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# Knowledge Politics and New Converging Technologies: A Social Science Perspective

## Converging Technologies – What Future?

## The Views of the Science and Policy Communities

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In his recent novel *Death at Intervals*, José Saramago imagines a society where death no longer happens following a decision by Death (written with a capital D) to take a break. The first reaction of elation is followed by a social crisis – within state and religious institutions – as families begin to commission illegal organizations to transfer their old and ailing relatives across the border to countries in which mortality still prevails in an effort to relieve themselves of the material and psychological burden of home nursing. Saramago's book is a sinister satire and critique of the way in which contemporary societies construct a fear and aversion of death, whilst being dependent on its existence all the time.

The situation described by Saramago might be closer to reality than we think. Modern science and technology does not promise immortality, but it does entail the hope of ever-prolonging healthy life expectancy towards the partial transcendence of death. Death happens and will continue to happen, but its omnipresence is constantly being denied,  that is at least in the northern hemisphere and in the context of constant innovations in modern medicine. The nano-, bio-, info- and cogno- (NBIC) science vision or converging technologies (CT) paradigm represents the latest quantum step towards technology-assisted human enhancement. NBIC stands for the application of computational logic and architecture to the human body through nano-scale manipulation. In conjunction with the knowledge about the mind gained by cognitive science, CT promises to break open new doors into new horizons. In the future, we are told, it will not only be possible to identify, anticipate and combat emerging illnesses whenever and whereever necessary, it will also be possible to manipulate our minds and our memories towards greater productivity or more effective use. Such engineering *of* our minds – or *for* our minds[1] – opens up new vistas for individual, but also societal development.

Naturally, not everyone is happy with this course of events. Unease is growing among religious individuals and groups, but also among those secularly committed to preservation goals – whether of the environment, nature or humanity. There is also concern within the science policy community, and, especially, among public administration officials, who are called on to 'govern' in an anticipatory manner. Anticipatory governance implies paying attention to all interests and value orientations, whilst at the same time ensuring that no major public outcry erupts unexpectedly or gets out of control. The field of converging technologies is expected to produce major confrontations with respect to values and normative orientations and is, therefore, one of the main focuses of anticipatory governance within contemporary science policy. The term 'knowledge politics' reflects this situation well. It was introduced by Stehr (2003) to describe all those activities dealing with the support or the rejection of the production, dissemination and use of novel technologies. The contention and politicization of knowledge is, of course, nothing new. What is new, however, is that such practices have in the meantime been institutionalized and transformed into generally-accepted activities for either soliciting or monitoring emerging knowledge. On the soliciting side, these practices include advocacy coalitions, science-industry alliances or lobby groups. On the contending side, knowledge politics covers activities such as bioethics councils or committees, citizens' dialogues or juries, ethical checklists, ex-ante risk assessments or ELSA-type research.[2]

Against this background, the present article represents an attempt to map the opinion-forming processes characteristic of this new field by examining the way the science and policy communities construct and appreciate converging technologies. The research on which the present article is based included in-depth interviews with policy-makers (5), scientists (8) and ethics experts (7), apart from extensive document and discourse analysis. The interviews were carried out in Austria in 2007 and 2008 within the framework of a research project on converging technologies.[3] Austria, like most other European countries, does not have an indigenous CT-discourse, but it evinces quite an internationally-oriented science and policy community. Thus, the opinions expressed by the experts could be said to represent more general views within Europe. For reasons of anonymity, the identity of the experts will not be revealed. Instead, they will be described with respect to their field of research or activity. All were to be found in the 40-60 age group, and the majority were male.

Previous work in this field has tended to focus on nanoscience and technology (NST) and the ways these may become contested like GMOs during the 1990s. Another component of this literature is the role played by NST in the collaboration between science and industry. Indeed, the NST field is growing very rapidly. Today, most countries within and outside Europe have large NST research budgets. This growth is also evidenced by the establishment of new journals in the field at the interface between science and business, such as ‘Nano Now’ or ‘The Journal of Nanotechnology’. In the science and technology studies (STS) field, which is dominated by social scientists, an equally strong interest in NST can be observed. Special issues or contributions on NST have been published in *Public Understanding of Science* (since volume 11), *Science Communication* (volume 27), *Social Studies of Science* (volumes 35 & 36) and the *Bulletin of Science and Technology* (volume 26). Only a fraction of this STS literature looks at converging technologies as opposed to NST alone. Notable exceptions are the two special issues of *Innovation* (volumes 20 & 22), on which this article is based. There, a number of authors, including notably Fuller (2009), Wolbring (2008), Ferrari (2007) and Schmidt (2007), critically review the converging technologies agenda. Much of this work was based on discourse analysis within the more general framework of the sociology of knowledge. The present article is the first to combine this with the systematic analysis of expert opinion.

The article is structured as follows:

The first section delineates the institutional settings within which the CT-discourse has emerged. These are often artificial settings in that they were created top-down by setting up new budget lines to guide research funding. The second section looks at the meanings of convergence and compares the meanings advanced in key policy documents, like those of the NSF, with those preferred by scientists. These differences are not only theoretical, but also rooted in different understandings of the nature of research per se. The third section turns to the risks and ethical issues surrounding converging technologies. At present, they are largely synonymous with those identified for nanotechnologies. In this respect, what is more interesting is the differences observed between the majority of scientists, on the one hand, and the majority of policy-makers and ethicists, on the other, regarding the role of anticipatory governance. Unlike policy-makers, who push for anticipatory governance, scientists consider this a nuisance in view of the complexity of the subject matter. Indeed, a detailed risk assessment only appears possible at the level of the specific application, and such applications are still rare.

The uniqueness of converging technologies has more to do with the philosophical agenda of the latter, the subject of the fourth section. CT represents the first explicit and concise elaboration of the technology-based enhancement agenda. This goes far beyond what has already been delineated by biotechnology and, especially, stem cell research. The next two sections deal with the questions of regulation and citizen participation respectively. Despite the general acknowledgement of the specificity of CT, all respondents objected to the idea that research, and knowledge production more generally, should be controlled. At the same time they plead for greater citizen awareness about new technologies as a means of legitimacy, but also indirect accountability. The final section of the article offers some conclusions as to the future of the CT-discourse.

## Institutional settings

The converging technologies discourse was introduced in Austria via the European Union and, more specifically, when the High Level Group on Converging Technologieswas set up in 2004.[4] As elsewhere in Europe, the Austrian CT-discourse is constructed around that on the more clearly delimited field of 'nano' science and technology (NS&T). Austrian scientists are actively participating in the European nanoscience research programme, which complements the Austrian Nanotech Programme. The latter has an annual budget of circa EUR 12 million, which is small in comparison with the programmes of larger countries, but still significant in the Austrian context both for its scope and its strong focus on research carried out in collaboration with industry. Since 2003, the Austrian Nano Initiative has funded nine big collaborative projects (each with a budget of two to four million) and three major regional cluster networks.

In order to react to concerns about the risks of nanotechnologies, in 2006 the Austrian Ministry of Transport, Innovation and Technology (BMVIT) commissioned two risk assessment studies on the subject. The first, carried out by the Institute for Technology Assessment (ITA) of the Austrian Academy of Sciences, provided an overview of the international risk assessment / regulatory debate on nanotechnologies; the second, carried out by the association NanoNet Research Cluster in Graz, focused on nanomedicine.[5] Both studies argued in favour of intensifying activities in the field and called for more science-policy dialogues with citizen participation. Austria is one of those European countries which have in the past displayed strong opposition to new technologies. GMO technology is a good illustration. Following a very successful civil society mobilization against GMOs in the early 1990s, Austria became one of the strongest proponents of the moratorium on the GMO Directive[6] and continues to oppose the use of GMOs on its soil. This largely suspicious attitude towards technology has motivated Austrian policy-makers to emphasize anticipatory governance with regard to all new technologies and NS&T in particular. Consequently, in 2007, ITA was entrusted with a three-year project on ‘Integrated Analysis of the Knowledge Base on the Environmental and Health Impact of Nanotechnologies’ (NanoTrust). In parallel, a centre on nanotoxicity is being set up at the Medical University of Graz in collaboration with NanoNet Styria. To this it must be added that all projects funded by the Austrian Nano Initiative are expected to carry out a preliminary safety and risk assessment at the beginning of research.

## Meanings of convergence and research trajectories

Convergence is commonly understood as indicative of the eventual dominance of the scientific method – meaning the method based on cause-and-effect relationships – over other methods and across scientific fields. Over the past few years, for instance, and in combination with IT and nanotechnology, it has become possible, for the first time within biology, to produce an incredibly large pool of data and information for testing several cause-effect hypotheses statistically. This is expected to contribute to major breakthroughs in medical research.[7]

The U.S. National Science Foundation (NSF) takes this reasoning or argument a step further. As outlined by Roco and Bainbridge (2002), the NSF vision of convergence has two principal components. It builds on ‘the synergistic combination of four major provinces of CT', based on 'material unity at the nanoscale and on technology integration from that scale' (2002, ix). This 'material unity' enables scientists to understand the natural and human worlds as *hierarchical* systems. The epistemological implications of this ontological hierarchy are best rendered by the postulation of a '*unifying science*' at the level of scientific research. In this context, unifying is explained as meaning the 'unified cause-and-effect understanding of the physical world from the nanoscale to the planetary scale' (x).

What is specific to the NSF understanding of a 'unifying' science is the link established between the scientific method and a presumed underlying hierarchy. The scientific method is relevant not only for describing specific cause-and-effect relationships in the physical world, but also for understanding the physical world as a whole. Seen from the reverse, it is possible to identify causes and effects because everything is ultimately structured hierarchically. Consequently, exploring causes and effects implies revealing hierarchies – or even *the* hierarchy – and eventually becoming able to reproduce them or reinvent them anew. According to Fuller (2009), the CT-paradigm has enabled the resurgence of the chemical worldview in science and technology:

‘*The physical and chemical worldviews can be regarded as complementary, especially from a theological standpoint. The physical worldview draws a clear distinction between Gods and humans, so that there are final barriers to our ability to predict and control nature. We aim to discover that beyond which we cannot turn to our own advantage. By contrast, the chemical worldview, much more heretically, envisages humans playing, if not replacing, the divine creator. Here matter is not treated as an insuperable barrier, but as raw material to be moulded – with more or less difficulty – to serve human needs. What matters is not the ultimacy of matter per se, but its moment of ultimate plasticity, the so-called edge of uncertainty that the nano-scale promises to provide.*’

The majority of the Austrian scientists interviewed for this study objected to this unifying approach, expressing a preference for a less reified vision of convergence. This begins with the cautious appreciation of the ‘nano’ hype in science and technology. Practically all Austrian experts among scientists and policy-makers agreed that the converging technologies paradigm has to do with ‘nano’ science and technology. However, the majority also pointed out that the novelty attached to ‘nano’ is policy rather than research-driven. Research at an ever smaller scale of matter delineates a process that is as old as the scientific obsession with the universe. Beginning with

Einstein, for physicists especially, the two areas are linked insofar as a theory of the universe is impossible without an understanding of the quantum level of reality. At least since the invention of computers, it has become clear that the future of technology, if not science, lies at the micro and, gradually, the nano level. Therefore, respondents invariably described ‘nano’ as a gimmick, a wrapping, a tag, a fad or a slogan used to attract funding. The use of visionary scenarios to attract research funding was something some respondents associated with the American way of justifying research expenditure.[8]

The convergence paradigm is nonetheless linked to specific novelties in institutional research practices. Two of the respondents[9] argued that contemporary discussions of convergence are indicative of the decreasing specialization within science, whilst six respondents[10] thought convergence described trends akin, even if not entirely equivalent, to interdisciplinarity. Both convergence and interdisciplinarity are concerned with the collaboration (direct or indirect) between disciplines. However, whilst convergence emphasizes the ‘applied’ dimension,[11] hence also closer links to industry, interdisciplinarity was perceived as being more ‘academic’, designating co-operation at the level of basic research.[12] None of the respondents held the view that this increased collaboration among disciplines would lead to a unified science. Some, however, thought that it would eventually lead to the emergence of a 'common language'.[13]

In line with the appraisal of convergence as involving a shift towards more applied research and closer collaboration with industry, all but one of the policy-makers interviewed[14] were of the opinion that major projects and networks were better suited for advancing the CT-paradigm. This is because they mobilize numerous researchers across several institutions and are thus able to achieve a critical mass in terms of human capital, financial resources and infrastructure. Furthermore, only major projects can attract industrial attention and compete with the U.S. This echoes the official line of the Sixth Framework Programme for Research, Technology and Development (RTD) of the European Union that ran from 2002 to 2006. By contrast, scientists advocate a different view, rejecting the 'big is beautiful' idea and arguing against the top-down design and artificial setting of major projects with strong industrial participation.[15]

The endorsement by the science community of basic research also manifests itself in preferences for the maintenance of disciplinary divisions with respect to training and education in general, and at the graduate level in particular. For many of those active in science, disciplines represent the guarantee of a solid education. Three respondents,[16] all physicists, cautioned against trivializing the research trajectory by thinking that all types of disciplinary combinations were possible at all stages of education or research.

Two additional systemic factors speak against extensively broadening the research training base. The first concerns the formative character of Ph.D. research, which is essentially a matter of specialization. The second has to do with the fact that those scientists making decisions about research programmes and priorities are not necessarily those working at the frontiers of scientific research. A career in research is often incompatible with a career in research policy. This might especially be a problem in small countries like Austria, which continue to display rigid hierarchical structures with respect to career advancement.[17]

In summary, it can be said that the CT-discourse in Austria is inserted in ongoing disputes on the future of scientific practices and research trajectories with reference to, first, the role of industry in applied research, and, second, disciplinary fragmentation. Policy administrators, especially, are keen to see research moving towards more applied areas with greater private sector involvement. For them, the converging technologies research programme represents a useful arena for promoting this agenda. By contrast, several scientists are apprehensive about these developments. This is because they have less faith in the revolutionary potential of grand visions such as convergence, but also because they fear the loss of their autonomy – and power – as a result of structural reform.

## **Risks and ethical issues**

### What the scientists think

Risk considerations and ethics do not figure prominently in the discourse of scientists on converging technologies. But this is not because these concerns are not recognized as important. The standard scientific answer to the question as to the social and ethical implications of converging technologies is rather that risks are endemic to scientific research (and technological products) and that this has always been the case. Ethical questions, especially, have less to do with the scientific method or technology, but rather with its use. In other words, any technology can be put to the 'wrong' use, with detrimental consequences. In this context, Austrian scientists will often point to World War II to illustrate the pertinence of this argument.

An additional asset of this point of view is that it warrants the distance between the scientist, on the one hand, and society, on the other. This gap is savoured by many scientists as a key aspect (or even the proof) of their autonomy. From this perspective, it is not necessary or particularly useful for a scientist to become involved in activities concerned with raising awareness about scientific research or with citizen deliberation about contentious issues. Younger scientists tend to be more positively disposed towards science communication, also because they are compelled to engage in related activities by their research contracts.[18] More generally, however, the fields of science and society are perceived as separate domains governed by different rules of exchange and interaction. In the minds of the majority of Austrian scientists, risk factors and ethical concerns do not change this distinction.

## The perspective of policy: anticipatory governance

Despite this cautious attitude of scientists towards a closer interaction between science and society, policy-makers have both advocated and promoted this agenda. Its new name is anticipatory governance. The scholars working at the Centre for Nanotechnology in Society at Arizona State University define anticipatory governance as the broad-based societal capacity to 'manage' emerging knowledge-based technologies according to governance as opposed to government principles (Barben et al. 2008). In contemporary policy analysis, governance is used to describe network-based horizontal forms of regulatory activity that rely less on command and control measures and more on stakeholder co.operation (White Paper 2002). In the science field, this ranges from innovation systems analysis and technology assessment (Salerno et al. 2008, Nordmann 2008) to public opinion surveys and deliberative exercises towards reflexivity and evaluation. EU policy-makers also consider anticipatory governance for nanotechnology as a means to avoid the problems previously posed by GMOs (Homeyer 2006). Since the BSE crisis at the beginning of the 1990s, the European Union has also been much more cautious in its regulatory activity in the food sector, including innovative food (Lindner 2007). Both the cases of GMOs and BSE were adjudged to be instances of government failure and the failure of EU information policy.

The limitations of converging technologies, and, especially, those emerging in relation to ethical and social dimensions, are the reason why the High Level Group on Converging Technologies, set up by the European Commission, prefers to talk of ‘Converging Technologies for a European Knowledge Society’ (CTEKS) rather than ‘converging technologies’ (CT) alone. CTEKS, unlike CT, includes the social sciences and humanities in the domain of converging technologies:

*'A European approach to CT needs to be informed by an awareness of their potential and limits. It acknowledges nano-, bio-, and info- as key enabling technologies but recognises that only careful agenda-setting can bring them together in a viable and socially beneficial convergent research. Converging Technologies for a European Knowledge Society or CTEKS exploit the potential of nano-, bio- and information technologies. They also include: the social sciences and humanities and other enabling technologies and knowledge systems; explicit awareness and study of limits, for example, with respect to cognition; an orientation towards common goals that are formulated within a European policy framework of public process and shared value.' (EC 2004, 19; author's emphasis)*

The High Level Group report points out that all four dimensions rendering converging technologies unique represent risk factors at the same time. These dimensions are the embeddedness of CT, their unlimited reach, their potential for engineering the mind and the body as well as their specificity.

**Risk factors**

To begin with, there are the ethical issues associated with the limited knowledge base on the new technologies and their possible abuses. These concerns tend to overlap with those about nanotechnologies. The UNESCO report on *The Ethics and Politics of Nanotechnology* of 2006 groups these into three categories. First, there is the equity problem: who benefits and when? Second, there is the environmental and health risk associated with the possible toxicity of both naturally-occurring and engineered nanoparticles: according to the report, the question is not whether nanotechnology is safe or not; it is rather how to make it safer. Third, there is the whole range of scientific ethical questions, including the extent to which there are adequate mechanisms for public scrutiny and for ensuring that the data and knowledge gathered is not abused. Here, the issue of data protection is of primary importance, considering the opportunities new technologies offer for trace and follow-up.

These concerns are reiterated in the Austrian Bioethics Commission report on nanotechnology published in 2007. According to the report – entitled 'Nanotechnology: Catalogue of Ethical Problems and Recommendations' – the nanotechnology challenge has to do with the fact that particles at this level are known to have distinct characteristics that may be different from those of bigger particles of the same material. This also implies that they may have toxic implications that are not yet fully understood, thus not addressed by existing regulatory frameworks. Therefore, exploring these risks is a priority in general, and, in particular, for applications in the fields of medical diagnosis and medication.

Nonetheless, even if it represents a new technological field, nanotechnology is not unusual with respect to the ethical concerns mentioned above. This is because nanotechnology is not one single technology, but rather designates a methodological approach. Risk and/or ethical issues will emerge, if at all, in relation to specific applications. In other words, any emerging risk factors or ethical issues will have to be examined in the case of each application individually.[19]

Biotechnology applications are currently the field driving debates on ethics. Here, stem cell research is only the tip of the iceberg, and not even the most salient policy concern, despite its wide publicity and contentious politics. The most important issues are those concerning medical diagnostic knowledge and techniques. In this context, writes the Austrian Bioethics Commission report, nanotechnologies accentuate well-known problems regarding the discrepancy between diagnostic knowledge and therapeutic capacity; the right not-to-know and the ever-increasing reliance on personal responsibility for making medical decisions in light of the diffusion of tests and medicine that are self-administered. At the same time, the increased possibilities for prevention raise questions regarding the relation to one’s body and our understanding of disease. At the societal level, on the other hand, increased life-expectancy is likely to aggravate inter-generational conflicts.

## A new philosophical agenda

Converging technologies perhaps merely underline well-known ethical problems, yet this emphasis is quite powerful, given how they enable, perhaps for the first time, the realistic envisaging of a brave new technological world, in which reason wins over the human condition (Dupuy 2005). It is this philosophical agenda that distinguishes the ethics of converging technologies from more general scientific ethics.

> *'The convergence of nanotechnology and other enabling technologies in specific engineering projects expresses an underlying philosophical agenda, namely the total constructability of humanity and nature (...). The most direct and profound effect of CTEKs is therefore to change traditional boundaries between the self, nature and social environment (...). In light of CTs, society will be confronted with far more frequent and deep transformations of peoples' and groups' self-understanding' (EC 2004, 31).*

To this ethical impact of CT, adds the CTEKS report, 'corresponds a legal impact since the existing legal framework is not ready to address technological transformations of the human body or mind' (EC 2004, 32). A case in point was recently discussed by

Wolbring (2008) with reference to Oscar Pistorius, the Paralympic bionic-leg runner with good running times, who was initially not permitted to participate in the Olympic Games with the argument that his bionic legs gave him a competitive advantage, and who successfully appealed against this decision.[20] According to Wolbring (2008), Pistorius' case raises the question as to how to deal with the ever greater forms of 'beyond species-typical functioning' brought about through enhancement or modification techniques.

The opposite case of intentional non-use exemplifies even better what is at stake. What to do, for instance, with a deaf couple who object to the implantation of a chip in their deaf newborn baby's ear? Assuming it is implanted early in life, such a chip would contribute to overcoming deafness in childhood and adult life. But for the baby's parents, deafness is not a 'disability', but rather a positive element of their identity – as individuals and as members of the community (of deaf people).[21] This they would like to preserve for themselves, but also for their child, who is, however, not yet cognitively able to make any decisions of informed consent.[22]

These two examples clearly exemplify the philosophical implications of the CT-agenda, and it is therefore hardly surprising to find that CT is today the site of fierce debates at the normative level. In this conflict, the so-called transhumanists,[23] advocates of technology-assisted human enhancement, are challenged by those who object to the exceeding of human or natural boundaries either because of their religious beliefs or because they are concerned that this may go against human dignity (President's Council of Bioethics 2008).

Human dignity in ethics marks an attempt to bring virtues and values back into ethical discussions and to do so in a prescriptive rather than a descriptive manner. Human dignity is expected to assist the critical evaluation of technical progress from a 'thicker' or 'deeper' perspective that does justice to personal experience as well as social identities, hence liberty and responsibility (Briggle 2009). Advocates of human dignity as a reference framework for ethics also view this as a useful means for 'opening' the debate on technologies and their implications, i.e. for shifting attention away from the narrow consideration of technological applications, thus allowing for more 'upstream', as opposed to 'downstream', debates. However, there are also dangers to this approach, its critics claim, who are not only to be found among the ranks of the transhumanists. Those liberals who are keen to see the principle of individual autonomy preserved in bioethics argue that human dignity does not provide a reasonable compromise between 'thick' and 'thin' bioethics because it, too, delineates a relative concept (Pinker 2008).[24] According to Dworkin

(2006), in a tolerant secular society that refuses by constitution to assign any specific religion or community the hegemony on morality, ethical decisions will inevitably have to rest with the individual. According to all ethics experts interviewed for this study, the role of ethical consultations or opinions is that of unveiling and demonstrating where the cleavages lie and what the opposing arguments are. Such consultations can and should be as broad-based as possible. Their objective should, however, not be to make decisions, but rather to discuss the various perspectives on any particular issue.[25]

## What regulatory framework?

Where does this leave the discussion about regulation? Is there or should there be new regulatory frameworks for converging technologies, whether at the level of research or at the level of application?

Insofar as research is concerned, all 19 Austrian respondents to our study agreed that this is neither feasible nor desirable. The freedom of research is a public good, to be protected as such. But an open information policy regarding research results and their possible risks is equally important. Only one scientist involved in commercial research was cautious about this point, pointing to the fact that the frequent lack of balanced information on a specific topic is less the mistake of scientists and more that of the media.[26] What is far more complicated is the regulation of technology use, and it is in this domain that we have seen the emergence of more detailed regulatory guidelines and procedures, such as on informed consent and participation in medical tests. Some scholars (Fukuyama and Furger 2006) have gone so far as to argue in favour of new agencies for dealing with emerging technologies and their implications for society.

The organizational dimension of the regulatory framework for governing new emerging technologies is also relevant in Austria. Like the United States, Austria is characterized by the absence of a legislative framework, solid institutionalized technology assessment structures and consultation processes in the biomedical field. According to Gmeiner (2006), this is, in part, because the 'areas of conflict are quite diffuse and no clear political profiles can be detected'. The Austrian Conservative Party, for instance, follows a pro-life approach, but is, simultaneously, the main spokesman for industrial interests. In the nanotechnology field, which remains less contentious, the approach taken instead consists of delegating the monitoring task to scientific institutions through project contracts. The Nano Trust Project mentioned earlier ismeant to monitor discussions about the possible risks of nanotechnologies, albeit only for a period of three years. Along similar lines, the European Union has opted for setting up committees at various levels and commissioning them with the task of coming up with guidelines for a Code of Conduct (Schomberg 2007, ETAG 2006). The latter prescribes an 'open and pluralist forum for discussion' and advocates that scientists should exercise 'integrity' when deciding on research topics and methods. Whether such mechanisms will suffice to create the critical mass of expertise and to consolidate procedures of knowledge transfer, criticism and reflexive evaluation remains to be seen.

## What about civil society?

Anticipatory governance presupposes the involvement of civil society in consultations regarding new technologies. This includes the support of the development of counter expertise by civil society organizations as well as the organization of citizen deliberation exercises.

As early as 2003, Greenpeace published a report on nanotechnologies and converging technologies, whilst in 2007 the ETC issued a broad appeal, urging the strict supervision of nanotechnology due to its health, safety and environmental hazards. The appeal, which was signed by 40 organizations world-wide, identified eight principles for the prudent treatment of nanotechnology, ranging from the application of the precautionary principle, the development of specific nanotechnology regulations, to public participation and manufacturer liability. In the field of convergence, ETC has still to voice any major opinions, but the name given to CT is indicative of its cautious approach , namely BANG, although this merely stands for 'Bits, Atoms, Neurons and Genes'.

Having dominated debates on life sciences and medical ethics, religious institutions have not yet been very active in the field of converging technologies. Two exceptions are the Church of Scotland and the World Council of Churches. The Church of Scotland is leading a project on the ethical and societal impacts of emerging technologies, which also takes the religious perspective into account. For a short time this has also included nanotechnologies.[27] In 2005, The World Council of Churches published the first volume of a series on 'Science, Faith and New Technologies', focusing on converging technologies and nanotechnologies (WCC 2005).

Scientific deliberations involving citizens have become quite fashionable in recent years. In the field of converging technologies – nanotechnologies, but also brain sciences and biotechnology – several related initiatives have been initiated top-down, often with funds from the European Union or national science budgets. Until now there have been no citizen deliberation exercises on converging technologies in Austria.[28] Four noteworthy examples from other countries are the Nanodialogues[29] and VivAgora[30] platforms, a consumer conference in Germany[31] and the 'Meeting of Minds' citizen conference.[32]

A frequent criticism of deliberative exercises is that they promote specific interests or that they have limited impact. The former criticism is based on the financial and organizational basis of deliberations, the latter on their limited reach and complicated subject-matter (Felt and Fochler 2008). Austrian STS scholars with experience in the field[33] also point to the unrealistic expectations often associated with citizen participation in consultation exercises – on the part of both citizens and organizers. The argument used to persuade citizens to take part in such activities is that they will thus have an opportunity to influence policy. In fact, direct impact on policy-making is the exception and not the rule. The main contribution of such deliberative exercises isactually awareness-raising and networking among citizens with different backgrounds and between (social) scientists and citizens. In the long-term and assuming some continuity, such exercises undoubtedly contribute to the opening of otherwise closed policy communities to both new people and new ideas. Organized on an ad hoc basis and incidentally, they may instead contribute to alienating citizens from politics and confirming their views about the gap between politics and society.

According to the experts interviewed for this study, another relevant measure to improve scientific citizenship in the long-term is education.[34] This is justified with reference to the assumption that strong (scientific) citizenship is only possible on the basis of a solid knowledge foundation. In the absence of such a knowledge basis, individuals are likely to fall prey to manipulative lines of argument or simply opt for a mistrustful attitude towards science altogether. This, in turn, makes discussions about the social, legal and ethical implications of new knowledge and technologies extremely difficult.

## Conclusions

The rapid advances in contemporary science and technology make it possible realistically to envisage a future in which human enhancement (physical and mental) plays a key role and not only for therapeutic purposes. The question centres therefore increasingly less on how far can we go, but on how far we wish to go (Stehr 2003).

Debates about converging technologies are unlikely to diminish in the coming years. The shift of science towards a greater emphasis on industrial applications will undoubtedly aggravate this trend and continue to raise questions about the legitimacy of this approach. Anticipatory governance linked to greater citizen involvement might help diffuse some of the opposition, but it might also give rise to new forms of contestation. The philosophical questions posed by CT about the human condition and its boundaries of definition will persist, just like the question as to the possibility or desirability of an overall regulatory framework.

In this new field of knowledge politics we are likely to continue to see a battle about the desirability and borders of technology-assisted human enhancement, and the two camps in this conflict will largely be made up of non-scientists. Within the science and policy communities, the opposing camps tend to be defined by the extent to which they believe in the novelty of converging technologies. Defined broadly, converging technologies might be anything and, in that, they are not substantively different from knowledge produced at the interdisciplinary interface. The benefit of this approach is that it downplays the novelty of converging technologies and, in so doing, relativizes and demystifies their possible implications. If converging technologies are nothing new, then there is also no necessity for a new approach to their external or self-regulation, or their ethical assessment. This view prevails within the scientific community and also the liberal ethics confraternity. The counter-argument is to define converging technologies much more strictly with regard to their scientific characteristics. But those who define CT as NBIC – that is as technologies combining nano-, bio-, info and cogno-science – will tend, like the first group above, to dismiss the potential dangers as not really existing, given that, as yet, there is little evidence for a fully fledged four-fold integration between these fields, with most real integration taking place between two and only rarely three fields.

Obviously the much vaunted and favoured science-society interface is still far from becoming reality.

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## Notes

[1] These are the terms used by the American National Science Foundation (2002) and the European Commission (2004) respectively regarding NBIC. See also the following discussion.

[2] ELSA stands for research on ethical, legal and social aspects and is often used as an acronym to refer to social science research in traditional scientific fields.

[3] This is a project on knowledge politics and converging technologies. The project involved mapping the CT discourse in various countries through document analysis and expert interviews with relevant stakeholders, i.e. policy administrators and politicians involved in research programming, scientists active in CT-relevant research (in physics, chemistry, nanotechnology, IT, biotech or cognitive science), ethicists, risk analysts and social scientists studying the politicization processes in science and technology. The interview guide used for the interviews included questions on the meaning and prospects of convergence, the implications for research trajectories and scientific education, the role of scientific citizenship and citizen deliberation as well as the outlook and need for new regulatory frameworks for converging technologies.

[4] That same year, Raoul Kneucker of the Ministry of Science and Research, representing Austria at the High Level Group, organized a workshop on converging technologies entitled 'Communicating Science: NBIC, A European Debate on Converging Technologies' with the participation of Mihali Roco, Eric Drexler and Harry Kroto.

[5] ITA (2006), *Zum europäischen Stand der Nanotechnologie-Begleitforschung*, im Auftrag vom BMVIT; NanoNet Styria (2006), *NanoGesund – Gesundheitsrisiken der Nanotechnologies*, im Auftrag vom BMVIT.

[6] The full title of the directive is 'Directive on the deliberate release into the environment of genetically modified organisms'. This was first proposed in 1990, but a moratorium on its application was effected in 1993, following widespread civil society opposition spilling over from one European country into another.

[7] Opinions expressed by R5 (physicist) and R12 (biologist).

[8] Interviews with R1 (policy-maker and lawyer), R2 (policy-maker) and R11 (chemist and medical research).

[9] Respondents R1 (policy-maker and lawyer), R7 (physicist and research manager).

[10] Respondents R1 and R2 (policy-makers), R5, R6 and R7 (physicists) and R8 (cognitive scientist).

[11] Respondent R2 (policy-maker).

[12] Respondents R1 (policy-maker), R5 and R6 (physicists).

[13] The ‘language’ metaphor was used by R2 (policy-maker) and R9 (cognitive scientist), albeit with different value judgements. The former thought it a positive development, the latter a negative trend.

[14] The exception was R4, a physicist with research management experience in basic research. All other policy-makers were actively involved in the promotion of applied research involving industrial collaboration.

[15] This was also a recurrent complaint voiced by the scientific community at the first European Forum on Nanosciences, organized by COST and the European Science Foundation in October 2006. Partly in response to these complaints, but also as a result of the realization on the part of public research administration at the European level that major projects only rarely produce high-quality output, not least due to administrative overload, the European Commission has reduced the number of calls for big, so-called ‘Integrated Projects’ or ‘Networks of Excellence’ in the 7th Framework Programme launched in 2007.

[16] Respondents R4, R5 and R6.

[17] The first of these comments was raised by various respondents, the latter only by R4 (physicist and research programme director).

[18] Only three of the eight scientists interviewed expressed positive views on dissemination and all three were in their mid-40s (Respondents R9, R10 and R11).

[19] These points were also repeatedly underlined by all STS and ethics specialists interviewed in the project, more specifically respondents R13 (medicine, STS, politics), R14 (STS), R15 (biology, STS), R16 (ethics), R17 (STS), R18 (ethics).

[20] Pistorius eventually did not participate in the Beijing Olympics, having failed to qualify for the South African team by a narrow margin.

[21] This case of non-use is considered a different way by those strongly in favour of the enhancement agenda of converging technologies. Bostrom and Ord (2006), for instance, argue against prudence in (bio)ethics by proposing the application of the so-called ‘reversal test’. In the case of a technology that would contribute to the enhancement of our intelligence, the reversal test would be to ask: not whether one is in favour of such an enhancement or not, but rather whether one would be in favour of an intervention that would lower our intelligence. This approach is based on psychological tests that have shown that individuals, often irrespective of their education, can be manipulated into answering questions on morality in a specific way, depending on whether the questions are positively or negatively phrased. One is significantly more likely to be in favour of a policy to fight a disease, for instance, if one knows that this will lead to saving 400 lives (out of 600) than if one is told the policy will lead to the death of 200 persons (out of 600). According to

Bostrom and Ord, such reversal tests can be used to reveal and, eventually, remove status-quo bias in applied ethics.

[22] I am grateful to respondent R18 for this example.

[23] See www.transhumanism.org. The World Transhumanist Association advocates the ethical use of technology to extend human capabilities, defined as 'better minds, better bodies and better lives'

[24] As a cognitive scientist, Pinker draws attention to the way our understanding of human dignity is intrinsically bound to our perception senses. The latter will tend to rely on either physical traits or symbolic representations. These are, however, as contested and relative as the original problem of ethics, which human dignity attempts to resolve. This does not mean that the concept of dignity is useless as such. But it does mean that in any discussion on bioethics or ethics of science and technology more generally, it, too, runs the risk of being used as an excuse to impose a specific view of morality on society through regulation. Ulrich Körtner, a member of the Austrian Bioethics Commission, argues along similar lines from a theological perspective: 'Linguistically, the words 'good' and 'evil' do not describe any objective facts but, rather, a subjective value judgement (...) Morality is not conducive to making these boundaries [between good and evil] clearer. At best it only indicates where we can expect to observe uncertain consequences. In any case, morality is a means of communication about human dignity. Where dignity comes into play, there is bound to be conflict (...) But even when ethics assumes a critical position vis-à-vis morality, it remains normative, hence also morally determined. That is why we must be cautious about calls for more ethics in either science, economy or politics – or even in education. This is two-edged. The ethics of science is the result of the scienticization of ethics just as moral politics is the result of the politicization of morals.' (Die Presse – Spectrum, 22.08.08)

[25] This was the perspective adopted without exception by all ethics experts interviewed for this study in Austria (Respondents R14, R16 and R18). It should be added that, despite repeated attempts, it was not possible directly to interview representatives of religious communities, who either referred us to their published opinions on specific issues or indicated that their views were religious and, as such, applicable to members of their religious communities.

[26] Respondent R19.

[27] See www.srtp.org.uk as well as Donald Bruce's contribution to the second edition of the magazine 'Nano Now' for the ethics of nanotechnologies.

[28] The Department of Social Studies of Science of the University of Vienna plans to organize a citizen deliberation exercise on the future of nanotechnology within the

framework of a research project funded by the Austrian Fund for Basic Research FWF. This is expected to commence in the autumn of 2008. The results of a recently completed deliberation exercise on genome research will be published in *Science and Public Policy*, Volume 35 (forthcoming).

[29] Nanodialogues was organized jointly by the University of Lancaster and the think-tank DEMOS and involved various UK agencies and industry. It was designed as an experiment in 'upstream public engagement' comprising four citizen dialogues on NST. The four themes are: (a) Nanoparticles, risk and regulation; (b) Bio-nanotechnology and the implications of convergence; (c) Globalization and nano diffusion; (d) Public engagement in the corporate innovation cycle.
See http://www.demos.co.uk//projects/thenanodialogues/overview and www.nanodialogues.org. Other ongoing deliberative exercises in the UK include Small Talk (see www.smalltalk.org.uk) and the Nanotechnology Engagement Group (see www.involve.org.uk/neg).

[30] VivAgora is a French association seeking to promote active citizenship in the field of S&T. It arranges debates and public inquiries on contested issues relating to technology. In 2006, it organized two public forums on NS&T, in Grenoble and in Paris. See www.vivagora.org.

[31] The Consumer Conference on Nanotechnology, modelled on the pattern of the Danish consensus conference, was piloted by the Federal Institute for Risk Assessment (BfR) in November 2006 and produced recommendations on the labelling of nano products. See www.bfr.bund.de/cmw5w/sixcms/detail.php/8601.

[32] Meeting of Minds – European Citizens' Deliberation on Brain Sciences was organized by the King Baudoin Foundation in 2005-2006; this consultation brought together citizens from nine European countries to debate on the social, ethical and legal implications of advances in brain sciences. See www.meetingmindseurope.org.

[33] Respondents R14, R15 and R17.

[34] This was an opinion shared by all respondents dealing with ethics (R14, R16 and R18) and those with an STS background (see fn33). Ethics education was not a key issue among discourses between scientists.