch et al. 2020; Shove 1998). Despite the wealth of insights from fields like STS that defy this separation and the many participatory methods that have been developed to overcome it – popular media, the general public, and also technological experts themselves continue to reproduce an image of society as the domain of contingency that opposed to the image of technology as the worldly effectuation of theories found by science. As such, it builds on the discourse of Enlightenment in which progress is secured by belief in our expanding control over nature (Stirling 2010). The decontextualized forms of knowledge that are produced by science are apparently considered to spill over into the realm of technology: technology is something that is detached from real-world settings (cf. Feenberg 1996; Latour 1987; Law and Mol 2001).

This conventional image portrays innovation as a step into unknown territory. Reading newspapers, or popular business and technology journals, it is not hard to find claims about self-driving cars, smart cities, virtual reality, genetic engineering, artificial intelligence, blockchain as if they are already reached their full societal uptake – suggesting that the curtain just needs to lifted in order to have them fully disclosed. What seemingly prevents the curtain from being lifted generally appears to be social anxiety and political sloth. We just cannot keep up with the pace of innovation, which creates problems, because we might just be too late and miss our chance to unveil the wonders of the future technological cornucopia. The image sketched out here shows technology and society as set so widely apart that they might pass each other by: technology is so decontextualized and so completely independent from the real world that, apparently, it can take different routes altogether (Bijker 1995: 253).

Though this account of innovation has a metaphorical and ideal-typical character, it does have rather concrete repercussions in our capacity to make it part of the public life-world. As technology is placed outside of society, it appears to make little sense to make innovation into a concern of the public. In line with these considerations is the framing of the uncertainties that are imminent to future technology as epistemic issues. This directs the debates on future technology to be on the *effects* of these technologies instead of targeting the conditions for design and the social preconditions (Felt and Fochler 2011; Van de Poel 2011).

The focus on effects is most clear in the way that the *desirability* of future technologies turns to be the pivotal points around which public debates on new technologies

revolve. In such discussions, we position ourselves in a future world or, conversely, position a future technology within our contemporary world, and then speculate about the acceptability of such a 'bi-temporal' world that simply cannot exist in reality (Nordmann 2007; Nordmann and Rip 2009).

Illustrative for the state of affairs depicted here is the way in which technological risks are generally addressed. These risks, commonly considered to be the consequences of the epistemological uncertainty that characterizes technology development, are as such taken as the side-effects of technology which have to be dealt with by society (or the public). Such assumptions, however, lead us away from societal questions that pertain to technological risks, which mainly have to do with politics and justice. After all, risks do not pertain to uncertainty *per se*, but also to asymmetries of power, in the sense that they involve questions about who is allowed to impose risks upon others and about the extent to which people have the ability to consent to such imposition (cf. Cuppen et al. 2015; Stirling 2010).

As indicated, this description of the conventional image of innovation is not meant to be exhaustive, there are clear examples in which the aspects of the innovation process are discussed, for instance in the case of the monopolization of high-impact technologies by large companies such as Google and Monsanto. The way in which certain applications of artificial intelligence and genetic modification are controlled by a single company that intends to develop and use such technologies to expand their economic powers, only testifies that we need to foster structural approaches that allow public discussions on a contextualized account of innovation.

4. A binary debate unrelated to reality

Not only do debates on technology typically assume a separation between society and technology, these debates also appear to lack realism. Often a first stage emerges that is characterized by the forwarding of *promises* about how such a new technology will resolve certain societal problems (Pesch and Ishmaev 2019; Van Lente 1993), potential risks tend to be downplayed or portrayed as manageable. A second stage ensues when overstated promises may lead opponents to formulate reactions that take a dystopian starting point (e.g. Jensen 2008; Robaey 2015; Weingart et al. 2008). Dangers and unintended consequences are emphasized so to counter the promises raised by the actors that endorse the new technology. Instead of numbers, opponents to new technology tend to develop a narrative frame that

allows the highlighting of the anxieties that fuel their resistance (Horst 2008; Krzywoszynska et al. 2017; Nerlich and James 2009).

As such, these debates step into the 'novelty trap', as it has been named by Rayner (2004). A binary debate evolves in which two factions try to overbid each other by creating increasingly unrealistic future images. Both sides tend to deny the legitimacy of their respective opponents, for either being unscientific or for being undemocratic (John and Matthew 2011).

It has to be admitted that binary debates are also common in other societal controversies. Politics appears to thrive on scaremongering and old and new media on clickbait and fake news. The social mechanism that underlies such a debate is that the involved factions have to create a resource base by raising attention. Innovation needs money, time, commitment, knowledge, and so on. To do attract a resource base, competitive developers tend to overstate the qualities of their intended designs. The contribution of the new technology to the economy, health, sustainability, liveability and so on is emphasized (e.g. Asveld et al. 2015; Te Kulve et al. 2013), so that investors and regulators can be committed to support the new development (Deuten and Rip 2000; Van Lente and Rip 1998). The quantitative and factual mode of argumentation helps to facilitate this process, as it provides an expert-based appearance and allows itself to be used in negotiations and coordination. In order to also gain public support, technology developers and policy-makers often take up the 'deficit model', meaning public resistance is primarily caused by ignorance, not by genuine concern (Wynne 1991). Evidently, this model only reinforces the mutual misunderstanding and distrust instead of resolving it.

The lack of realism that is imminent to these debates does not mean that they have no impact: despite the apparent assumption that innovation is zero-sum game, values and concerns that are forwarded in the public debate often become embedded in regulations and in techno-scientific and societal practices (Levidow and Carr 2007; Weingart et al. 2008). At the same, it is hard to recognize these adjustments as the outcome of a social debate that has taken place, because the debates themselves are held in idealized terms that do not relate well to the nuanced character of such amendments.

5. A democratic deficit of innovation

In liberal democracy, the imaginary of the public conveys this 'public' as an intangible phenomenon, which has no empirical representation. It only exists as a collective self-

representation that comprises individuals that are on a 'public space', which can be seen as a 'meta-topical space of non-assembly', meaning that it brings together a plurality of public spaces in which concrete topics are discussed (Habermas 1999; Taylor 2002). Topics singled out as 'public' may come to be featured as common concerns that inform political decision-makers about which decisions to make. In other words, the public debate takes place outside of the political realm but inside of 'society' itself which is considered to freely choose the themes to discuss and the way in which these discussions are held (Dewey 1927; Marres 2007). Not only is the imagined public free to choose the concerns, it also has to have the capacity to form its own classifications, meanings and definitions about those things that the public selects as shared concerns (Pesch et al. 2017b; Wynne 2008). The imaginary of the public needs maintenance, for which we have to rely on the presence of independent media (both traditional and new). These media not only make it possible to think of a collectivity of individuals in terms of a transcending public, they also allow forward the organization of the debate

The separation between technology and society and the lack of realism in most discussion on technology withhold the opportunity to create meanings regarding these technology and as such they are not able to discuss the way that new technologies relate to their conceptions of the 'good life' – pointing towards a democratic deficit. To repair this shortcoming, it first needs to be fully acknowledged that technologies are *made by actors* who base their choices and decisions on the meanings and understandings they entertain. As such, a democratic debate on technology would involve the public scrutiny of those meanings and understandings, so that these may become more aligned with societal demands.

The starting point to construct such a debate is derived from scholarly insights on innovation, such as the 'sociology of expectations' (Borup et al. 2006; Van Lente 2012). This allows for a view that reveals technologies as the outcome of decisions that are wilfully pursued by certain actors (Stirling 2010). Resources are to be designated, in the sense that technologies do not emerge out of nowhere but depend on the time, money and knowledge that is put in their development. To find resources, promises about solutions have to be made so that resourceful agents become convinced that they might gain advantage from the new technology (Deuten and Rip 2000; Garud and Rappa 1994). In fact, many technologies are developed as self-fulfilling prophecies: because promises are raised about the capacities of future technologies, resources are found to make these technologies real. It is ironic that because predictions about technology turn out to be true, 'folk' conceptions, as sketched above, about innovation are invigorated.

Such a promise-effectuation cycle can be observed in many cases (Pesch and Ishmaev 2019). New technologies, such as synthetic biology or smart cities, may not have a tangible manifestation yet. However, because such technologies are considered to *become* a reality in the near future, actors from different institutional angles prepare the scene in such a way that over time these technologies are substantiated. These actors that become 'enrolled' into the sociotechnical network (Callon 1990), make the choices that are necessary to materialize the technology. These choices and actions may not only include deliberate ones, but also relate to the implicit moral values and normative assumptions of a social order that has motivated certain decisions. There appears to be no reason not to demand the articulation of these implicit considerations and promises to a public forum, given their potential impacts, as is also sustained by hermeneutic technology assessment (Grunwald 2020).

In other words, a decisive step in this is to shift the focus from technologies to the decisions that constitute an innovation. The imaginaries that inspire innovations need to be scrutinized within a public debate so that the public can qualify these imaginaries. To allow for that, the sequence of decisions that constitute an innovation needs to be unpacked. The next section will give a suggestion on how such an unpacking could be done, based on the considerations given above about the way innovation processes are instigated and furthered.

6. Processes of Metamorphosis

Innovation is usually described as a process that involves systems (Carlsson et al. 2002; Etzkowitz and Leydesdorff 2000) or networks (Garud and Karnøe 2003; Sovacool and Hess 2017). A problem of such descriptions is that it hard to identify entrance point for interventions that ensue a public debate on innovation. By all means, technology developers cannot be said to be insusceptible for external pressures. Policies, regulation, public opinion, long-term trends, these are all factors impacts the decisions of technology developers. But such impacts come across as rather undirected and subjected to contingency. The goal of having a public debate would be to have interventions that are much more targeted, which is allowed for by looking at concrete decisions made by individuals. As such, I will base my description of innovation as the effectuation of *ideas* of a technology developer – acknowledging the somewhat artificial nature of this starting point. Most typically, such a developer would be an engineer or designer, but might also be forwarded by other persons, such as a manager or policy makers. From this individualistic starting point, I will sketch out the involvement of a larger network in the next section.

In this section, I will use Richard Sennett's idea of 'metamorphosis' (2008) and connecting this idea to the insights developed in fields such as STS and innovation studies, with the aim of identifying the choices that can be subjected to public scrutiny. Actors deliberately work *towards* metamorphosis, not only by trying to develop an idea that solves a certain problem, but also by creating commitment so to have resources allocated so that this idea can be materialized. Commitment is predominantly based on the concrete functions that are promised to be achieved by the design process. This phase in innovation is all about the effectuation of an *imagined* metamorphosis, which is usually informed by science-based knowledge. A technology developer has an *idea* about what works and aims to find the strategic capital necessary to turn this idea into a reality (cf. Felt and Fochler 2011: 324). The dominant way in which this imagination is conceived reduces the innovation to something that only concerns matter and knowledge, neglecting the sociotechnical system and the presumed moral order that also play a role in the construction of a sociotechnical imaginary that figures as the wide background of the problems that the perceived technology is believed to resolve.

Sennett uses the notion of metamorphosis to describe the acts of *craftsmen*. Such a metamorphosis occurs when an object is changed, joined with another object, or when an object such as a tool is applied in another context. Technology developers are craftsmen deliberately pursuing such metamorphoses. They are trying to find a configuration of artefacts and actions that 'work' (Rip and Kemp 1998). The quest for a working metamorphosis can be seen as a puzzle. There are different pieces, material objects – natural or manmade – and actions that are aligned with each a certain way so that a newly established arrangement emerges that is considered to be working.

The notion of metamorphosis helps to emphasize the fact that technology developers, and especially engineers, are craftsmen. Indeed, they have been considered as such until the era of modern science-based engineering that came up in the nineteenth century. However, since then engineers have been trained as scientists, creating the appearance of a decontextualized version of technology. However, in real life, engineering is still very much a craft; it revolves around the metamorphosis from an idea to a working configuration, even if this craft recruits science-based knowledge to expand the range of possibilities and imaginations.

A metamorphosis creates something new, a configuration of matter and practice that was hitherto unknown. Whilst being unknown, the effects of metamorphosis are not

completely unforeseen. A technology developer aspires to make something work, she will see an opportunity to explore an artefactual arrangement that is believed to resolve certain problems or fulfil certain needs (Rip and Kemp 1998; Rip 2009). Especially in current innovation processes, which usually require an extensive resource base, technology developers are purposefully trying out new arrangements that are expected to produce desired results. In this, actors are very much guided in their decisions on how engage in a process of metamorphosis by the expectations and beliefs they entertain.

7. How the puzzles of innovation are made

A said above, an innovation can be seen as a puzzle: a process in which actors tries to make the pieces fit. The question is how this puzzling process takes place and who or what defines which puzzles need to be solved? These puzzles do not emerge out of thin air, but follow social processes and individual choices. In rare cases, a metamorphosis may be the result of luck or individual commitment, but in general inventions require a huge resource-base, consisting of money, personnel, knowledge, support, planning, and so on. A possible metamorphosis needs to be *imagined*, *conceptualized* and *communicated* in order to create a supportive network of entrepreneurs, science-based experts, investors and policy makers.

Most technologies are developed inside of organizations, which range from small start-ups to organizational juggernauts and from private enterprises to state-owned research centres. To an increasing extent, organizations involved in technology development are found in interdependent systems, implying that an innovation process is characterized by a heterogeneity of actors, goals, outlooks and activities. As a technology is developed, the interdependence of this heterogeneous network increases. The process of design is at the same time a process of involving actors that aim to align the new technology with specific organizational interests, deciding about the desirability, feasibility, scope, function, and release of the new technology (Elzen et al. 1996; Pesch 2015).

In these networks, the formation of new ideas is a process that taps on the mental models, cognitive schemes and professional experience of technology developers (Dosi and Nelson 1994). New puzzles are approached by taking exemplary designs or comparable cases as a starting point. A process characterized by trial-and-error allows the adaptation of existing templates, converging into a solution that 'fits'. This suggests that existing solutions guide new innovation trajectories, giving rise to a high degree of technological path-dependency (Berkhout 2002). The dependency on past experiences also has an institutional dimension. To

be able to coordinate activities in a network, actors will reproduce existing beliefs about which decisions are viable. With that, existing rules are reproduced out of the need to reduce the transaction costs of the innovation process (Callon 1998).

Coordination of actions also depends on a shared future vision. The development and reproduction of such a future vision allows the forging of networks and the creation of resources (Van Lente and Rip 1998). Future visions consist of expectations that concentrate around certain functionalities, uncertainties and effects. These visions also include expectations about what the societal or industrial problems are that need to be resolved by a new technology (cf. Bijker 1997). As such, an innovation process pertains to emergent and path-dependent dynamics that need to be aligned with each other in order to further the innovation. This means that the scope of reflections about the new technology and its anticipated effects are 'closed down' as much as possible in order to keep the process going (Stirling 2008).

Visions are part of sociotechnical imaginaries, which relate to the social order that is pre-empted by the technology developers. These implicitly held imaginaries not only concern the way that the future society is considered to be, including the distribution of social roles and institutional responsibilities, societal problems and uncertainties, but they also entail a normative idea about what a future society *ought* to be. In other words, technologies are developed against the background of unscrutinised normative starting points (Sand 2019).

Innovation activities are largely reactions to implicit problem definitions that are socially constructed. This makes metamorphosis by design less intentional as it might have seen at first sight. Moreover, design is also connected to other technologies in the sense that they build on previous trajectories and on expected interlinkages with new technologies. Choices, assumptions, and promises, they all can be subjected to public exposure and assessment, so to test their contribution to the public good.

8. An innovation agenda

The aim of this section is to reformulate the innovation process in such a way that it caters to a public debate on innovation, in the sense that the assumptions, expectations and decisions of innovators can become subjected to public scrutiny. To do so, I will compare innovation processes with conventional policy processes by using Kingdon's so-called streams model (Kingdon 1984; Pesch et al. 2017a), which explains how the process of political agenda-setting depends on the simultaneous occurrence of: 1) a political stream, that designates

events and discourses that give legitimization to certain actors to take decisions that are favourable for them; 2) a problem stream that denotes particular societal issues that are considered to be problematic by some; and 3) a solution stream that points towards a set of generic policies or approaches that are believed to provide effective forms of management. These streams usually have their own advocates, but if brought together, by contingency or through the wilful activity of a policy entrepreneur, an issue is set on the political agenda: a problem that is accompanied by a solution and political back-up. Once on the agenda, it will be secured of attention, at least for a certain period. Resources will be found to address the issue and to, eventually, resolve it.

The description of the process of metamorphosis hints at the fact that an innovation follows a similar kind of agenda. Ideas that instigate an innovation, assume a certain problem that is considered to be solved. These problems and their imagined solutions set up an innovation agenda, but this is done so in an implicit way. In this, policy, expertise, management, media, investment opportunities play a formative role. In contrast, the domain of innovation knows no procedures that allow the legitimacy of actions and decisions of innovators to be subjected to public scrutiny.

As has been shown, technology development requires a strong resource base, that implies that to effectuate innovation, developers have to turn to actors that dispose over resources and comply with their interests. This basically means that technology tends to reproduce existing power asymmetries, excluding the consideration of the interests and preferences of societal actors. With that, societal vulnerabilities may become even intensified. A second aspect that needs to be raised involved the imaginaries that figure as the implicit background of technology development. Innovations are based on normative assumptions and expectations about the future social order. If not subjected to public deliberation, the desirability and tenability of these assumptions and expectations remains uncontested and, in the end, fundamentally undemocratic – in spite of their potential impact on public life.

Based on the exploration made above, some of the key ingredients of a public debate can be identified. Most notably, the *expectations* and *normative assumptions* which motivate the innovation process and the promise that recruit resources need to be opened up of public scrutiny by adding these to an 'innovation agenda'. With that, the content of agenda goes much further than the technical performance of the future technology at stake or the societal impacts seen as side-effects. Ideally, the debate should cover the full scope of the sociotechnical imaginaries entertained by technology developers, dealing with questions such as: what is the social order that is assumed by the actors involved in the innovation process?;

and what are their problem definitions and how do these actors account for these problem definitions? Other questions need to be posed relate to the distribution of risks and responsibilities, such as which societal groups that are most vulnerable to risks and who is responsible to address these risks?

9. The contribution of technology assessment organizations

A final question to cover in this paper is how an innovation agenda can be successfully created, which will require a considerable change of current practices and ideas. This is especially difficult as the 'public' cannot be simply identified or addressed, as it only exist as an imaginary. The only tangible source of insight we have for knowing what the 'public' wants, thinks or needs are empirical publics in which societal actors mobilize themselves or are invited to act in name of the elusive public at large – but still such empirical publics are only a 'proxy' for the wider public (Michael 2009; Pesch 2019; Walker et al. 2010).

This suggests that in order to further the innovation agenda, we have to establish empirical publics so to have a discussions on innovation, with the aim of encouraging the advance of a debate of the intangible public-at-large in which innovation is seen as an issue that is relevant for its shared life-world. The most appropriate entrance here is to connect to the practices developed by a technology assessment organizations, which have now existed for decades in different countries.

Technology assessment (TA) has started as an approach that aligned quite well with the conventional separation of innovation and society, but over the decades it has taken up more constructivist approaches to technology (Decker and Ladikas 2004; Smits et al. 1995). Modern versions of TA include a wide range participatory methods for involving stakeholders in decisions about technology (Felt et al. 2013). As such, TA and the organizations that organize it has played a valuable role in enticing more political and societal awareness about the challenges of new technologies (Cruz-Castro and Sanz-Menéndez 2005; Delvenne et al. 2011; Tran and Daim 2008).

As Armin Grunwald (2019) maintains, there are good conceptual and empirical reasons to endorse the democratic qualities of participatory TA. At the same time, there are still some theoretical and operational complications with regards to turning innovation into a genuinely public issue. To start with, participatory processes of TA are mainly targeting new technologies and their expected outcomes, aiming to improve their quality and societal fit, but not turning innovation itself into a concern of the public-at-large. Moreover, it is not evident

how results and insights can spill over from a small-scale participatory setting to the wider 'public' (Gehrke 2014; Michael 2009). This is also because a small group of invited participants bears a different character than an imaginary public, meaning that in the end such a group cannot be seen as representative for the public-a-large (Huitema et al. 2007; Pesch 2019; Wynne 2007). Furthermore, the efficacy of participatory methods may not only impeded by the unwillingness of decision-makers to seriously engage in a dialogue (Bogner 2012), but also by the tendency of the members of these small groups themselves to the separation between technology and society, especially if the groups consist out of non-experts (Felt and Fochler 2011; Joly and Kaufmann 2008).

This means that TA organizations firstly face the challenge instigating a public debate, while only having the opportunity to set up discussions that are mere 'proxies' of public debates. To address this challenge, it is above all important to *acknowledge* this proximal nature of any approach that relies on inviting a selection of members of the public-at-large (Cuppen 2018; Wynne 2007). For this acknowledgement opens up the preparedness to deploy other means of stimulating public debate and retrieving public opinions. The goal of a TA organization is to successfully turn a topic into an 'issue', by emphasizing the way in which innovations affect all of us. It is not the goal to identify what the 'public' thinks about an innovation – that is up to the intangible workings of the public debate itself.

The second challenge is to overcome the reproduction of prevalent approaches to debates on technology, as this would not allow for overcoming the democratic deficit observed above. By *questioning the technologists* instead of the technology, this problem may be resolved – at least to some extent. This does not mean that a discussion should neglect the future technology and its effects, but that this discussion should be embedded within the wider discussion about the motivations and beliefs of the technology developers.

10. Conclusions and discussion

The aim of this paper is to instigate a real debate in the imaginary public – with such a goal, one cannot escape contradictions. Bringing in sociotechnical futures that are similarly imagined complicates matters even more, giving rise to many theoretical and practical issues. The compartmentalized structure of academic disciplines is ill-fitted to deal with such matters that involve both philosophical and empirical questions. Moreover, as this paper can only be explorative in nature, it has touched upon a diversity of matters that all deserve more profound attention.

With that, I realize that many of the claims and conjectures that I have introduced could have been formulated differently or approached from an alternative conceptual angle. This is especially so because I have taken on notions that already have traction within different scholarly fields, perhaps giving rise to confusion, because concepts could understand in another way, or annoyance, because I have introduced no novel insights. Nevertheless, I hope to have made clear that the democratization of innovation is to be made into a topic of wider theoretical and practical attention – especially given the place of new technology in our everyday lives. Current approaches appear to be unsuccessful in positioning innovation where it belongs, which is at the heart of the public debate.

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