

This is an electronic version of the following Elsevier-published article:
Genus, A. Rethinking constructive technology assessment as democratic, reflective, discourse.
Technological Forecasting and Social Change 2006, 73(1), 13-26.
doi:10.1016/j.techfore.2005.06.009

Rethinking constructive technology assessment as democratic, reflective, discourse

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Rethinking constructive technology assessment as democratic, reflective, discourse

Abstract

This paper conceives technology assessment potentially to be a constructively democratic, reflective and discursive process. The paper reviews selected literature focusing on the notion and practice of constructive technology assessment (CTA). CTA aims to produce better technology in a better society, and emphasises the early involvement of a broad array of actors to facilitate social learning about technology and potential impacts. The paper presents a new perspective of CTA based on a discussion of contiguous research on the social implications and control of technology, reflexivity and reflection in the 'risk society' (Beck), and on public understanding and participation in science and technology. The paper concludes that the future development of CTA is well served by improved articulation or revision of core elements of the approach, for example by emphasising a concern for interaction and socio-technical criticism based on democratic principles. In addition, to conceive of CTA as a discursive activity may facilitate the analysis of the limitations in practice on the role of non-experts participating in technology assessment and the capacity for self-reflection of all actors.

1. Introduction

Contemporary thinking regarding the relationship between technology, innovation and society tends to support the inclusion of diverse participants in processes of assessment and decision-making. In particular, the employment of participatory approaches has been proposed to accommodate the interests of a wide range of actors holding different value positions, while minimising the potential risks associated with technology development. Constructive technology assessment (CTA) appears to represent a particularly promising approach to technology assessment that builds on earlier insights gained from research concerned with the impacts of technology on society, the social shaping of technology, and incremental decision-making, and attempts to find ways to improve the social robustness of technology [1-7]. Over the past fifteen years or so explicit or implicit reference to CTA has been made in the practices and policy documents of public decision-making bodies in (especially) Netherlands and Denmark, as well as at the OECD and in the EU (namely through the EUROPTA and ADAPTA programmes) [1, 2, 8, 9]. One of the key elements of CTA concerns the need for reflexivity of actors participating in technology assessment activities. However, the paper argues, the literature on CTA could be better informed about some relevant contributions on this topic. For example, whilst it does draw on Beck's work on *reflectiveness* as key to '[opening] up the political', and in so doing enable societies to deal better with risky technology [10], it could benefit from Schön's work on the development of professionals' *'reflection-in-action'* to enhance cooperation with others in uncertain or difficult problem situations [11]. A second key aspect of the CTA approach is 'alignment', which is linked to the matter of how interactions among participants produces societal learning capable to enhance understanding future possible impacts of technology. Here, studies of

public participation in science and technology decision-making have examined the effectiveness in operation of a variety of mechanisms associated with the practice of CTA, such as interactive technology assessment, consensus conferences, scenario workshops, electronic consultation, public inquiries and citizen juries [12-18]. Attention has been drawn to questions involving the political function of such processes (be it democratic decision-taking, or merely broadening debate), the incorporation of lay participants, and the extent to which agenda and discussion remain (unfairly) dominated by technical experts in meetings [19-21]. There is a question mark concerning what it takes for individuals and organisations to be critical and self-critical of positions and values held regarding the development of technology and its eventual operation. Literature on CTA has identified a role for socio-technical criticism and self-reflection in improving social choice with regard to technology [1, 7]. However, this needs to be made more explicitly, for example with regard to highlighting the factors that dull the discursive capacity of actors in technology assessment or limit the potential for self-reflection. Bearing in mind what has been said in this introductory section, the paper outlines the characteristics and strategies associated with CTA, identifying the promise and opportunities offered by the approach as well as limitations or dilemmas to be confronted. The paper thus offers a new perspective of CTA.

Specifically, Section 2 of this paper provides some background and an introduction to CTA, positioning it in the context of the debate about the extent to which impacts of technology may be anticipated, in terms of the dilemma associated with the need for promotion of potentially beneficial technology for society whilst controlling harmful impacts. Section 3 then utilises available literature to shed light on the nature and

significance of reflexivity, and considers its relevance to (constructive) technology assessment. Section 4 discusses implications of the arguments made in the previous section for democratising decision-making about technology and improving social learning through alignment. The discussion here proposes a notion of CTA as a discourse of technology assessment, indicating that there are subjective factors, which may constrain self-reflection and socio-technical criticism. The section also addresses the role and factors affecting the effectiveness of public participation in science and technology development, with particular reference to experience in practice with mechanisms aimed to improve interactions among the actors. Finally, Section 5 provides a concluding, summarising section drawing together the various strands of the paper, while making suggestions for redefining CTA.

2. Constructive technology assessment: background, characteristics and strategies

Previous work has sought to define the social, economic and technical factors shaping technology development, initially by opening up the ‘black box’ in an attempt to move beyond technological determinism towards an evolutionary view of technology development. It is sensible therefore to frame the intellectual development of CTA in the light of such concerns about how to deal better with the impacts of technology in society, including Collingridge’s work on the dilemma associated with the promotion and what he called the ‘social control of technology’ [22, 23]. On anticipation of impacts of technology on society Rip refutes Rosenberg’s argument that we do not and cannot know the impacts of technology calling this a ‘message of despair’ for any attempts at technology assessment [2]. Where Rosenberg sees a ‘hard truth’ regarding the foresight of the eventual impacts and uses of technology [24], Rip sees an ‘additional

truth' which holds that 'anticipations need not be correct to be useful in guiding action productively'; and that they can be useful as visions of future which 'orient our actions' and 'stimulate learning about possible impacts'. What matters more than anticipations *per se* is the 'quality of the actions and interactions' to which they refer. It is necessary therefore to consider the process by which anticipations come about, including the manner in which the 'critical evaluation of alternative routes' occurs [2]. As regards the social control of technology Collingridge and his colleagues observed that early in the development of large-scale technology (case studies include nuclear power plant, high rise tower blocks, and more recently the Channel tunnel project) too little robust data (on likely benefits, costs, safety implications and so on) is available to decision-makers on which intelligently to base important decisions about investment or dis-investment. However knowledge about such impacts tends to become available too late to be of help since it arrives only after costs are sunk and some severe negative impacts are experienced. In a sense then, the problem of control only becomes visible *ex post*, promotion activities become detached from control ones and overly expensive, dangerous or unfair technology can seem irreversible [22, 23, 25-27]. Recent contributions have shown a concern to bridge promotion and control activities and to shed light on the various choices available within the design and development process *ex ante*. In addition, the proper focus and role of academic enquiry regarding the relationship between technology and society has become the subject of some debate [28-30]. Both of these concerns are visible in the literature on CTA, the development and core of which the next few paragraphs outline.

CTA is one member of a family of recently emerging TA approaches aimed at improving the understanding, evaluation and practice of technology development in its various aspects. (Schot and Rip refer also to 'TA', 'awareness TA', 'strategic TA' and 'interactive/participatory TA' [7], though this paper is concerned with CTA as interactive, participatory technology assessment involving a wider range of actors than the focus on governmental agencies, producers, user or consumers found in some narrower variations on the CTA theme). Institutionally, the origins of CTA lie in agencies such as, in the USA, the US Office of Technology Assessment and, in the Netherlands, the work of the Netherlands Organisation of Technology Assessment (NOTA, subsequently known as the Rathenau Institute). Developments of the approach since the mid-1980s have seen increasing attention (for example in Denmark and Netherlands) to the issue of social learning, as distinct from merely attempting to improve the public understanding of science and technology, partly influenced by the Danish approach to public debate about technology. The measures taken to improve social learning have included widening public involvement in the development of information technology and biotechnology, for example, in Denmark by means of consensus conferences and dialogue workshops. This type of mechanism may well be designed to feed into Parliamentary decision-taking processes. However, more informally, iterative discussions and negotiations occur between technology developers and 'other concerned parties in society' [7]. Rip and colleagues' book on the subject cites the OECD representation of CTA as a 'constructive' approach to technology assessment that aims to minimize social conflicts and unwise investments [1]. In both prescriptive and descriptive-analytical approaches, attention to the process by which decision-making evolves in practice is required. Descriptive case studies utilising this approach,

such as that of development of the Danish wind power industry, serve to highlight possible episodes of failure based on the difficulty of the actors to successfully negotiate points of transition [31].

Briefly the main elements of the CTA approach, as proposed by Rip and colleagues, may be stated as follows. Firstly, characteristics of CTA may be specified [1, 3, 4, 6, 7]:

- a) integration of anticipation of the future effects of technology into the promotion and introduction of technology, meaning ‘that actors involved in control activities should actively participate in the technology design and development practices’;
- b) inclusion of more social actors and aspects of technology during development and introduction of technology ‘in order to improve the quality of technology in society’;
- c) that modulation (‘change’) processes should be seen as ongoing, enabling all actors to learn about ‘the possible new linkages between the design options and the demands and preferences of the envisaged users’. Learning should ‘include aspects of the political and social articulation of acceptability of technology in development and its linkages to broader cultural values in society’;
- d) actors should be ‘reflexive’ about the processes of co-evolution of technology and society, of technology and its impacts’.

Three ‘generic’ CTA strategies: have been defined: technology forcing, strategic niche management; and alignment, which Schot and Rip state should be combined in specific cases ‘to stimulate reflexivity, anticipation, and learning’. Technology forcing ‘modulates’ technology development from the demand side;

it 'inverts traditional TA' by stipulating required impacts rather than taking 'the technology as given and [exploring] potential impacts' [7]. An example given of technology forcing concerns the State of California, which prescribed standards for clean air and stipulated the percentage of car sales that should come from zero-emission vehicles. The 'forcing', however, need not stem from governmental regulation, and may occur through the actions of, for example, insurance companies or NGOs, possibly in conjunction with governmental mandate. Strategic niche management modulates from the supply side, with technology developers who wish to introduce technology successfully, and in anticipation of subsequent phases of incremental development, needing to broaden design and development and to attend to wider societal issues. A central aspect here is the protection of desirable nascent technologies so that they can develop without government support, mindful that too much protection 'will only create expensive failures', whilst too little may expose them to 'too harsh' a selection environment. The orchestration of technology development and introduction occurs 'through setting up a series of experimental settings (niches) in which actors learn about the design, user needs, cultural and political acceptability, and other aspects'. And here learning 'must' take precedence over the 'goals of the technology [promoter]' [7]. The third generic CTA strategy concerns alignment. Alignment 'focuses on the interactions as such and attempts to create and exploit loci: actual spaces, forums and institutionalized linkages between supply and demand...offering opportunities to modulate developments.' Loci such as consensus conferences and dialogue workshops 'should function as 'negotiation spaces', but have been recognised by Schot and Rip presently to be either too remote from design activity or 'too much a part of technology push introduction strategies'. Hence whilst participation in such processes can stimulate 'anticipation, learning ...and reflexivity...Feedback is limited and the

outcomes [from the processes used] have little force by themselves'. And, in addition, the institutionalisation of alignment processes may actually impede further broadening of design and development [7]. Such potential difficulties point up issues related to the preservation and nurturing of reflectiveness, socio-technical criticism and, moreover, to the analysis of democratic and discursive aspects of technology assessment, which have not featured strongly in elaborations of CTA. For example, the most authoritative statement of the past and future of CTA to appear as yet in an academic journal makes no explicit reference to democracy or democratic principles, despite the aim to achieve better technology in a better society [7]. Another key contribution acknowledges that 'CTA proponents ... have not placed democratic criteria as a prominent goal in the development of the CTA perspective' [6]. However, an early paper by Rip considers democratically made decisions to be more 'robust' in contexts where democracy is prized, drawing attention to ways in which democratic ideals are articulated and 'consolidated', an idea to which this paper will later return [32]. The following section discusses the nature and significance of reflexivity and reflectiveness for technology assessment, before moving on to outline a democratic and discursive approach to CTA.

3. The Significance of Reflexivity and 'Reflectiveness' for Technology Assessment

Recent theoretical developments in the sociology and politics of technology have attempted to address the relationship between technological choice, the natural environment, social organisation and the promotion/control of risk within society. A key contributor is the German sociologist Ulrich Beck [10, 33-36] who identifies reflexivity and reflexive modernisation in relation to what he calls the 'risk society'.

Reflexive modernisation contains both ‘the reflex-like threat to industrial society’s own foundations’, through the spread of ‘old routines’ of technology and risk assessment, ‘which is blind to dangers’, but also ‘the growth of awareness [of risks], the reflection on this situation’ [10]. Simply put, ‘risks’ (often defined statistically as probabilities of physical harm resulting from technological processes) are consequences of the development of technology in association with science and industry. In contemporary society their ‘effects’ may be catastrophic and their calculability becomes deeply problematic using ‘institutional yardsticks’. Society is reflexive to the extent that there is a fundamental contradiction that means that harmful consequences are produced therein, which cannot adequately be overcome using prevailing assessment procedures [33], including the use of damage assessment and limitation, control, responsibility and compensation for loss. A second stage of reflexive modernisation, Beck states, ‘forces people to reflect on the bases of the democratic, national and economic model of the first modernity, and to examine prevailing institutions’, including the role of science and scientific rationality in assessing potential dangers, e.g. those arising from technology development and its introduction. In this way therefore a reflective society questions the authority of science and expert assessment [10], a process somehow connected with, but which should not obscure, the reflexive nature of risk society.

The nature of reflexivity and reflectiveness has implications for the theory and practice of CTA, since it has been stated that CTA is, and should be, about ‘reflexive modernism’ [37], though the sense of the term used in writing about CTA is actually more like what Beck calls reflectiveness and self-reflection than his ‘reflexivity’. Nonetheless, the point has been made that researchers in the field of science and technology

studies should engage with their subject matter, and its role in society, in a 'reflective or ironic' way [37], with direct implications for the possibility of providing an open forum for the airing of diverse views and for bridging macro-level policy and micro-level activities. To some extent this mirrors arguments, by Schön, concerning the capacity of professionals in disparate fields for 'reflection-in-action', when confronted by unique or difficult problems [11]. This reflection-in-action is subject to 'the pace and duration of the situations in practice', which influence the pace at which reflection-in-action occurs; situations of crisis may prompt more spontaneous and immediate reflection about a problem than long drawn out public inquiries. It is suggested that only 'action science' can convert the rare practice of 'reciprocal reflection-in-action', which is 'cooperative inquiry in adversarial contexts' into, 'a dominant pattern of practice'. 'Ordinary' social science by contrast 'tends to ... treat as reality, the patterns of institutionalized contention and limited learning which individuals transcend, if at all, only on rare occasions' [11]. This point is significant to the extent that constructive technology assessment is characterised by an action orientation requiring the involvement of researchers or analysts to organise and steer participatory exercises, which call for participants to articulate and to reflect upon their own positions.

The need for such reflection-in-action is implicated in the bid to avoid dualities such as promotion-control, and technology-society, distinctions that have been associated with prevailing approaches to technology assessment. Without it interactions between actors with different visions or assessments of technology may be characterised by superficial exchanges with the parties being reluctant to accept close scrutiny of their positions by others, or themselves to probe the assumptions which underlie their own viewpoint. The extent

to which reflection occurs will therefore be mirrored in the acknowledgement and exposition of deeper values connected with technology development, of the roles played by diverse parties within the co-production process, and of potential avenues for improving the values-learning and selection process. Whilst proponents of CTA acknowledge that processes and criteria for building anticipation, reflectiveness and learning are sometimes difficult to identify and apply [7], their articulation and relevance to technology development are central to the maturing of CTA theoretically and as practice. Clarifying these criteria and key factors affecting reflectiveness/self reflection and social learning should contribute to the objective of CTA to broaden participation in technology assessment at an early stage of development. This should also highlight democratic and discursive aspects of CTA, which do not feature centre-stage at present but which will be of significance to the aim of CTA to produce better technology in a better society.

4. CTA as Democracy and Discourse

The argument here is based on the view that anticipation, reflectiveness and social learning, are the product of a number of factors not fully recognised in the literature on the CTA approach. These do include but are not limited to the interactions between parties in a technology development network. Reflectiveness and social learning may also be the subject of the judgements that the various actors make about their own and others' values, motives, standing and trustworthiness, and the veracity of statements they all make. Such judgements may well be based on emotional grounds [38]. Different actors may not be reflective with regard to the presence of and roles played by others in technology development [7]. For CTA therefore what is suggested is the need for fundamental work in two areas capable of producing insight into the extent to

which actors in technology development are reflective, and the potential for social learning whether based on free information exchange or openness to criticism. These areas concern: a) the core principles of CTA linked to the degree to which it aims to enhance participation and/or democracy; and b) discursive aspects of CTA.

a) CTA: a democratic perspective

An aim of CTA is to find ways of experimenting with technology in society (rather than in a laboratory) in order to avoid or to learn about possible harmful impacts. However, ‘forcing’ strategies based on strong visions of the future may only reflect the dominant position and choices of certain central actors, rather than selection based on the mutual interaction and learning of promoters and others [39]. Moreover, CTA could be criticised for taking an over-optimistic view of pluralistic decision-making based on the activities of interest groups [40], and for neglecting the ‘truly democratic participation’ of individual, non-expert, lay citizens [6]. The extent to which CTA can avoid the criticism that it will turn out to be no more than a ‘utopian dream’ depends in part on how the core elements of the approach are defined or refined [40]. Two issues are connected with this point. The first is the degree to which there is explicit recognition within the CTA approach of disparities in political influence between the various actors involved or affected by development. The second issue concerns the analysis of processes by which closure is unfairly or prematurely achieved [40]. The next few paragraphs sketch out some thoughts on the above in the aim of contributing to the future development of CTA.

CTA sets great store by the need for alignment and mutual adjustment of diverse actors in technology development [1-7]. In practice, dialogue workshops, consensus meetings, certain educational programmes and citizen experiments with new technology have accompanied such policy innovations. The underlying thinking governing the emergence of such processes has differed amongst advocates of CTA, however. For example, practice and the CTA literature emanating from the Netherlands emphasises the need for socio-technical criticism but acknowledges that the approach accords only a secondary role to democratic technology decision-making [6]. In comparison the basis of practice of CTA in Denmark has been consensus development, conflict minimisation, and social acceptance of new technology, whereas the OECD has made reference to building a broadly based consensus within its adoption of a constructive approach to technology assessment [7]. If one accepts Beck's argument that scepticism of prevailing dispositions and institutions for technology assessment is a key factor in dealing with risk in contemporary society [33], there may be serious implications for versions of CTA predicated upon acceptance, consensus and conflict minimisation rather than democracy, critique and challenge. Thus measures to broaden participation at one level arguably may serve only to short-circuit the exchange of values held dear by various actors, which occurs at another deeper level. In addition to exacerbating the neglect of certain viewpoints or values another potential by-product of an emphasis on consensus or conflict reduction may be identified. This concerns the possibility that influential actors or experts may not be encouraged to reflect on, or to make explicit, their own deep-seated values or assumptions about technology. The extent to which technology assessment processes fail to probe powerful or influential actors could render them less

accountable to others in society for their role in promoting risky technology than might otherwise be the case.

The paper accepts Callon's observation that the aims of CTA at least refer to a 'principle of democracy' [40], but notes that this has never been developed or articulated within the approach. At the same time one must also take into account the realisation that 'good' (i.e. democratic) processes may not necessarily produce higher quality of decisions than non-democratic processes but should at least produce more socially robust or legitimate decisions in contexts where democracy is highly valued [32]. Such caveats notwithstanding, it is proposed here that a notion of CTA could be defined with reference to a number of criteria, which have been invoked to classify or to evaluate methods for eliciting the participation of civil society in science and technology policy. One may point to the following criteria as relevant aspects of any potentially effective democratic process of interactive decision-making [41, 42]: representativeness; the balancing of a variety of interests; early involvement at an early stage; the influence of outcomes from participatory exercises on final policy; legitimacy/credibility of the process; openness to and capacity for criticism of values; accountability and responsibility for decisions made and their consequences; ease of access to resources; control over the framing of agenda and over the definition of objectives; and the cost-effectiveness of participatory methods used. Where some of these criteria are employed to measure participation by the public in science and technology policy, it is necessary for future work to specify how these may serve to evaluate content and output of the processes involved, and not merely the inputs, a point to which Schot has alluded [6].

The claim that CTA represents ‘creative incrementalism’ is thought provoking [1]. This claim refers to the need to recognise the emergent, decentralised nature of technology assessment and development, although this appears to be assumed by CTA and may be more apparent within the specific (northern European) geographical locations in which CTA is practised than elsewhere. Moreover, there is ambivalence regarding the nature of the processes concerned. On one hand Schot and Rip refer to ‘technical change’ as being driven by ‘dynamic multi-actor and decentralized co-production processes’ and to the determining role on development of interactive processes, which no one central actor can shape [7]. However, on the other hand, the same authors do point to limitations of participatory mechanisms associated with CTA, which may fail to open up genuine ‘negotiation spaces’. Further, the role of the state is ambiguously treated in CTA. Thus on one hand the state is accorded the role of overseeing and protecting the process of social learning [7, 32, 37]. On the other hand the state will have to act as the ‘shadow of authority’ required to break through any impasses or stalemate between the actors [3, 4], a duality which potentially undermines public credibility in government activity [8].

One way around this tension between the claims of CTA and constraints on decentralised decision-making in practice is to direct analysis towards examination of the normative merits of CTA claims. Thus one route to take in rethinking CTA could be to emphasise the need for democratic, dispersed and decentralized decision-making, with the aim of extending the scope of possibilities for participation of interest groups and ‘ordinary’ citizens. What should then occur is to make an explicit link between decision processes and technological choice as well as between development and design, and to find examples which deviate from

these revised rules of CTA but which seem to throw up ‘good’ technology however defined. This is analogous to previous work on technology policy which focused on comparing incremental with non-incremental (or ‘inflexible’) technology, both with regards to the decision processes employed and the scale and performance of technology selected in particular cases [22, 23, 25, 26]. Following Winner the analysis searches for missing or marginalised actors to demonstrate how processes of technology promotion or control may be biased [43]. Such analysis may blend earlier and later accounts of incrementalism, taking into account their different notions of democratic participation. One layer of inquiry could seek to identify institutional impediments, which impair participation of competing interest groups, whilst another layer aims to identify barriers to the participation of individual citizens linked to their lack of ‘probing’ capacity [44]. All in all what is being advocated here is analysis drawing upon an examination of political processes related to technology development but possibly with a more discursive orientation premised upon insights into the nature of argumentation, discourses and social action, as discussed below.

b) Discursive aspects of CTA

Potentially insightful contributions on discursive aspects of CTA come from a reading of Foucault. Briefly, Foucault is concerned with the prospect of difference and ongoing disagreement between actors. Foucault is concerned with the truth effects of discursive power on ‘subjects’ whose sense of purpose and identity is intimately bound up with the ideas, practice and knowledge, which constitute the discourse they generate and reproduce [45]. Where Habermas, say, emphasises the ‘force of the better argument’ in producing social action based on rationally arrived at agreement, Foucault draws attention to the power relations and struggles implicit in arguments, agreements and actions, where resistance to hegemonic discourses may

occur [46]. Foucault orientates the analysis towards subjectivity, to focus on the ‘way in which individuals are transformed into subjects whose sense of meaning and reality becomes tied to their participation in the discourse [in this case of technology assessment]’ [47]. As the discourse has emerged so too have a language and accepted techniques of technology assessment, which together have become the dominant rationale for explaining and managing technology in society. In consequence, individuals or groups that do not possess the skills and discursive capacity to contribute to the discourse, or read its ‘text’ may be marginalised from technology assessment and development. In addition, a key aspect of the concept of discourses is the idea that practitioners gain some positive sense of self worth from being able to take part and to act within the discourse [48]. This is a view of power (in the sense of individual subjective empowerment) that might be viewed as extending analyses of coercive power, strategic mobilisation of bias to circumvent opposition (non-decision making) [49], and hegemony of dominant values in society [50]. It is a view that draws attention to possible socio-psychological limitations to the full participation of ‘non-expert’ citizens in modulation processes such as interactive TA, consensus conferences, citizen juries or public inquiries. In any case attention to technology assessment as discourse may extend or complement existing research on public participation in science and technology. At present this research receives little attention in the literature on CTA. However, key findings from such studies are presented below to illustrate the kinds of phenomena that a democratic and discursive version of CTA should be concerned about.

With regard to ‘interactive’ technology assessment, for example, a number of shortcomings have been identified, some of which point to problems of political processes and organisation, others of which are

connected more clearly with the socio-psychological factors referred to above. The factors cited include: poor definition of the link between the exercise conducted and the process by which key decisions are made; differences in the participants' levels of financing, information, and status; strategic game playing by actors; and a lack of 'reasonableness' in negotiation connected with the images and expectations that participants have of each other [51, 12]. Research on the operation of consensus conferences echoes some of these comments. For example, it has been noted that the professional experts in consensus conferences seem to adopt 'instrumental rationality', whereas the lay members represent something closer to a communicative, cooperative rationality [52]. In addition, attention has been drawn to the influential role of whoever selects the topic for deliberation and the matter of who is to count as an affected citizen or as experts to be selected [15]. Further, studies of consensus conferences in Denmark have shown that more effort may be needed to engage lay citizen voices in shaping technology early on, though the outputs of such conferences have played a role in regulating use of new technology and in funding allocations for research. In particular, it appears that whilst lay members set the agenda and produce the text of the conference report, the professional experts control the framing of the problem, have more influence *ex ante* over the promotion of specific options, and bring their own individual and collective agenda to the table. Indeed the steering committee responsible for the general oversight of meetings, including the selection of expert and lay members and definition of the topic to be debated will tend to comprise authorities on the field in question [53]. Similar comments have been made with regard to other participatory processes. For instance, Thompson and Hoggett identify 'emotional dynamics' such as dependence on authority figures, and lack of respect for the contribution of others, which undermine the work of citizen juries [38].

It is necessary to recognise issues of incorporation connected to the institutionalisation of participatory processes. Danish experience exemplifies the view that an effective contribution to decision-making is more likely if these are ‘institutionalized as an instrumental model of technology assessment, that is, within parliamentary or government settings’. In other words, participatory mechanisms ‘[feed] into the representative decision-making system (by acting as an information and consultative source to Members of Parliament and governmental officials), and [do] not act as its substitute’ [17]. A rather different view (based on analysis of experience in other countries) is that, far from contributing to democratisation, institutionalisation may only serve to create ‘participation traps’. For example, Levidow points to the polarisation of debate over biotechnology in Germany, where in the 1990s environmental groups attempted to challenge the orthodoxy of technology assessment, which would not allow a ‘problem induced’ approach to evaluating the technology. Instead, a ‘technology-induced’ paradigm prevailed. This emphasised risk-benefit analysis of biotechnology within its own terms. This was a position that the NGOs could only accept with some loss of credibility, and which was far removed from their own, which was to compare biotechnology solutions with non-biotechnological means for crop management. For the NGOs the dilemma was essentially to remain within what they saw as an unfair, unwise TA process with which they did not agree, or to retain credibility by standing outside of the official TA process, to pursue a vigorous, oppositional stance [54]. Overall this illustrates how public debate about technology development can be both circumscribed and polarised at the same time.

Related issues concern both elucidation of the values of non-experts who take part in technology assessment processes, the extent to which these change with the process of participation, or become the target by technology promoters seeking to get future users or the public ‘onside’. There are contrasting positions on this matter. On one hand, some studies argue that the fundamental values of lay members do not change with involvement [55]. On the other hand, the effect of lay member participation is primarily to increase their knowledge of the technical issues in question compared with those who have not taken part, and to ameliorate any concerns and opposition they may have had towards the technology. The perception that forums for participation have become institutionalised and incorporated may not help their aim to contribute to wider public debate. This suggests that CTA alignment mechanisms need to be enmeshed with and not isolated from wider public discourse and hence need to create a dialogue with public debate.

5. Conclusion

The formulation of approaches to constructive technology assessment discussed in this paper owes much to research on the relationship between technology and society, the social shaping of technology, and social control of technology. To a degree the aforementioned share a concern to analyse the design and ‘directioning’ of evolving new technological developments, and to assess the role played by diverse stakeholders, holding different value positions, in assessments and decisions about potentially risky technology. CTA shares such concerns and promotes an interventionist, prescriptive stance towards the mitigation of potential risks of technology and the advocacy of participatory processes to enable more socially robust technology. This paper has sought, however, to highlight the potential insights to be derived

from the work of Beck, Foucault and others in rethinking the conceptual foundations of CTA. It has done so by identifying fundamental tensions between notions of a socially inclusive, reflexive and *reflective* process of technology assessment and development, certain representations of CTA, and the conduct in practice of participatory processes related to technological decision-making. The paper has proposed two key areas, which with further study could contribute to the future development of CTA and to resolve the tensions referred to.

The first of these concerns the underlying position of the CTA approach regarding democratic decision-making. The paper has advanced the view that contention and openness to criticism are prerequisites for producing reflective techno-scientific expertise. This capacity for, and receptivity to, social probing lies at the heart of Beck's arguments concerning the 'opening up of the political' within risk society. It also connects well with Lindblom's later ideas on incrementalism [44]. Incorporating such thinking into CTA need not cut across the general aspiration of the approach to produce socially robust technology. Indeed it may serve more explicitly the aim to democratise the development process, which is currently a secondary aspect of CTA. This invites further specification of inequalities of access to, and influence over, technological decision-making processes and choice. In this area any aim to improve reflectiveness and social learning associated with technology assessment and development as well as to democratise debate must confront the extent to which technology development processes are marked by contest but also constraint. To do so pushes to the fore analysis of elitist, pluralist, and more fully democratic decision-making processes and the need to examine the relationship of such processes to the content of technology

decisions, for example the link between closed decision processes and the selection of irreversible technology options. Further, the kinds of judgements that actors make of each other, together with questions of their trust in each other need to be brought under the microscope to analyse the potential for mutual adjustment based on openness to criticism. A second area for future enquiry is suggested: to invoke the work of Foucault to redraw CTA as a discourse comprising the communities and practices of technology design, development and ongoing assessment. Where the previous point refers primarily to aspects of political organisation, here the analysis of discursive aspects of technology assessment draws attention to subjective factors, which mould and reproduce the dominant discourse, and the personal skills required to open or close spaces for argumentation.

The paper has considered the role of various processes for broadening social debate and deepening social learning and reflectiveness, offering suggestions around which a new view of CTA could be directed. For example, one outcome of the consideration of the limitations of participatory processes is that questions should be raised concerning exclusive reliance on a governmental level, legitimated system of (constructive) technology assessment. The extent to which this form of assessment, whether predicated on an 'open' or 'closed' system, still requires commentary from wider, more broadly based lay groups and individuals is an issue for further reflection and development. Here a key activity is to understand the factors that enhance the capacity of interest groups and citizens to probe the claims of particular assessments and to encourage a wider ranging debate. This may become particularly important where pressure to reach consensus may

undermine existing controversies, particularly in cases where it is pertinent both to question the privileged position of scientific/technical expertise and preferred understandings of the issue at stake [56].

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