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From Nanoethics to the Normativity of Technological Visions

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ABSTRACT
Although the variety of different ethical concerns regarding nanotechnologies has been recognized, there is a diffused dissatisfaction in the debate. Nanoethics has been often reduced to a mere check list of concerns or to a sophisticated form of risk and benefit analysis. The debate is not innovative anymore and suffers from repetition. Although the traditional tools of bioethical analysis can be useful for dealing with nanotechnological applications which are already existent or in the pipeline, for a deep engagement with future possible applications the ethical analysis should go beyond the idea of applying abstract ethical principles.
Aims of this paper is to propose an alternative way for the normative reflection on those (nano)technological applications which are still at the level of visions. It will be argued that a reflection of the challenges of the future for the current (present) discourse on technological developments is a new and promising field of reflection. Longer detached from an engagement solely with the consequences of technological development, the new analysis will be more comprehensive and lie at the interface between epistemology, ethics and politics.

KEYWORDS
Nanoethics, visions, future, technology

1. *Nanoethics is difficult*

Nanotechnology has been widely perceived as the key technology of the 21st century, since it was expected to both produce entirely new materials and to revolutionize production processes in virtually all industrial branches (cf. European Commission 2004). Nanotechnologies, as enabling technologies, are now widely diffused and researched, although until now there has been no revolution. The hype around the promises and expectations of the "nanorevolution" has stimulated an ethical debate, also because the nanotechnological "reshaping of the world" (cf. National Science and

Technology Council 1999) has been linked with a larger project of improving human performances: Nanotechnologies have been seen as one of the four areas of convergence in the NBIC concept (Roco and Bainbridge 2002). The ethical debate on nanotechnologies, almost two decades old, appears extremely heterogeneous due to two main factors: the lack of a worldwide accepted definition of nanomaterials (at least for a long time) and the unclarity about both the appropriate method of analysis as well as the ranking of the issues at stake.

For a long time there has been a long debate around what can be classified as nanomaterial and thus which kind of technologies are nanotechnologies, because there was no worldwide commonly shared and general definition of nanotechnology beyond a general identification of the study and control of matter at the molecular and atomic scales (i.e. a definition which gives a precise range, or which refers to fields of application). Indeed, with very few exceptions, it is difficult to find any kind of matter that would not qualify as an object of such nanoscale research: every branch of experimental science and technology nowadays deals with material objects structured at the nanoscale. There have been various efforts in different continents to find a definition, which are influenced by the topics regarded as the most important in the local context. In Australia for example there has been a huge debate about the size of nanoparticles in suncreams. Recently, the EU has adopted the "Recommendation on the definition of a nanomaterial", which is provisionary until it will be reviewed in December 2014[1] "in the light of experience and of scientific and technological developments". This Recommendation defines a nanomaterial solely based on the size of the constituent particles of a material (between 1 and 100 nanometers), without regard to hazard or risk. For the European Commission the necessity of confining the definition solely to properties connected to the scale has been motivated by the need to formulate a definition which can be broadly applicable in Union legislation and to be in line with other approaches worldwide, as it is stated in the Recommendation.

[1] According to this Recommendation *a nanomaterial* means: "A natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50 % or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm - 100 nm". The definition will be used primarily to identify materials for which special provisions might apply e.g. risk assessment or ingredient labeling.

Despite this attempt, there is still disagreement of what nanotechnologies are and whether they can be distinguished from nanoscience: For example the Royal Society and the Royal Academy of Engineering (2004) define nanotechnology as encompassing a wide range of tools, techniques and potential applications, and nanoscience as the study of phenomena and manipulation of materials at atomic, molecular and macromolecular scales, where properties differ significantly from those at a larger scale. Due to the multiplication of activities around nanotechnologies, Sweet and Bradford (2006) have pointed out the unusualness of agreement around this definition. This disagreement can be explained not only as a technical matter (cf. Decker et al. 2004; Schummer 2004), but also as a political one: Weber (2008) for example has proposed to see nanotechnology as an *empty signifier* and as a political project that serves certain interests and strategies, acting as a technosocio-political innovation strategy for economic expansion.

As already noticed (Ferrari 2010), the lack of a worldwide accepted definition of nanomaterials is both epistemologically and ethically relevant, because it influences – or at least it has influenced for a long time – the setting and legitimization of scientific research areas and therefore the scope of the research (in particular through priority setting, which can vary through different countries, cf. Schummer 2004). Furthermore, this lack can open or confine the ethical discourse, depending on which issues are perceived as relevant. In particular, questions of risks connected to nanomaterials are often discussed with other more general and visionary goals of possible future developments of nanotechnologies, such as human enhancements or particular applications in nanomedicine.

One of the main questions which have characterized the beginning of the nanoethical debate has been whether we need a new field of ethical inquiry and whether these technologies pose new questions (cf. Ferrari 2010). For Ball (2003), there is no need for a new field of ethical inquiry because the questions are the same as in the field of biotechnology. Although Moor and Weckert (2004) recognize that there are nascent but important concerns regarding nanotechnology, they remain in a central position: they do not want, on the one hand, to disregard most of the risks associated to applying nanotechnology because the technology itself is in its infancy but, on the other hand, they do not want that the ethical evaluation comes too late. Authors who focus more on issues of the individual, such as questions of autonomy and privacy or of risk perception and the legitimacy of changing

'human nature', often see the nanoethical debate as a development of a more general bioethical framework (Ebbesen et al. 2006). Other authors confine their analysis to specific fields of application of nanotechnologies, such as the European Group of Ethics in Science and New Technologies in its statement on nanomedicine, in which they call for the use of principles of biomedical ethics in untangling the challenges of nanotechnologies (EGE 2006).

Nanotechnologies are emerging technologies, characterized by an extreme heterogeneity of the fields of application. Therefore many authors call for treating the issues differently regarding the specific context or field of application (Ferrari 2010; cf. also Spagnolo and Daloiso 2009).

2. *Nanoethics is boring*

Although the variety of different concerns regarding nanotechnologies has been recognized, there is a diffused dissatisfaction in the debate. Many authors express the feeling that nanoethics has been reduced to a check list of the various issues, which are common to other technological fields, and it has in some sense become boring now, since many issues are just repeated (Dupuy 2007; Ferrari 2010; Patenaude et al. 2011).

"How are we to understand the fact that the philosophical debate over nanotechnologies has been reduced to a clash of seemingly preprogrammed arguments and counterarguments that paralyzes all rational discussion of the ultimate ethical question of social acceptability in matters of nanotechnological development?" (Patenaude et al. 2011, Nanoethics: 285)

As already discussed (Ferrari 2010), the nanoethical debate has shown some features which are typical of the bioethical debate in general: the predominance of an utilitarian approach and the ignorance of important knowledge developed in other discourse, notably philosophy of technology and STS, concerning the uncertainty and complexity of technological developments as well as the moral and political nature of artifacts in shaping the normative space of new and emerging technologies.

Especially in the debate around human enhancement (HE) (NBIC convergence), the discourse is characterized by a polarization both of positions (foremost concerning issues of human nature, cf. Ferrari 2008) and of the way in which the issues are framed. Patenaude and his colleagues (2011) have noticed a "talking past each other" in this debate. In their

analysis of the structure of the arguments used in the debate they identify seven categories of moral arguments which are based on epistemological stances which appear irreducible for two main reasons: first because there are different opinions on the possibility of knowing moral obligations or the human condition as a moral fact; second, because there are different conceptions of practical reasoning that correspond to the epistemological positions.

Béland and his group (2011), analyzing the debate on converging technologies, have offered an explanation of the impasse: first they argue that any given argument deployed (arguments based on nature and human nature, dignity, the good life) can serve as the basis for both the positive and the negative evaluation of NBICs. Second, they point out that it is impossible to provide these arguments with foundations that will enable others to deem them acceptable and, third, that it is difficult to apply these same arguments to a specific situation. Finally they point out that moral arguments are ineffective in a democratic society, because decisions should be taken on a democratic base and thus normative issues have a political dimension.

All these analysis are valuable and interesting, but they cannot really offer an alternative to the "impasse" of the debate. On the one hand they indicate that there is something important around questions about human finitude, the role of technological development in the society and the values which frame it. On the other hand, the debate cannot escape large degrees of generality; it tends to remain abstract and unsatisfactory, and thus difficult to translate for public engagement exercises.

Following Weber (2008), we can observe that nanotechnology not only works as an empty signifier regarding its socio-economic role, but also its ethical one. Depending on which kind of ethical issues are perceived as relevant to the field of nanotechnologies, different interests and strategies are served in the debate. If the main problems concern the risks of new nanomaterials, the debate concentrates on issues regarding the most appropriate risk assessment framework to address environmental, health and safety (EHS) concerns and the need to stimulate public engagement. If, however, the main issues regard nanotechnologies as enabling technologies in the context of converging technologies or, in general, for enhancing human properties, other issues become relevant, such as the normative stance of human nature, the desiderability on technological interventions modifying species-specific characteristics as well as the societal role of technological

development. Although in the second case the issues seem broader, at closer look, we see that again the way in which issues are framed is again the one that regarding risks and benefits (cf. Allhoff/Lin 2008).

In describing consequentialism as the starting point of the so called NEST ethics (the ethics of new and emerging technologies), i.e. the thinking about the possible consequences of technological developments, Swiestra and Rip point out:

"In practice, NEST-ethics starts with a consequentialist pattern of ethical argumentation: the new and emerging technology is deemed desirable, or not, because its consequences are desirable, or not. Since such consequences are still speculative, they have the form of promises, or warnings and concerns when put forward in an action-oriented context. NEST-ethical discussion typically starts with the promises made by scientists and technologists and those who identify with their message about the new options." (Swierstra and Rip 2007: 11)

The thinking about possible consequences, i.e. risks and benefits of technologies, takes the form of a thinking about the future and thus of a reflection about expectations and promises of developments which, in many cases, have not yet taken place. De facto a large part of the nanoethical debate is characterized by the attempt to find plausible forms of applying an enriched form of risk-benefit analysis on possible future development (cf. Ferrari 2010). What appears here to be largely disregarded concerns the special nature of promises and expectations, more precisely the ethical role of (nano)technological visions.

3. *Regaining enthusiasm for nanoethics through looking at the future*

In the very recent debate there are emerging attempts to regain the sense of the future in talking about ethics, influenced by the studies in the field of philosophy of technology, technology assessment, STS and sociology of expectations. In particular the so-called Collingridge Dilemma, originally formulated in 1980, has gained renewed attention: This dilemma states that although in principle it is easier to influence the course of events in the early phases of scientific and technological development, it is precisely in this early stage that the required knowledge that would enable one to intervene in a constructive manner is absent. In new reflections on emerging technologies, there is a sense that preparatory ethical reflection on

technologies which are in their infancy has to deal with specific challenges: This reflection has no longer to be conceived as an application of principles or rules which are commonly shared in society, but it has to take into account the multifaceted and complex nature of technological developments which are yet to happen or not in the future. As Wynne (2006) already suggested, we do not have to conceive the ethical reflection on nanotechnology as a reflection on nanoscale objects or processes but rather as a "reflection on human relations, imaginations, meanings, commitments, and normative visions of valued ends which human knowledge and technology-making should be devoted to" (Wynne 2006, p. 2). An ethics that looks at future technological developments is, therefore, a reflection in the present but which deals with promises, expectations and imagination on possible trajectories, which may or may not happen.

Palm and Hansson (2006) have proposed an ethical technology assessment (eTA), based on indicators of negative ethical implications at an early stage of technological development, which can subsequently be used to guide design or technology policy. The focus of eTA is on the whole life-cycle of technology development, from initial R&D to ultimate impacts on society, and it takes place by confronting projected features of the technology or projected social consequences with ethical concepts and principles, in particular focusing on possible conflicts of interests. The knowledge on these possible conflicts may then be used to adjust design processes to avoid ethical concerns or to steer decision-making on an emerging technology. Palm and Hansson (2006) then propose an ethical checklist of nine issues as the most common in emerging technologies (privacy, sustainability, issues of control, influence and power and issues of gender, minorities and justice).

In 2011, Stahl has elaborated a new method for the ethical assessment of emerging information and communication technologies (ICTs), which gained the name from a project he was involved in: the ETICA approach (Stahl 2011). Despite the focus on ICTs, this approach contains general issues which can be applied to other fields of emerging technologies. This approach, which consists of three stages[2], relies on multiple futures methods and studies, under the assumption that while individual studies will contain

[2] The first stage consists in the identification of the issues; in the second, the evaluation stage, the ethical issues are evaluated, ranked and ordered in relation to each other. In a third and final stage, the governance stage, governance recommendations are developed for policy makers for dealing with the ethical issues described in the earlier stages.

biases and shortcomings, their aggregate use will tend to yield more reliable results. It aims at arriving at a foresight analysis, choosing then the future considered the most desirable or important.

The role of ethics as a reflection projected to the future is the starting point of the anticipatory technology ethics (ATE) approach proposed by Brey in 2012, based on three levels of ethical analysis: the technology, the artifact and the application level. At the technology level, the ethical analysis focuses on features of the technology at large, particular subclasses of it, or techniques within it, considering ethical issues inherent to the character of the technology, issues that pertain to consequences that are likely to manifest themselves in any or nearly any artifact or application of the technology, or issues pertaining to risks that the technology will result in, artifacts or applications that are morally problematic. At the artifact level, the analysis considers features of artifacts that present moral issues, due to the inherent character of the artifact, or to its consequences in most or all of its uses, or to the controversial nature of some of its potential applications. At the application level, the ethical analysis focuses on particular ways of using an artifact or procedure, or on particular ways of configuring it for use (Brey 2012).

The constructive technology assessment and the socio-technical scenario approach, developed in STS and TA studies originally by Rip (Rip et al. 1995; Schot and Rip 1997), focus on the futuristic character of new and emerging technologies and are informed by the socio-constructivist idea of a coevolution between science and society: Precisely because technological developments are not to be seen as separated from the rest of society but they are in a mutual shaping relationship with it, it is possible to steer technological patterns even at early stages. Rip and te Kulve (2008) have then applied this idea to analyze nanotechnologies: Since many nanotechnology applications remain little more than promises, for these authors the study of their implications can be seen as exercise in "social science fiction" based on the identification of complex and overlooked interactions between actors. The aim of the socio-technical scenarios, adopted in the Netherlands by a number of organizations including the Rathenau Institute and the Dutch national nanotechnology consortium, NanoNed, is to stimulate a reflexive change, and to broaden thetechnological development by including more aspects and more actors at an early stage.

Socio-technical scenarios and constructive TA are not ethical reflections in the strict sense: however, they play an important function in broadening

the normative horizon to the considerations of relationships between different actors and how different articulations of the socio-technical developments can lead to different results. Central idea of social-constructivism is namely the possibility of steering the process of technological development. As a consequence, an analysis of possible future developments cannot be static, i.e. an application of principles or criteria to some material developments in the future, but is a "process in the making", in which technological developments change permanently through the interaction with society. In better words, there are no strict technological developments in the future, but *socio-technical developments*, therefore the ethical analysis should take this dynamicity into account. Thus besides the engagement with hard impacts of technologies (such as new knowledge and structural changes), it is important also to explore "soft impacts": Trying to anticipate how technology, morality and their interaction can evolve is the task of the techno-ethical scenarios approach, developed in the Netherlands by Swierstra and his group (Swierstra et al. 2009; Boenink et al. 2010). This method is based on an assessment of expectations' plausibility focused on statements on technological feasibility, societal usability, and desirability of the expected technology, together with a reflection on potential changes in morality bound to the expected technology (Lucivero et al. 2011). Since scientific and technological development coevolves with society, not only material changes are to be expected from technological developments, but also changes concerning morality. Therefore, the task of the ethicist is also to spur the imagination of the so called "techno-moral change" and to engage in a deep reflection, which has to be horizontally and vertically broadened: The horizontal extension concerns the number of people and the background knowledge against which to judge certain claims by including different sources of information as well as different stakeholders. The vertical extension regards the need to feed the discussions and assessments with historical knowledge, so that the plausibility of claims on behalf of emerging technologies can be grounded in experience, at least to some extent (Lucivero et al. 2011).

Common to the previous approaches is the thinking that if we are assessing technological visions, we should explicitly acknowledge that. Despite their differences, these approaches concentrate on the fact that technologies will materialize, that they will coevolve with society and that we therefore need (new) methods for developing the best possible scenarios or to understand possible changes in moral attitudes and conflicts arising from

the contingent nature of technologies. These attempts, therefore, try to respond in different ways to the dissatisfaction towards an ethical analysis which tends to ignore the fact that it is analyzing technological visions and not already existing applications, thus it performs a speculative analysis. Following (Nordmann 2007), the speculative ethics suffers from

> "a radical foreshortening of the conditional, that is, … what one might call the 'if and then' syndrome. An if-and-then statement opens by suggesting a possible technological development and continues with a consequence that demands immediate attention. What looks like an improbable, merely possible future in the first half of the sentence, appears in the second half as something inevitable. And, as the hypothetical gets displaced by a supposed actual, an imagined future overwhelms the present" (Nordmann 2007, p. 32).

The 'if and then' -syndrome presents technological visions which are presented as (almost) already there, thus not only distracting from more urgent questions, but also supporting expectations, serving more or less implicitly as a research agenda. Furthermore it transmits a naive and false picture of how technologies develop (not paying attention to the history of contingency and surprises in the technological development). As already argued for a particular field of cognitive enhancement (Ferrari et al. 2012), some academic debates around specific technologies develop on their own without taking in account whether the technological developments they are referred to are technologies in the pipeline or technological visions projected for a distant future. This runs the risk to transform entire discussions into "phantom debates" (cf. Quednow 2011), as the debate on pharmaceutical cognitive enhancement has shown (Ferrari et al. 2012).

Moreover, from a political point of view the engagement in speculative ethics provides a general and often implicit justification of the current status quo. It is often argued that technologies will come and that then we need to engage as soon as possible with potential ethical consequences. This way of framing the discourse does not only suffer from technodeterminism (cf. Cooper 1999; Fox and Swazey 2008), but it rules out the possibility of saying no to a technology (cf. Nordmann and Schwarz 2010). In this way, therefore, the normative reflection runs the risk of losing its principal task, which is to investigate radical questions also through challenging current frameworks of technological development. In thinking about future technological development, abstract ethical arguments which remained detached from political questions appear limited and poor, precisely because they avoid to

engage with the situatedness of this development in a concrete socio-economic context as well as the power of technological visions in present.

4. *Reshaping normative reflection through visions*

Due to the previously shown forthcomings in the current ethical debate on new and emerging technologies, we believe that the ethical reflection needs to be broadened by recovering a different sense of time when analyzing the challenges posed by technological visions. The openness of the future, which was recognized by the approaches previously mentioned, regards both the way in which technologies will materialize as well as the social, economic and political context in which they will develop. Despite their differences, the previous approaches tend to perform a pragmatic analysis, the one which probably fits at best with the idea of socio-constructivism, since it is interested in exploring new moral possibilities (in this case coming from new technological developments) (cf. Keulartz 2004). However, the engagement with the future can also follow different patterns and lead to a larger reflection, engaging with elements coming from other philosophical areas as well as other disciplines.

Reshaping normative reflection in relation to ideas of future technological developments begins with a deep rethinking about the task of the analysis. From the explicit acknowledgement of the fact that we very often deal with technological visions in new and emerging technologies should follow a different kind of analysis with respect to the traditional bioethical framework. Even if for the ethical discussion of already existent technological applications (such as some nanomaterials or some nanoproducts) or already in the pipeline the methods of applied ethics can be fruitful (mostly if they are alsolinked with a critical analysis of societal values), in the case of possible technological developments in a distant future the analysis needs to be more comprehensive. If we want to avoid technological determinism, we have to acknowledge the fact that technological visions, such as for example the idea of "reshaping the world atom by atom" (cf. National Science and Technology Council 1999) or to enhance particular human capabilities, may or may not happen not only because we do not know whether a technology will succeed or not, but also because this depends on political decisions in the present. Technological visions are constructed by different actors, deeply entangled with their

attitudes, knowledge, perceptions, values, world views and interests. Precisely for these reasons, technological visions act in the "immanence of the present" (cf. Grunwald 2006), since they develop in particular cultural context, on the basis of interpretations of current knowledge. As for example indicated for pharmaceutical cognitive enhancement, the normative questions are very concrete and regard the present, such as the opportunity to spend financial and human resources in the research for substances, to change the regulation system in the case of clinical trials as well as other reform in the health care system (Ferrari et al 2012).

For recovering a different sense of the future in the normative analysis of technological developments, different reflections on the sense of time and on the engagement with the future have been developed. In order to avoid speculative ethics, Grunwald (2010) has proposed to engage in an explanatory philosophy of nanotechnology that works as a *preparation* for future applied ethics. This form of philosophical analysis, later also conceptualized as hermeneutics of technological futures (Grunwald 2012), is necessarily as broaden as the field of (applied) ethics, involving epistemological, anthropological, hermeneutical and social reflection. In particular, in order to assess the normative nature of technological visions Grunwald (2004, 2010) has elaborated the concept of vision assessment, which mainly consists of two steps: 1) deconstruction of the elements which comprise such futures (knowledge, uncertainties, ad hoc assumptions, values, etc.) and their 'construction' to create one picture of the future; 2) an assessment of the validity or plausibility of these elements and of the overall 'rationality' of this future scenario as compared to the rationality of other alternative scenarios.

Vision assessment as a form of TA (dealing with the future) has been criticized by Nordmann (2010), who perceives it as a typical instrument of technoscientific thinking since it is based on the idea of the possibility of shaping the future. Since for Nordmann (2011) technoscience is characterized no longer by a (purely) theoretical curiosity and truth-seeking attitude, but rather by the acquisition of basic capabilities of visualisation, manipulation, modeling nature, the image of a future (not yet existent) which can be constructed through the instruments of the present is an expression of the technoscientific logic. The very fact that the Collingridge dilemma is considered a dilemma that is in need of a solution reveals that efforts in the present to avoid it constructing countermeasures are efforts directly to maintain control (cf. Liebert and Schmidt 2010). Whether the

future in the science mode is conceptualized as the time in which knowledge, oriented towards a state of truth, justice and beauty is subjected to an indefinitely long process of criticism, in the technoscientific mode future indicates the time in which the attainment of physical control or the working of a device is self-vindicating: In particular, in the case of nanotechnologies there is the idea of multiple nanotechnological possibilities waiting to be realized, so that the future appears an intensification of the present, as a fulfillment of present promises (Nordmann 2010). As alternative Nordmann proposes a "forensic of wishing" as an analysis of texts in which promises and expectations are produced, but avoiding the idea of shaping the future:

"This kind of TA, as a forensic technoscience, is no longer in danger of becoming absorbed into the spirit of technoscience by assimilating the technoscientific hubris of "shaping the future". Instead, it takes as its starting point the age of technoscience with its impoverished conception of the future as the mere realisation of technical possibilities. By assessing this conception with its logic of wishfulfilment it becomes a critical observer rather than implicit promoter of technoscientific hubris" (Nordmann 2010: 13).

A reflection of the challenges of the future for the current (present) discourse on technological developments is a new field of reflection. Longer detached from an engagement solely with the consequences of technological development, the new analysis will be more comprehensive and lie at the interface between epistemology, ethics and politics. It will play a fundamental role in the years to come, since new and emerging technologies are multiplying and they are more and more shaped along goals, rather than through a well-defined context of research. Perhaps the time is mature for engaging (again) in a deep philosophical reflection on the sense of time, as the different conceptualization of the future in science and technoscience described by Nordmann suggest. This reflection will necessarily also encompass an engagement with the past, since many ideas which currently shape visionary projects are connected with utopias and dystopias of previous centuries (cf. Coenen et al. 2010) and they also can be seen as reactions to the scarcity discourse which emerged in the 70ies (cf. McCray 2012). All in all, time has now become an essential object of reflection for disentangling the normativity of technologies.

References

Allhoff, Fritz, Lin, Patrick. 2008. *Nanotechnology and society. Current and emerging ethical issues*. Dordrecht/Amsterdam: Springer,

Béland, Jean-Pierre et al. 2011: "The Social and Ethical Acceptability of NBICs for Purposes of Human Enhancement: Why Does the Debate Remain Mired in Impasse?" *Nanoethics* 5(3):295-307

Boenink, Marianne, Swierstra T., Stemerding D. 2010. Anticipating the Interaction between Technology and Morality: A Scenario Study of Experimenting with Humans in Bionanotechnology. *Studies in Ethics, Law, and Technology* 4, 2, DOI: 10.2202/1941-6008.1098

Brey, Philipp A. E. 2012. "Anticipatory ethics for emerging technologies". NanoEthics 6(1), pp. 1–13

Coenen, Christopher & al. (2010): *Die Debatte über »Human Enhancement«: Historische, philosophische und ethische Aspekte der technologischen Verbesserung des Menschen*. Bielefeld: Transcript.

Cooper, Anne Coleen. 1999. "The slippey slope and technological determinism". P*rincet J Bioeth* 2(1), pp. 64–76

Decker, Michael et al. (2004): „Ich sehe was, was Du nicht siehst … zur Definition von Nanotechnologie". *Technikfolgenabschätzung*, 13, pp. 10-16.

Dupuy, Jean-Pierre 2007. "Some pitfalls in the philosophical foundations of nanoethics". *Journal of Medicine and Philosophy* 32(3): 237–261.

Ebbesen, Mette &Andersen S & Besenbacher F. 2006. "Ethics in nanotechnology: starting from scratch?". *Bulletin of Science Technology Society*, 26, pp.451–462.

EGE (European Group on Ethics) 2006. *Nanomedicine. Nanotechnology for health. European technology platform, stretegy research agenda for nanomedicine*, November 2006, Belgium: European Commission.

European Commission 2004. *Nanotechnologies: A preliminary risk analysis* on the basis of a workshop organized in Brussels on 1-2 March 2004 by the Health and Consumer Protection Directorate General of the European Commission. Luxemburg: Office for Official Publications of the European Communities.

European Commission 2011. R*ECOMMENDATIONS – COMMISSION RECOMMENDATION of 18 October 2011 on the definition of nanomaterial*, Official Journal of the European Union L 275/38, 20.10.2011, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:275:0038:0040:EN:PDF

Ferrari, Arianna 2008. "Is it all about human nature? The ethical challenges of converging technologies beyond a polarized debate". *Innovation. The European Journal of Social Science Research* 1, 21, pp. 1-24.
Ferrari, Arianna 2010. "Developments in the Debate on Nanoethics: Traditional Approaches and the Need for New Kinds of Analysis". *Nanoethics* 4, 1, pp. 27-52
Ferrari, Arianna & Grunwald A. & Coenen C. (2012): "Visions and Ethics in Current Discourse on Human Enhancement" *Nanoethics* 6, 3: 215-229.
Fox, Renee C. & Swazey, Judith P. 2008. *Observing bioethics*. Oxford: Oxford University Press.
Grunwald, Armin 2004. "Vision assessment as a new element of technology future analysis tool-box". *Proceedings of the EU-US Scientific Seminar: New Technology foresight, forecasting & assessment methods*, Seville, May 13–14 2004
Grunwald, Armin 2010. "From speculative nanoethics to explorative philosophy of nanotechnology. *NanoEthics* 4, pp. 91–101
Keulartz, J. & al. 2004. "Ethics in a Technological Culture. A Programmatic Proposal for a Pragmatist Approach". *Science, Technology and Human Values* 29 (1), pp. 3-29.
Liebert, Wolfgang & Schmidt, Jan 2010. "Collingridge's Dilemma and Technoscience: An Attempt to Provide a Clarification from the Perspective of Philosophy of Science". *Poiesis & Praxis* 7, pp. 55-71.
Lucivero, Federica & al. 2011. "Assessing expectations: towards a toolbox for an ethics of emerging technologies". *NanoEthics* 5(2), pp. 129–141.
McCray, P. 2012. *The Visioneers: How a Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future.* Princeton*:* Princeton University Press.
Moor, James & Weckert, John 2004. "Nanoethics: assessing the nanoscale from an ethical point of view", In: Baird D, Nordmann A, Schummer J (eds) Discovering the nanoscale. IOS, Amsterdam, pp 301–310.
National Science and Technology Council (NSTC) 1999. *Shaping the World Atom by Atom*, http://itri.loyola.edu/nano/IWGN.Public.Brochure
Nordmann, Alfred 2007. "If and then: a critique of speculative nanoethics". *NanoEthics* 1, p. 31–46
Nordmann, Alfred 2010. "A forensics of wishing: technology assessment in the age of technoscience", *Poiesis and Praxis* 7(1–2), pp. 5–15
Nordmann, Alfred (2001): The Age of Technoscience., in Nordmann A. , Hans Radder, und Gregor Schiemann (ed.) *Science Transformed? Debating*

Claims of an Epochal Break, Pittsburgh: Pittsburgh University Press, pp. 19-33.
Nordmann, Alfred & Schwarz, Astrid 2010. " Lure of the „Yes": The Seductive Power of Technoscience". In: Kaiser M., et al (ed.) *Assessment Regimes of Technology: Regulation, Deliberation & Identity Politics of Nanotechnology*, Dordrecht: Springer, pp. 255-277.
Palm, Elin & Hansson, Sven Oven 2006. "The case for ethical technology assessment (eTA)". *Technol Forecast Soc Change* 73:543-558
Patenaude Johane & al. 2011. "Moral arguments in the debate over nanotechnologies: Are we talking past each other?" *NanoEthics* 5(3), pp. 285-293.
Quednow, Boris 2011. "Ethics of neuroenhancement: a phantom debate". *BioSocieties* 5(1), pp. 153–156
Rip, Arie, & Te Kulve, Henko 2008. "Constructive technology assessment and socio-technical scenarios". In: Fisher E, Selin C, Wetmore JM (eds) *The yearbook of nanotechnology in society, vol 1: presenting futures*. Springer, Berlin, pp. 49–70.
Royal Society 2004. *Nanoscience and nanotechnologies: opportunities and uncertainties*. London: Royal Society, http://www.nanotec.org.uk/finalReport.htm
Schummer, Joachim 2004. "Societal and Ethical Implications of Nanotechnology: Meanings, Interest Groups, and Social Dynamics". *Techné*, 8 (2), pp. 56-87.
Stahl, Bernard. 2011): "IT for a better future: how to integrate ethics, politics and innovation". *J Inform Comm Ethics Soc* 9(3), pp. 140–156.
Sweet L., Bradford S (2006): Nanotechnology - Life-Cycle Risk Management, Human and Ecological Risk Assessment, Vol. 12, 528 - 551.
Swiestra Tsjylling & Stemerding D., Boenink M. 2009. "Exploring Techno-Moral Change: The Case of the Obesity Pill". In: Sollie P., Düwell M. Evaluating New Technologies, The International Library of Ethics, Law and Technology 3: 119-138
Swiestra, Tsjalling & Rip, Arie 2007. "Nano-ethics as NEST-ethics: patterns of moral argumentation about new and emerging science and technology". *Nanoethics* 1(1): 3–20.
Wynne, Brian 2006. "What could the Foundations of NanoBioInfoethics be? Some lateral thoughts". Paper presented at the the Avignon-Stanford Meeting, 17-18th December 2006, available at: http://ica.stanford.edu/france/conferences/workingpapersseries/ethics