

Widening the Circle of Nano Research: A Case for Reflective Action Research in Flemish Society

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Abstract

Drawing on the hard lessons learned from the public controversy over genetically modified crops, policy makers as well as scientists and technologists have begun to recognize the need to engage wider audiences in technology innovation. While this *upstreaming* of public involvement is by no means a new idea, it is increasingly being called for in social democracies seeking to address the societal implications of nanotechnologies. One case in point is the highly industrialized region of Flanders, Belgium. Its government is funding a research project entitled “Nanotechnologies For Tomorrow’s Society”, which the authors coordinate. The endeavor brings together scientists, stakeholders, and interested citizens in an effort to collectively construct sustainable nanotechnology trajectories. As this entails more than merely assessing possible technology impacts, an open, experimental model of social science research with respect for the undetermined nature of nanotechnology, is set forth. Its key aim is to discover and reflect on the motivations and considerations of nano-researchers, as well as to openly debate the economic and social driving forces that shape the technology in the Flemish region. Identifying and systematically calling into question these underlying incentives with all participants, is the central feature of the research method. It is, we argue, crucial to move the debate upstream, as not only does it reveal which nanotechnology trajectories are in the making, but also suggests how they could effectively be adjusted or altered to better fit society’s needs. In this article we outline the Technology Assessment framework that underlies our reflective action research approach and motivate its application in co-shaping nanotechnology developments in Flanders.

Keywords: nanotechnology, upstream public engagement, governance, reflective action research, Technology Assessment

1. Introduction

Nanoscience and nanotechnology hold the promise of major advances for humanity in the coming decades, but also raise profound questions and concerns about their ethical and societal implications. Yet public knowledge about potential impacts remains limited and the debate is still mostly confined to experts, even in countries heavily investing in a nanotechnology future. To scientists and nanotechnology developers this is worrisome, as they fear it could result in the sort of public backlash that accompanied the arrival of genetically modified crops, with the risk of stifling innovation. This explains why and to a greater extent than before, they seek public legitimacy for their scientific research.

From a governance perspective on science and technology, scientists seeking public recognition is a promising evolution, as it opens the way to early public involvement,

integrating societal concerns into technology development whilst innovations take place (i.e., in ‘real-time’). For nanotechnology, which is still in its early stages of design, public involvement is thus expected to steer its development in a more socially desirable way. But this is no easy task, as nanotechnological innovations take place in contexts of much uncertainty and unpredictability, and involve a wide diversity of actors. The undetermined nature of the technologies proves to be a serious challenge as well, as there is much speculation on where it is taking us, but almost nothing or very little can be said definitively about its eventual societal impacts.

To deal with the complexities at hand, we ask how the upstreaming of public involvement and deliberation processes on nanotechnology is best organized to meet both scientists’ and wider society’s needs. To this end we lay out a reflective action research model that builds on both Constructive and Real-Time Technology Assessment and illustrate its present application in shaping nanotechnology developments in the region of Flanders, Belgium.

2. Innovation Policy and Technology Assessment in Flanders

The development of innovations in technology has long been presented as a linear three-step model, going from scientific discovery in a laboratory, to breakthrough, to broad diffusion on the market. In this rather simplistic conceptualization, new processes and products are developed and distributed almost systematically, whereas in reality innovation is difficult to steer, because it is hard to analyze (Petermann, 2000). It is open-ended and stochastic rather than deterministic. Although those involved in technology innovation seemingly act rationally and independently, their actions are in fact shaped by the complex interplay between science, technology, and innovation, and are dependent on interaction with other

players. Any knowledge gained by forecasting is therefore inevitably limited and makes planning uncertain. This not only holds for knowledge institutions that explore the boundaries of science and technology, and for companies that seek to bring new products to market, but for users who have to weigh advantages and disadvantages, and for policymakers who have to manage the risks as well (Den Hertog, Smits, 2004).

In Flanders the latter have often developed contradictory policy strategies to cope with the uncertainties at hand. In the eighties, governmental innovation policy was framed within a top down approach characterized by attempts to centralize control on innovation. The focus of this policy was on selectively fostering critical directions ('picking winners') in science and technology, and then on improving the flow of knowledge in the innovation chain (Goorden, 2004). In this 'science-driven' and 'technology-push' approach, Flemish innovation policy selectively rewarded those research groups who placed their research activities explicitly in the domains government was pushing for. With the aim of 'picking winners', Flemish Government encouraged world-class research in generic fields of technology such as micro-electronics. This led to the establishment of the Flanders Interuniversity Institute for Micro-electronics, IMEC, in 1984, and later to the establishment of the Flanders Interuniversity Institute for Biotechnology, VIB. As a result, universities and public research institutions with an interuniversity structure became influential players in technology innovation. The institutional context in which they operated emphasized the central role of research actors in the innovation system with the focus on a science driven philosophy.

In the same period, the first Technology Assessment (TA) initiatives were launched as academic research programs. These programs were charged with examining the social impacts of new technologies such as biotechnology and micro-electronics. The need for TA research was framed within the dominant science-driven and technology-push approach.

From this perspective it is considered necessary to predict and anticipate the social impacts of science and technology, in order to adequately steer and orient governmental research and technology programs. One could say that TA was assigned the task of giving public governance a helping hand in ‘picking winners’. As such the initiatives represented an ‘instrumental’ type of TA in which the social scientific and policy analytic approaches of experts dominate (Guston and Sarewitz, 2006).

In the nineties, there was a growing responsiveness to the idea that Flemish innovation policy needed a shift in focus, departing from a technology-push approach to striving for a policy which stresses the importance of technology diffusion. This was reflected in the support of a bottom up growth of innovation clusters as collaborations between all innovation actors (companies, universities, technological institutions, public administrations), with attention for spontaneous feedback loops between innovation phases. Following this thread of thought, the Flemish Government sought to stimulate endogenous growth in Flanders by anchoring technological innovation in geographic regions and in existing activities.

Policy makers called for a kind of ‘bottom up’ TA as well, which was described as an approach “that may not slow down or have a negative influence on creativity and the innovation process”.¹ To this end TA activities had to be organized in close interaction with research and development practices in governmental technological programs on biotechnology, new materials and energy, and environmental technology. The expectation was that if TA was practised in direct consultation with science and technology producers, research would lead to socially useful applications.

Today, both the top down and bottom up policy approaches towards technology innovations are encountering their limits. Selective governmental support for priority

¹ ‘Technology Note’ of the Flemish Government, 1994.

technologies and activities seems to be a gamble. There is no reason whatsoever to assume that government officials are better at recognizing growth opportunities in the market than entrepreneurs (Hosper, 2002). On the other hand, a lack of vision for orienting investments in Research and Development (R&D) and public resources in a bottom up approach makes the dividing line between a bottom up approach and an ad-hoc policy very thin.

This ambivalence is also present in the Flemish TA approaches. In general, top down academic experiences involving early warning mechanisms for negative impacts of new technologies have had little or no impact on reorienting research programs or redesigning technology trajectories. Apart from the sheer impossibility of predicting in advance (and thereby hopefully evading) the unwanted effects of new technologies, an explanation for this limited impact is found in the imposed institutional divide between academic TA research and current technological developments. Successive bottom up experiences with relegating TA to R&D projects and technological programs at least incited scientists and technologists to think critically about their research practices. However, if the institutional context for R&D does not systematically offer civil society incentives for reflection on technological developments as well, the palette of contributed perspectives shrinks to those areas that are considered most relevant to scientists and engineers, notably safety and health risks, and market opportunities.

In order to create a more discursive type of TA in which the lay public participates through a genuine deliberative process, TA as a practice became lodged in an institution advising the Flemish Parliament, the Flemish Institute for Science and Technology Assessment, viWTA, in 2000. Yet, even here TA is not fully ingrained in the innovation process; rather it is done in a different location and time, isolated from the R&D enterprise itself.

In this respect, developing adequate TA frameworks and procedures to deal effectively with the emergence of nanotechnologies is a big challenge for Flemish innovation policy. In a recent survey by viWTA, a group of R&D directors from companies, universities, and public administrations voiced some expectations and concerns. They stated that public governance should play the role of mentor by creating and governing new ways of collaboration amongst all the relevant social actors. Secondly, they underlined the need for a collective vision and the formulation of social demands in relation to the policy goal of spending 3% of Flanders' Bruto Regional Product on R&D by 2010. Thirdly, because broad public support for technological innovation in Flanders is missing, science and technology should have a more prominent place on the public and political agenda.

Given these assertions, the research project Nanotechnologies For Tomorrow's Society (NanoSoc) comes at a timely moment, within what appears to be an encouraging institutional constellation. It is funded by the Flemish Institute for the Promotion of Science and Technology in Flanders (IWT) in a strategic program which supports interdisciplinary research among natural and social scientists, and with the explicit aim of involving civil society. Therefore it calls not only on nano-researchers and social scientists, but on stakeholders and interested citizens as well, in an attempt to clarify the opportunities and challenges in the social shaping of nanotechnologies in Flanders through a participatory process of reflective inquiry. The process in itself is considered as important as the outcomes it generates, as we recognize its potential in building more equitable and sustainable relationships between scientists and the wider community, to which we seek to contribute. In the following sections we link up the different TA frameworks supporting our research endeavor and elaborate its key characteristics.

3. Linking up the TA Frameworks

Seeking to integrate societal concerns into nanotechnology developments through a process of reflective inquiry with stakeholders is novel to Flanders, but the participatory TA approaches to which our project is indebted and on which it draws, are not. Constructive Technology Assessment (CTA), Real Time Technology Assessment (RTTA), and ‘public engagement’ represent three approaches that aim to publicly assess technology innovation processes before they close down or become locked in, i.e. at an early, *upstream* stage (MacNaghten et al., 2005). Although they differ in their origins and methods, all three are responses to the need for more discursive TA forms, as each one is concerned with ensuring the reflexive co-evolution of science, technology, and society (Rip, 2005).² Thence, they move away from traditional models of TA which are expert-oriented and focus primarily on impacts and effects of new technologies, towards integrating public concerns and desires during, rather than after, the process of technology development.

CTA, which was developed in the eighties by Arie Rip for use by the Dutch government, attempts to do so by letting “societal aspects [of innovation] become additional design criteria” (Schot and Rip, 1997). These criteria are established through the combination of specific analytical techniques, which include mapping and analyzing the ongoing dynamics of technological development, as well as the actors and networks involved; examining how technology is embedded in society and assessing emerging patterns; articulating with stakeholders socio-technical scenarios relating to future developments and possible impacts; and stimulating reflection through dialogue between innovators and users (Rip, 2005). What these techniques illustrate, is the strong emphasis CTA places on analyzing the ongoing interactions between technology and society, in order to improve their co-

² Arguably, public engagement is more a school of thought on science, technology, and society, than a TA approach.

evolution. Significantly, this is done within a participatory framework of early engagement, by including users – the so-called demand side – in the process of technology construction.

RTTA continues along the same path, although its originators describe their model as making use of more reflexive measures, such as focus groups and scenario development to elicit values and explore alternative potential outcomes, and analyze them as they evolve over time as well. The model further seeks to integrate socio-technical mapping and dialogue with retrospective and prospective analysis, in an attempt “to situate innovation of concern in a historical context that will render it more amenable to understanding, and, if necessary, to modification”. The overall purpose of RTTA is “to build into the R&D enterprise itself a reflexive capacity that encourages more effective communication among potential stakeholders, elicits more knowledge of evolving stakeholder capabilities, preferences and values, and allows modulation of innovation paths and outcomes in response to ongoing analysis and discourse” (Guston and Sarewitz, 2006).

The idea of building more reflective capacity into the practice of science fits well with the British ‘public engagement’ school of thought on science, technology, and society. Proponents of this approach note that processes of engagement tend to be restricted to endlessly debating possible risks, while deeper questions about the values, visions, and vested interests that motivate scientific endeavor often remain unasked or unanswered (Rodemeyer et al., 2005). Attempting to widen and open up such debates, public engagement “[moves] away from models of prediction and control towards a richer public discussion about the visions, ends and purposes of science. (...) The aim is to broaden the kinds of social influence that shape science and technology, and hold them accountable”. The most effective way of realizing this aim, is to “reach a situation where scientific ‘excellence’ is automatically taken to include reflection and wider engagement on social and ethical dimensions” (Wilsdon et al., 2005).

All three approaches relate to other science and technology frameworks as well, such as ELSA (Ethical, Legal, and Social Aspects), and build on existing and newly emerging notions in the field, such as responsible innovation and the idea of governance of science and technology, and of co-operative research (Stirling, 2006). They can be further broadened and deepened by drawing on various disciplines (natural and social sciences, as well as the humanities), on techniques of mediation and facilitation, and by thoroughly analyzing innovation dynamics and the embedding of technology in society. The latter is particularly noteworthy for this paper, as it entails assessing with innovation actors larger patterns (technological, historical, political, economic, cultural, and other contexts) that enable or constrain them, to make actions more reflective (Rip, 2005).

From these complementary perspectives we create an overarching framework for early technology assessment, appropriate to both the policy context for TA in Flanders (as outlined in the previous section), and to the highly speculative domain of nanotechnology, given the uncertainties and wide disagreements about nanotechnologies' societal implications which accompanies their rapid emergence. From CTA we retain its focus on critically analyzing the co-evolution of technology and society, whilst from RTTA we retain its emphasis on critically reflecting with actors on what motivates their actions and exploring action alternatives considerate of societal concerns. In what follows we expound further on what constitutes this reflective action approach of ours and account for the according research methodology.

4. The choice for reflective action

As described at the outset of this paper, innovation with new and emerging technologies involves a wide diversity of actors who interact in a context of much uncertainty and

unpredictability. Innovation should thus be understood as a search process where advancement comes about through variation and selection, rather than by deliberate planning. Within such a potentially disruptive setting, dialogue between actors can guide innovation along a new, more balanced course (Larosse, 2004). From this understanding of co-responsibility to technology innovation, both the promoters of science and technologies (scientists, engineers, and technology assessment experts, amongst others), as well as technology demanders (regulative authorities, pressure groups, citizen-consumers) can contribute significantly to guiding and encouraging technology developments in which social aspects, desirability, and acceptability are taken into account, by sharing with each other their perspectives, needs, and concerns. The research endeavor we initiate follows this line of argument, as it engages nanoscientists and technologists, social scientists, stakeholders, and interested citizens in a social learning process to openly discuss and shape nanotechnology developments while they take place. Its focus is on three case studies relevant to nanotechnology innovations in Flanders: smart environment, biosensors, and new materials.

To initiate prospective reflection and future-oriented debate, we pose participants two overarching questions: (1) *Which nanotechnology trajectories (developments) are likely or possible?*, followed by (2) *Which trajectories are worthwhile or desirable for a future society?*. Thus participants look first for which future nanotechnology trajectories they deem probable and therefore require further consideration, to then discuss which trajectories are worth elaborating and refining. The first question is addressed in an exploration stage and a visioning stage; the second in a normative stage and a design stage, as outlined below.

- Exploration stage: Anticipation of possible technological trajectories that are the result of processes of variation (several technological trajectories are considered) and selection in the case under study. Based on these outputs,

scientific experts and a citizens' panel construct socio-technical scenarios for the future.

- Visioning stage: Supplementation, specification, and concretization of these scenarios building on experiences ordinary citizens have with new and emerging technologies.
- Normative stage: Construction by scientists and stakeholders of a shared image of a sustainable future for the societal application areas to which the technological trajectories under consideration are related.
- Design stage: Creation of possible technological trajectories and their social embedding, which innovation actors find realistic and interesting, and stakeholders and citizens value positively.

As each stage intends to bring together different kinds of actors (to maximize mutual learning), we draw on qualitative social scientific research methods designed specifically to facilitate and structure communication processes between participants from diverse backgrounds. In the exploration stage we use a two-round Delphi study which engages both natural and social scientists, as well as a panel of citizens that is considered more or less knowledgeable about nanotechnology (through study or experience), but does not consist of nanotechnology professionals. Both groups are asked to anticipate the effects of the technology by reflecting on the social changes and risks in relation to its emergence. More specifically, participants share with each other general expectations, as well as their personal views regarding possible future technology options. The purpose of confronting these perspectives is not so much to gather accurate information about specific technology trajectories presently in the making, as to stimulate imagination and hint at alternatives for future technology developments. To enhance creative thinking, participants respond

anonymously to written questionnaires. Their answers are then passed on to each other via e-mail.

In the second stage outcomes generated from the Delphi rounds are translated into future scenarios (images or representations of the future) and presented for critical examination to a second citizens' (or 'lay') panel, sociologically representative of the Flemish population. The panel is invited to supplement and rethink the scenarios presented to it, as laymen usually assess technologies more from a 'gut feel', based on unique experiences with technology, rather than scientific expertise (Hanssen and van Est, 2004). By sharing their perspectives and expectations users can contribute to making scenarios more socially robust, and in the long run, to developing sensitivity amongst innovation actors to user needs and concerns. The format for this exercise is based on the scenario workshop designed by the Danish Board of Technology. It entails the three consecutive phases of criticism, vision, and realization.

The socio-technical scenarios are then passed to stakeholder representatives from various organized interest groups in Flemish society to assess potentially significant shifts in values, norms, and belief systems that take place as society and technology co-evolve. The purpose of this exercise is to recognize core values and ideals to which society as a whole is committed (and thus in all probability seeks to preserve), and which ones are apt to modification or adaptation as new technologies impact on society by changing expectations and realities. To structure this debate, stakeholders apply value tree analysis to come up with a shared image of the future. This method consists of asking participants to arrange value concerns along the branches of a tree structure, where higher level criteria correspond to generic, overall objectives, and the criteria at the lower levels to attributes that are relevant for the attainment of the larger objectives. The results are then communicated back to the innovation actors (from the first stage), who are asked to appraise the technology trajectories

in terms of their usefulness, and perform vision assessment to reflect on possible strategies that can contribute to realizing the projected future.

Taken together, the group interactions outlined above make up the reflective action component of our research project, as they provide participants and innovation actors in particular, with strong incentives to reflect systematically on the embedding of technology in society and its many implications. As with Real Time TA, the focus is on rendering these actors aware of alternative potential outcomes, by exploring promising areas of technology innovations and by reflecting with them on values and basic attitudes that determine technology developments. Most importantly, the reflection exercises are an ongoing process, initiated with nanotechnologies still in their relatively early stages of design.

To complement the reflective process, the research endeavor also entails a process and an impact analysis, both of which are not elaborated further in this paper, but deserve short mention, as the first of the two analyzes the quality of the reflective process, evaluates the interactions of the participants and the social learning effects that take place during and after their exchanges, while the second looks at how these interchanges influence and possibly reshape participants' views and expectations, thereby possibly affecting their research practices and the organizational cultures in which they work as well. Its significance lies in pointing to institutional preconditions that either stimulate or hinder the integration of societal reflections into the dynamics of R&D.

5. Conclusion

Successful innovations with new and emerging technologies like nanotechnologies, depend on how well they are socially embedded. Raising awareness and sensitivity amongst innovation actors towards user concerns and broader societal implications of technologies can contribute to shape the direction of research and developments in a manner that meets the

needs of those affected. It is our hope that the early dialogue processes which we initiate between nanotechnologists, stakeholders, and citizens in the Flemish region stimulate scientists and researchers in particular to explore alternative outcomes and critically question the values and assumptions that are built into research and innovation. As the reflective action approach presented in this paper integrates both Constructive and Real Time TA methods to create an overarching framework for early technology assessment, it can also be of use to TA practitioners, and instructive to researchers working in the ever developing field of science and technology studies as well.

References

- Den Hertog, P., and Smits, R. (2004) Co-evolutie van innovatietheorie, innovatiepraktijk en innovatiebeleid, analyse van de mogelijke rol van parlementaire TA in innovatiebeleid, Studie in opdracht van viWTA, viWTA, Brussels.
- Goorden, L. (2004) "Innovation Policy and Technology Assessment in Flanders", Study Commissioned by the Flemish Institute for Science and Technology Assessment.
- Guston, D.H., and Sarewitz, D. (2006) "Real Time Technology Assessment", in *Technology and Society*. 23, 4 (*in press*).
- Hanssen, L., and van Est, R. (2004) De dubbele boodschap van nanotechnologie. Een onderzoek naar opkomende publiekspercepties, Rathenau Instituut, The Hague .
- Hosper, G.J. (2002) Clusterbeleid tussen trend en traditie, in *Tijdschrift voor Wetenschap, Technologie en Samenleving*. 10, 4, 152-156.
- Larosse, J. (2004) Do small countries have (dis)advantages? The rise of MAP's as instruments for strategic innovation policy. The case of Flanders, IWT, Brussels.
- Macnaghten, P., Kearnes, M., and Wynne, B. (2005) "Nanotechnology, Governance, and

Public Deliberation: What Role for the Social Sciences?”, in *Science Communication*. 27, 2, 1-24.

Petermann, T. (2000) Technikfolgen-Abschätzung und Diffusionsforschung, TAB-Diskussionspapier nr. 8, Bureau für technikfolgen-Abschätzung beim Deutschen Bundestag.

Rip, A. (2005) “Technology Assessment as Part of the Co-Evolution of Nanotechnology and Society: the Thrust of the TA Program in NanoNed”, paper contributed to the Conference on “Nanotechnology in Science, Economy and Society”, Marburg.

Rodemeyer, M., Sarewitz, D., and Wilsdon, J. (2005) *The Future of Technology Assessment*, Woodrow Wilson Center, Washington DC.

Schot, J. and Rip, A. (1997) “The Past and Future of Constructive Technology Assessment”, in *Technological Forecasting & Social Change*, Vol. 54, nos.2&3, 251-268.

Stirling, A. (2006) *From Science and Society to Science in Society: Towards a Framework for ‘Co-operative Research’*, Brussels.

Wilsdon, J., Wynne, B., and Stilgoe, J. (2005) *The Public Value of Science. Or how to ensure that science really matters*, Demos, London.