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ARE (OFFICIAL) ETHICAL APPROACHES TO NANOTECHNOLOGY AFFECTED BY CULTURAL CONTEXT AND TRADITION? A COMPARATIVE ANALYSIS: EUROPE–USA[1]

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Abstract: Lately, nanotechnology has become one of the main topics in the debates regarding what has been called the *Next Industrial Revolution* within what are known as *emergent technologies*. This paper contains a comparative analysis of the different philosophical groundings, arguments and principles invoked in the official ethical approaches proposed by each of two of the main Western communities. By *official ethical approaches* or *official positions* we mean the opinions officially expressed by the government institutions about how ethical considerations prompted by nanotechnologies should be tackled. The analysis is based, then, on the official points of view, expressed through two documents, namely two official releases issued by governmental offices or institutions in both communities, Europe and the United States of America, and considered by the authors as representative of the official opinions of the governmental institutions in each society.

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INTRODUCTION

Some experts, especially from US government agencies and industrial organisations, qualify nanotechnologies as *the next industrial revolution* (National Nanotechnology Initiative, 2000), with all the social, legal and ethical implications that this entails. How individuals and communities face up to the social, legal and ethical implications of nanotechnology may be influenced by different socio-cultural specificities (Schummer, 2008). Two of the communities that are investing the most public and private resources in nanotechnology are the European Union and the United States of America. Could the respective approaches of these two communities to the ethical considerations revealed by nanotechnology, if there are any, be shaped by their respective cultural traditions and social contexts? According to Spanish philosopher Adela Cortina, the

> ...*American way of thought* goes along with the *American way of life*, traditionally imbued by pragmatism. Rational decision-making for actual situations is what really matters and, consequently, what informs the maxims that make it possible. Much more is unnecessary because then discrepancies arise; hence, trying to delve beyond the surface when making decisions only contributes to increasing disagreement. On the other hand, the European, and mainly Germanic, way of philosophising is not satisfied with this modest approach and keeps searching for explicit principles (Cortina, 1993).

In this quotation, Cortina is referring to a general framework, but this pattern is still valid when talking specifically about the ethical issues of nanotechnology. In this sense, J. Schummer points out five dimensions of cultural diversity affecting the perception of ethical issues of nanotechnology in different societies: language, cultural heritage, economy, politics and ethical framework (Schummer, 2008).

We analysed the main ideas contained in two selected official documents released by both society's governmental institutions which can be considered the official positions in both communities, and we then used this analysis

to compare how the ethical aspects of nanotechnology are being officially dealt with in both regions.

CHALLENGES OF NANOTECHNOLOGY

The properties of materials at the nano-scale and the capacity to manipulate atoms to shape matter leaves the door wide open to almost an infinite number of technological possibilities and makes difficult to talk about nanotechnology as a specific discipline. Instead, that it would be more accurate to refer to it as a cross-sectional technology. We can think, then, about nano-applications in almost any scope. This is why there are authors who prefer to use the term *nanotechnologies*, in plural, an opinion that can have consequences such as how to study its ethical aspects (Gordijn, 2005).

Our personal position on these issues depends on our individual moral values, and it seems logical to also expect a correlation between traditional collective values, which form the *ethos* of a community, and the way this particular society as a whole handles them through its institutions, such as through funding policies or research agendas (Berger, 2008). Biotechnology gives us examples of how individuals and communities base their responses to the controversial values issues that can be historically attributable to cultural background. In this technological field, we can see how GMOs have been treated differently in Europe (where the precautionary principle has taken the prominent role) and in the USA, where the *substantial equivalence* principle has been the main argument (Hunt & Mehta, 2006) (Comission de l'Éthique de la Science et de la Technologie (CEST), 2003).

ETHICS OF NANOTECHNOLOGY. WHAT'S NEW?

Like any human activity, nanotechnologies deserve a reflection to address the questions as to the moral correctness or incorrectness of our decisions and our actions or omissions. But does nanotechnology raise new aspects of a moral nature that cannot be resolved through today's ethical reflection? The answer to these questions is not trivial, and there are divergent arguments on both sides.

Nanotechnology, in combination with biotechnology (nano-bio-

technology) and especially its application to human health, which we call *nanomedicine*, goes deeply into an area that can touch very basic values, duties and rights and even the essence itself (if we can speak of an essence) of human beings as individuals (as living entities and as human) and of the human species as a whole.

Thus, nanotechnology can be seen as an enabler (Bruce, 2006) which provides other leading technologies with ability, giving them the tools to reach the goals that until now have only been described as science fiction.

ETHICAL APPROACHES TO THE *NANO-ISSUE*

The amazing promises for the future of nanotechnology mean that in recent years progress on research investments in this field, both public and private, has become a race between the main world powers, a race in which none of them wants to be left behind. Holding primacy in the nanotechnological universe has become a strategic goal.

Because to our knowledge, specific regulations for technologies in the nanometer scale have not yet been fully developed by the legislative bodies, nowadays the limits on research and application fall within the voluntary moral scope and thus represent a challenge for ethics, which also should play a major role in the regulatory process that must inevitably be pursued in the near future.

Several groups from both sides of Atlantic, more or less involved with research and/or with societal and ethical aspects of technology, have expressed their opinions on the ethical issues that should be addressed in a world in which nanotechnologies are used (Hermerén, Marczewski & Nielsen, 2007; Van de Poel, 2008; The Ethics of Nanotechnology, 2007; Fernández Agis & Fernández Castillo, 2007; The Royal Society, 2004; The Action Group on Erosion, Technology and Concentration, 2003; Swiss Reinsurance Company, 2004 & Davies, 2009). There are also several independent multidisciplinary groups specifically dedicated to reflecting on what could be called the responsible development of nanotechnology, including The Foresight Institute, The Center for Responsible Nanotechnology and The Nanoethics Group. Likewise, international organisations like UNESCO have expressed their opinion (United Nations Educational, Scientific and Cultural Organization, UNESCO, 2006). Governmental agencies are the other actor involved as the depositories of governments' trust. The agencies, in fact, hold

the regulatory responsibility as representatives of the entire population. Nevertheless, it seems that more attention should be paid to ethical aspects of nanotechnologies in view of the low number of publications compared to the research efforts in this field (Mnyusiwalla, Daar & Singer, 2003).

Among all these opinions, French thinker Jean-Pierre Dupuy spotlights some of the errors that are committed, in his opinion, when trying to develop a Nanoethics. He specifically highlights three major pitfalls:

> Identification of ethics with prudence', a certain conception of prudence that reduces ethics to a rational calculation of risks, in economic and not ethical terms; "confusing ethics and cost-benefit analysis (CBA)" and "constant formal switching between *technologies* and *techniques*", that is to say, the frequent use of these terms as synonyms when they actually are related but not coextensive concepts (Dupuy, 2007).

In the other shore of Atlantic Ocean, in his report for the Project on Emerging Nanotechnologies North American philosopher Ronald Sandler describes what he thinks are three other of the most important misconceptions about ethics and emerging nanotechnologies: "It is too soon to tell what the social and ethical issues are", "the nanotechnology revolution is inevitably good" and "the point of the social and ethical issues is to secure public acceptance" (Sandler, 2009). As can be seen, many opinions are being proffered, some of them suggesting that different errors are being made when dealing with ethical aspects of nanotechnologies.

In this paper, the official ethical positions that are being taken by two of the main players with regard to research in the field of nanotechnology have been analysed: Europe (European Union) and the United States of America.

The two *official* texts analysed, which have been selected under a criterion of *officialdom*, including the procedures used to reach the conclusions, could be seen as concise expressions of two different world views and may or may not reflect the public opinions within each society. We can assume the limitations that this analysis strategy can confer on the conclusions drawn, given the aim of the paper, which is restricted to an assessment of the official postures. Hence, the scope of the analysis is not an extensive meta-study based on an individualised survey of the single opinions expressed by the different groups or individuals from each society but an analysis of the arguments and principles shown in two specific official releases that we consider reliable barometers of their respective official positions.

Cultural contexts and traditions

Different dimensions of cultural background specificities are key influences on the perception of the ethical issues of nanotechnology (Schummer, 2008).

History shows that, even with the common Plato-Aristotle heritage that confers a certain perspective of the world (teleology, essentialism, causality) on the whole Western philosophical tradition, later differences can be observed if we look into the philosophical principles guiding the evolution in thinking at European level. On the one hand is continental Europe and on the other is the UK. These differences are indeed transposed overseas to the point that we could now speak of two philosophical traditions, one European-continental and the other Anglo-American.

Focusing on moral reasoning, continental traditional thinking can be roughly considered close to a deontological approach to moral issues, mostly with a Kantian influence, and a contractualist point of view of society, all within the Greek tradition framework which provides the aforementioned essentialist, teleological and causality factors. Meanwhile, other philosophical streams have arisen in the British Isles in the past few centuries: British Empiricism, Hume's scepticism, moral emotivism, Hobbes' socio-political view and consequentialism, especially utilitarianism with the figures of J. Bentham and J. S. Mill as the fearliestproponents can be considered important philosophical influences on the later Anglo-Saxon world view, which is somehow related to the analytic philosophical stream. Thus, while continental Europeans seem inevitably pushed to search for principles (understood as universalisable rationally justifiable rules) and committed to an underlying human essence that has to be either preserved or reached, Anglo-Saxons seem to feel devoted to *evaluable* facts and effects in order to obtain a kind of science-based maximisation of utility, frequently taken as either happiness or welfare, setting aside what can be considered, from this standpoint, *speculative* assessments, although some duty-influenced aspects crop up every now and then, as in the case of stem cell research in recent times.

The truth is that both cultural contexts accept the idea that a single theory of ethics is not enough to reach all the answers in every decision-making process, and that considering different theories at different times would yield better results. Summarising, we could state that articulated joints of different theories, with the predominance of deontological elements on continental Europe and utilitarian elements in the Anglo-American area

of influence, are respectively the guidelines for moral reasoning in both communities. Although this distinction might seem subtle, this difference in nuance can actually lead to divergent conclusions.

These influences may be at the root of the results of a 2005 study (Gaskell *et al*., 2005).[2] Somehow Americans seem to feel more confident and comfortable with science and technological innovations than Europeans (Hunt & Mehta, 2006). That could be due to a different historical vision of the nature-human tension. Roughly, Europeans seem to feel attached to something like an essentialist idea of a given human nature which is meant to be preserved or at least which deserves to be considered; Habermas speaks in this sense about the division between *the grown and the done* based on an Aristotelian conception of the world (Habermas, 2001). Virtues like prudence and excellence, among others, and the precautionary principle, combined with a teleological vision, are the cornerstones of good and the good life. In contrast, North Americans would take this tension as a kind of struggle in which human welfare has to prevail over nature's threats. Science and technology have become the means to accomplish this goal. With this point of view, a consequentialist approach to the process of decision-making will be seen as adequate, and the principle of utility would be the proper criterion to assess the worthiness of an action. Briefly, it is good if its consequences or effects are good; thus, a balance between pros and cons becomes the fundamental moral instrument. However, a connection with deontology-contractualism has to be considered as well in the North American contemporary tradition through John Rawls' theory of justice, which harks back to concepts like justice and dignity (Rawls, 1971).

Geopolitical aspects of both communities can also be counted among the factors that could affect the way new challenges are handled. The European Community is made up of several independent states/communities, each with its own history, cultural background and set of values which have to be put together, and which can lead to a necessary degree of public dialogue. This represents a socio-political context in which a universalistic scheme like discursive ethics, proposed mainly by the philosophers J. Habermas and K.O. Apel, finds a good breeding ground as a means of

[2] According to this study perception of nanotechnology seems to be much more positive in the US that it is in the European Community, thus a 50% of Americans versus a 29% of Europeans think that nanotechnologies will improve our lives, and 35% of Americans versus 53% of Europeans admit that they don't know what nanotechnologies will bring.

grounding moral reasoning (Cortina, 1986). Inasmuch as it can be defined as a more harmonized society compared to Europe, the USA could not see a public dialogue with normative purposes as so necessary.

How these cultural contexts and traditions are reflected in the official approaches to the potential ethical, social and legal aspects of nanotechnologies in each community will be discussed shortly.

Additionally, it is interesting to mention here what the Comission de l'Éthique de la Science et de la Technologie (CEST) in Québec (Canada) underscores in its report dedicated to the ethical management of genetically modified organisms (GMOs) (CEST, 2003). The Québécois attribute the adoption of the precautionary principle in their *façon de faire* to the Europeans, while a *substantial equivalence* approach characterizes the North American way, according to CEST. This is regarding the GMO issue, but it is interesting to note the parallelism with nanotechnologies, as CEST also says in its report on *Ethics and Nanotechnology* (CEST, 2003). CEST defines the Canadian attitude as closer to the USA's but recognises the suitability of adding some degree of the European precautionary manner.

A recent report (June 2010) from the NANO project observatory (European Centre for Analysis Expert, Scientific and Economic Nanotechnologies) entitled "Toolkit for Ethical Reflection and Communication", contains the following statement: "The European promotion of the precautionary principle contrasts sharply with the United States' confidence in cost-benefit analysis" (Pavlopoulos, Grinbaum & Bontems, 2010, p. 24), which would be in line with our thesis.

The officiaEuropean l approach

The European Commission, the body in charge of representing the interests of the EU as a whole, is made up of political representatives of all the member states but is independent from national governments (The European Commission). In February 2008 it released a document containing a series of recommendations and a code of conduct (European Commission, 2008), acceptance of which is voluntary, aimed at responsible research in nanoscience and nanotechnology, which could be considered the substantiation of the ethical reflection on nanotechnology in Europe, at least temporary.

Both the procedure for its preparation and the document itself define the position taken on the Old Continent.

The recommendations, objectives, scope, definitions and the code of conduct that appear (as well as the regular revisions that the document itself foresees) have been developed based on the results of participatory processes among everyone involved (*stakeholders*): the member states, researchers, companies, investors, consumers, citizens. This participatory approach reflects the European intention to adopt a dialogic attitude, a discursive ethics approach of a deontological nature that specifically grounds its regulatory procedural principles on the discussion between anyone who might be affected by the norm in question (and the presumed consensus that can result to ensure that all the stakeholders accept it) as a source of objectivity (or inter-subjectivity) sought as the moral criterion, which is especially appropriate in communities where diversity is a defining trait, as it is in the European Union. In this sense, the EU has promoted the creation of research projects (NanoBio-Raise, 2008; (Hullmann) in the ethical, legal and social aspects (ELSA) that are essential for shaping the EU's official position.

With regard to the substantive part, i.e., the code of conduct, a reading of its *General Principles* gives us an idea of the position adopted, which is primarily deontological. It is a voluntary code of conduct, a statement of intent with no binding force. This, in fact, is one of the most controversial aspects of the code, as some people think that the European Commission should already begin to legislate.

Thus, the General Principles contained in the EU Code of Conduct are (in this order):

- *Meaning*: Research activities in nanotechnology must be understandable to the public and must respect fundamental rights and seek the welfare of both individuals and society.
- *Sustainability*: These activities must be safe, ethically acceptable and should contribute to sustainable development, according to the Community's objectives and to the United Nations Millennium Development Goals (composed of 8 goals and 21 quantifiable targets, monitored by 60 indicators) (United Nations, 2008).
- *Precaution*: The precautionary principle is one of the main pillars of the European position, as shall be explained later on.
- *Inclusiveness*: Transparency and respect for the right to information of all those concerned must be taken into consideration in all research activities in Nanoscience & Nanotechnology. It must be ensured that participation in the decision making process of all the involved or affected agents is allowed.

- *Excellence*: This is a reference to the ethics of virtue. Research activities must comply with the best standards and guidelines of good laboratory practices.
- *Innovation*: Nanoscience & Nanotechnology research should be clearly focused on the maximum creativity, flexibility and capacity for planning of innovation and development.
- *Accountability*: The ethics of responsibility is evident in this principle, which stresses the need for researchers and organisations to be responsible for the social and environmental impact and on human health that their research might generate, today and in future generations.

In their titles and in the respective explanatory texts, these principles contain references to concepts such as respect for fundamental rights, welfare, goals, the precautionary principle, transparency, the right to information, participation in decision-making, biological, physical and moral integrity, excellence and responsibility. In addition, they explicitly express consideration towards future generations, animals, plants and the environment. These are aspects that refer to a combination of different ethical theories, though mainly to a deontological kind of ethics and to an ethics of virtue.

However, some of these elements could also be interpreted from a utilitarian point of view, such as considerations of future generations and animals, as moral subjects to be taken into account when trying to get *the greatest happiness of the greatest number*, as well as references to the balance of risks and benefits of nanotechnology and the welfare of both individuals and community. A strategic calculation of the consequences that this kind of analysis assumes induces us to think about a consequentialist approach to a certain extent.

In spite of this, the primary axis of reflection in Europe, if any, is the precautionary principle. It is made explicit in one of the principles of the code of conduct, entitled, as we have already seen, *Precaution*. But the influence of the precautionary principle is not limited to this point; rather it can also be noticed as a grounding factor in different independent European works on the topic (Michelson, 2004).

The precautionary approach is the practical application of the philosophical basis of precaution given by the precautionary principle and provides us with tools to deal with situations where "...scientific evidence is insufficient, inconclusive or uncertain, and preliminary scientific evaluation

indicates that there are reasonable grounds for concern (...) inconsistent with the high level of protection chosen by the EU" (UNESCO, 2005), following the EU's definition.

We could say that nanotechnology mostly fits those characteristics that would make the application the precautionary principle appropriate: (1) complexity of the natural and social systems that govern the causal relationships between certain human activities and their consequences, and (2) unquantifiable scientific uncertainty in the characterisation and assessment of hazards and risks (UNESCO, 2005). These properties make some decisions to be taken about a certain activity, such as nanotechnology, unfeasible for cost-benefit analysis methods only. Therefore, it seems reasonable to think that the content of the precautionary principle might be a good option if applied properly (Weckert & Moor, 2008).

On the other hand, the precautionary principle has its detractors whose main arguments, though not the only ones, are that it slows down innovation and economic progress, or that the precautionary principle is, in fact, an inappropriate way to manage risk based on fear (Sunstein, 2005) because the energies of regulators and regulated communities may be diverted to the speculative hazards (Graham, 2004).

The official North American approach

Regarding the official American position, we could say that it is summarised in the document released by the President's Council of Advisors on Science and Technology (PCAST) (The President's Council of Advisors on Science and Technology, 2008).[3]

PCAST reviews the work of the National Nanotechnology Initiative program (NNI) through the National Nanotechnology Advisory Panel

[3] "...an advisory group of the nation's leading scientists and engineers who directly advise the President and the Executive Office of the President. PCAST makes policy recommendations in the many areas where understanding of science, technology, and innovation is a key to strengthening our economy and forming policy that works for the American people. PCAST is administered by the Office of Science and Technology Policy (OSTP)." "The Council's 35 members, appointed by the President, are drawn from industry, education, and research institutions, and other nongovernmental organizations. In addition, the Director of the Office of Science and Technology Policy serves as PCAST's Co-Chair." The President's Council of Advisors on Science and Technology website Home Page, Retrieved November 30, 2009, from http://www.ostp.gov/cs/pcastv

(NNAP). The NNI was established in 200,1 and since then it has coordinated the federal government's activities related to nanotechnology (About the NNI).

This document is a compilation of information on the state of the art of nanotechnology around the world. It includes information on the latest developments, trends in investment, the position of USA in the nanotechnology landscape, patents, publications, the market situation and strategic recommendations. Possible ethical implications are treated in the section "Implications: Addressing Environmental, Health, Safety, and Ethics Issues Responsibly". This chapter may be considered the expression of the official position on the ethical reflection and is partly based on queries to different nanotechnology research groups in the country's universities and especially on the participation of the President's Council on Bioethics (PCB), which conducted a study whose conclusions were published in a summary (Crowe, 2008).

The PCB's text, which expresses the opinions of bioethics experts, is organised around three questions: How could nanotechnology affect human health and the natural environment? Can nanotechnology actually be considered a new kind of technology with new ethical implications? And how it could endanger human dignity?

The fundamental ideas expressed in this section of the PCAST document are the following:

There are currently no ethical aspects attributable only to nanotechnologies, beyond what is typical of new technologies. In any case, nanotechnological developments that raise important ethical questions, such as in terms of human dignity, do not exist yet; therefore, conducting an in-depth ethical analysis is considered premature, although there are many applications in which concepts like human dignity, identity, privacy and fundamental rights may be affected. The current official U.S. position is then opposed to the existence so far of grounds for eventual potential *nanoethics* as a specific discipline, and advocates the integration of the ethical reflection on nanotechnologies into the global reflection on new technologies, basing this opinion on a *substantial equivalence* between nanotechnologies and other technologies already existing. This is not to say that a reflection on the ethical issues arising from nanotechnologies is not deemed necessary, but it does mean that this reflection is essentially equivalent to ethical reflections on other technologies.

However, risk assessment research for specific nanotechnologies is considered important, as is research into the benefits and social implications,

integrated with research activities and technical development with the recommended participation of researchers in the fields of the social sciences and the ethics of technology and academic experts in science, technology and society, in order to establish frameworks to ensure that the net effect of applying nanotechnologies is positive. Preparation of a future code of conduct is not ruled out someday, if deemed necessary.

The main recommendation is to continue research efforts in the areas of environment, health and safety (EHS).

This approach, pragmatic and focused on the efficiency of results, which seek a maximization of utility, in the form of welfare, through a strategic-instrumental calculation of the factors, suggests a kind of consequentialism or a pragmatic approach in which the consequences or effects determine the moral goodness of actions. This is particularly an essentially utilitarian view in which the principle of utility becomes the leading normative guideline. In this case, the maximum aggregate utility, in terms of welfare of the greatest number, would be used to determine the moral goodness or acceptability of a technological application without it being considered necessary yet to deal with deontological aspects.

However, the truth is that deontological elements are not completely discarded in the American perspective. The experts on the President's Council on Bioethics, for example, mention questions about human dignity in their report (Crowe, 2008), although they are postponed (in fact, they are not mentioned explicitly in the PCAST document) as they are not considered relevant factors at this moment.

Moreover, talking about the process of creating the official position, the prevailing opinion in this case is the opinion of the official advisory agencies. Although other experts and public opinions are being actually heeded, this is for informational purposes and not with the aim of starting an open participatory process of deliberation. This is a methodology that may also reflect a pragmatist pattern: letting the experts talk may be the most efficient way of finding answers.

These positions can also be noted in recent official releases, such as the Nanotechnology Education Act (HR 4502 IH), recently introduced (January 2010) by House Representative David Wu. This does not intend to be an official pronouncement about ethical considerations, but from it one can deduce what are officially considered the most important issues in this field. The purpose of the document is

> "to strengthen the capacity of United States secondary schools and institutions of higher education to prepare students for careers in nanotechnology (...)" in order to "(...) maximize the benefits of nanotechnology to individuals in the United States (...)",[4] which is one of the goals identified and explicitly expressed within the section on Findings (Wu, 2010).

CONCLUSIONS

Nanotechnologies indeed show the ethical implications of new or emerging technologies. Whether or not there are ethical issues unique to nanotechnologies that would make a specific ethical reflection worthwhile is still being discussed. There are supporters of both lines of thinking.

Several group and individual opinions have been proffered about the ethical aspects of nanotechnologies, and the European Commission and the President's Council of Advisors on Science and Technology have both released documents expressing what we can consider the official positions of the European Union and the United States of America, respectively. Both documents can be considered the highest official documents up to date explicitly expressing an opinion on this topic.

The European Commission, following a discursive process, has produced a document that includes recommendations and a code of conduct for research in nanoscience and nanotechnology. In this document, the active involvement of everyone who might be affected (*stakeholders*) was sought. A list of principles based primarily on ethical considerations of a deontological nature was included, with special attention to the precautionary principle, which could be considered the backbone of the reflection. In addition,, elements of the ethics of virtue and some consequentialist tips can be observed in the document.

On the other hand, the United States of America, through the President's Council of Advisors on Science and Technology (PCAST), has expressed its position regarding the ethics of nanotechnologies in a single section of a document dedicated to nanosciences and nanotechnologies as a general topic.

The *official* North American point of view states that so far nano-

[4] http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_cong_bills&docid=f:h4502ih.txt.pdf (P.2 L.7)

technologies do not require a specific ethical reflection different from that required for other new technologies. This opinion is based on an approach influenced by the principle of *substantial equivalence*.

In the North America, the ethical grounds are fundamentally utilitarian, with the principle of itility as the main moral criterion, which refers to a weighing of the possible consequences in terms of risks, benefits and social implications. Although deontological issues such as human dignity are mentioned by some authors, thinking about them at the moment is considered premature.

The differences noted between the European and U.S. approaches may respond to current intrinsic peculiarities of the two communities, as well as being a manifestation of the historical and cultural heritage and social circumstances of each society, especially regarding moral philosophy, the Old Continent on the one hand and Anglo-American society on the other.

REFERENCES

About the NNI. (n.d.). Retrieved December 9, 2008, from the National Nanotechnology Initiative website: http://www.nano.gov/html/about/home_about.html.

Berger, M. (2008), *Europe and the U.S. take different approaches to Converging Technologies*. Retrieved June 13, 2009, from Nanowerk LLC: http://www.nanowerk.com/spotlight/spotid=6905.php.

Berne, W. R. & Schummer, J. (2005), "Teaching Societal and Ethical Implications of Nanotechnology to Engineering Students through Science Fiction", *Bulletin of Science, Technology & Society, 25* (6), 459-468.

Bruce, D. (2006), "Ethical and social issues in nanobiotechnologies: Nano2Life provides a European ethical *think tank* for research in biology at the nanoscale". *EMBO Rep., 7* (8), 754-758.

Comission de l'Éthique de la Science et de la Technologie (CEST). (2003). *Avis: Éthique et Nanotechnologie: se donner les moyens d'agir*. Government of Québec.

— (2003). *Avis: Pour une gestion éthique des OGM*. Government of Québec. Retrieved July 25, 2009, from http://www.ethique.gouv.qc.ca/index.php?option=com_docman&task=doc_download&gid=17&Itemid=73.

Cortina, A. (1986), *Ética mínima. Introducción a la filosofía práctica*. Tecnos, Madrid.

— (1993). *Ética Aplicada y Democracia Radical*. Tecnos, Madrid.

Crowe, S. (2008). *Staff Paper, The President's Council on Bioethics*. Retrieved December 9, 2008, from Understanding the Ethical Implications of Nanotechnology: Highlights of a Limited Inquiry by the President's Council on Bioethics: http://www.bioethics.gov/background/nanotechnology_implications.html.

Davies, J. (2009), *Oversight of Next Generation Nanotechnology*. The Woodrow Wilson International Center for Scholars, The Project on Emerging Nanotechnologies (PEN).

Dupuy, J. (2007), "Some Pitfalls in the Philosophical Foundations of Nanoethics". *Journal of Medicine and Philosophy* (32), 237–261.

European Commission. (2008). *Commission Recommendation of 07/02/2008 on a code of conduct for responsible nanosciences and nanotechnologies research.*

Fernández Agis, D. & Fernández Castillo, A. (2007), "La nanotecnologia, inquietudes sociales y problemas éticos derivados". *El Catobeplas. Revista crítica del presente*, 61.

Feynman, R. (1959, December). *There's Plenty of Room at the Bottom. An Invitation to Enter a New Field of Physics, Engineering and Science*. Retrieved February 5, 2009, from http://www.its.caltech.edu/~feynman/plenty.html.

Gaskell, G., Eyck, T., Jackson, J. & Veltri, G. (2005). Imaging nanotechnology: Cultural support for technological innovation in Europe and the United States. *Public Understanding of Science, 14*, 81-90.

Gordijn, B. (2005), "Nanoethics: From utopian dreams and apocalyptic nightmares towards a more balanced view". *Science and Engineering Ethic*, 11 (4), 521-33.

Graham, J. (2004), *The Perils of the Precautionary Principle: Lessons from the American and European Experience*. The Heritage Foundation, Washington, DC.

Habermas, J. (2001), *El Futuro de la Naturaleza Humana. ¿Hacia una Eugenesia Liberal?* Paidós, Barcelona.

Hermerén, G., Marczewski, K. & Nielsen, L. (2007), "Opinion on the ethical aspects of nanomedicine", *Opinion*, 21. The European Group on Ethics in Science and New Technologies to the European Commission

Hullmann, A. *European activities in the field of ethical, legal and social aspects (ELSA) and governance of nanotechnology*. European Commission, DG Research.

Hunt, G. & Mehta, M. (Eds.). (2006). *Nanotechnology: Risk, Ethics and Law*. London, Sterling, VA: Earthscan.

Michelson, E. (2004). *Analyzing the European Approach to Nanotechnology, occasional paper on nanotechnology*. Woodrow Wilson International Center for Scholars Foresight and Governance Project.

Mnyusiwalla, A., Daar, A. S. & Singer, P. A. (2003). "Mind the gap: Science and Ethics in Nanotechnology". *Nanotechnology*, *14* (3), R9–R13(5).

NanoBio-Raise. (2008), *Responsible Action on Issues in Society and Ethics*. Retrieved from List of other (EU) nanoethics projects: http://nanobio-raise.org/Members/susanne/document.2007-06-22.3119798394/document_view?portal_status_message=Your%20contents%20status%20has%20been%20modified

National Nanotechnology Initiative (2000), *Leading to the Next Industrial Revolution*. US National Science and Technology Council's Committee on Technology.

Pavlopoulos, M., Grinbaum, A. & Bontems, V. (2010), *Work package 4: Ethical and societal impacts. Toolkit for Ethical Reflection and Communication* (Deliverable S D4. 4. 1 and D4.4.2). ObservatoryNano: European observatory for science-based and economic expert analysis of nanotechnologies., CEA-LARSIM.

Rawls, J. (1971). *A Theory of Justice*. Harvard University Press.

RNCOS. (2009, May). *Nanotechnology Market Forecast to 2013*. Retrieved August 20, 2009, from http://www.reportlinker.com/v2/p0118193/Nanotechnology-Market-Forecast-to-2013.html.

Sandler, R. (2009). *Nanotechnology: The Social and Ethical Issues*. The Woodrow Wilson International Center for Scholars & The Pew Charitable Trusts, The Project on Emerging Nanotechnologies (PEN).

Schummer, J. (2008), "Cultural Diversity in Nanotechnology Ethics", in F. A. (eds.), *Nanotechnology & Society. Current and Emerging Ethical Issues*. Springer, Netherlands, pp. 265-280.

Sunstein, C. R. (2005). *Laws of Fear. Beyond the Precautionary Principle*. The Press Syndicate of the University of Cambridge.

Swiss Reinsurance Company (2004), *Nanotechnology. Small Matter, Many Unknowns*. Swiss Re Publications, Zurich.

The Action Group on Erosion, Technology and Concentration (ETC Group) (2003), *The Big Down: From Genomes to Atoms*. Retrieved July 15, 2009, from http://www.etcgroup.org/upload/publication/171/01/thebigdown.pdf.

The Ethics of Nanotechnology (2007). Retrieved July 15, 2009, from nanotech-now: http://www.nanotech-now.com/ethics-of-nanotechnology.htm.

The European Commission. (n.d.). *Europa website*. Retrieved December 2, 2009, from European Union Institutions and other bodies: http://europa.eu/institutions/inst/comm/index_en.htm.

The Nanoroadmap Project. (2006). *Roadmaps at 2015 on Nanotechnology Application in the Sectors of: Materials, Health & Medical Systems, Energy. Synthesis Report*. AIRI/Nanotech IT.

The President's Council of Advisors on Science and Technology. (April 2008). *Second Assessment and Recommendations of the National Nanotechnology Advisory Panel*. Retrieved November 30, 2009, from http://www.ostp.gov/galleries/PCAST/PCAST_NNAP_NNI_Assessment_2008.pdf

The Royal Society (2004), *Nanoscience and Nanotechnology: Opportunities and Uncertainties*. Retrieved July 15, 2009, from http://www.nanotec.org.uk/report/Nano%20report%202004%20fin.pdf.

UNESCO (2005), *The Precautionary Principle*. UNESCO, World Commission on the Ethics of Scientific Knowledge and Technology (COMEST), Paris.

United Nations Educational, Scientific and Cultural Organization (UNESCO) (2006). *Report: The Ethics and Politics of Nanotechnology*.

United Nations (2008), *The Millennium Development Goals Report 2008*. Retrieved July 1, 2009, from http://www.un.org/millenniumgoals/pdf/The%20Millennium%20Development%20Goals%20Report%202008.pdf.

Van de Poel, I. (2008), "How Should We Do Nanoethics? A Network Approach for Discerning Ethical Issues in Nanotechnology". *NanoEthics* (2), 25-38.

Weckert, J. & Moor, J. (2008), "The Precautionary Principle in Nanotechnology", in F. Allhoff, P. Lin, J. Moor & J. Weckert (Eds.), *Nanoethics: The Ethical and Social Implications of Nanotechnology*, pp. 133-159. Wiley-Interscience.

Wu, D. (2010), *A Bill to Strengthen the Capacity of Eligible Institutions to Provide Instruction in Nanotechnology*. Retrieved April 6, 2010, from 111TH Congress 2nd Session; in the House of Representatives: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_cong_bills&docid=f:h4502ih.txt.pdf.