NANOTECHNOLOGY & ETHICS EXPERT GROUP: REPORT OF THE FIRST MEETING

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Introduction

Mr. ten Have, director of the Division of Ethics of Science and Technology of UNESCO welcomed the participants and presented the plans for the working group. The objective of the working group, he stated, is twofold: exploration of the state-of-the-art in nanotechnology, resulting in papers collected in a book published by UNESCO; and reflection on possible international actions presented in a policy paper. The policy paper resulting from the reflections of the experts, and drafted by UNESCO, would be discussed at the next meeting of the Bureau of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST), which would then decide to make recommendations to the Director general in the area of nanotechnology.

The participants introduced themselves:

- Mr. Henk ten Have, Director of the Division of Ethics of Science and Technology of UNESCO is a medical doctor and philosopher by training and has been a bioethics professor in the Netherlands; he joined UNESCO in September 2003;
- Mrs. Simone Scholze, lawyer by training and Programme Specialist in the Division of Ethics of Science and Technology of UNESCO, has been a policy maker in science and technology and ethics in the Brazillian government for 18 years;
- Mr. Julien Tort, philosopher, economist and engineer by training, is Programme Specialist in the Division of Ethics of Science and Technology;
- Mr. Jun Fudano is a member of COMEST and Director of the Applied Ethics Center for Engineering and Science at Kanazawa Institute of Technology (KIT), Japan. At KIT, he also holds a position as Professor of the History of Science and Technology, and of Science and Engineering Ethics;
- Mr Bert Gordijn is professor at the Department of Ethics, Philosophy and History of Medicine of the Radboud University Medical Center in Nijmegen, The Netherlands;
- Mr Peter A. Singer is Professor of the Department of Medicine, University of Toronto, Canada; he is Director of the Joint Center for Bioethics of the University, and Staff Physician at the University Health Network;
- Mr Joachim Schummer teaches philosophy of chemistry at the Institute of Philosophy, University of Karlsruhe, Germany;
- Mrs Margareth Spangler Andrade, has a PhD in applied sciences and is professor of metallurgical engineering at the Federal University of Minas Gerais, Brazil; she is currently director of technological development at the Fundação Centro Tecnológico de Minas Gerais;
- Mrs. Michele Jean, Chair of the International Bioethics Committee, has been the Canadian Deputy Minister for health from 1993 to 1998, vice chair of the Quebec Health Research Fund; she is a member of the Quebec Commission on Ethics of Science and Technology, and an historian by training;

- Mr Donald Evans is Director of the Bioethics Centre, Dunedin School of Medicine, University of Otago, New Zealand;

Invited as members of the group, but not able to participate in this specific meeting were the following persons:

- Mrs. Kyunghee Choi, is a Professor in the Department of Science Education at the Ewha Womans University of Seoul, Korea; Mrs. Choi submitted a paper entitled *Education of Ethics in Nanotechnology: Formulating and Implementing Educational Strategies*, which will hopefully be discussed at the next meeting;
- Mr Maciej Nalecz, Director of the Division of Basic and Engineering Sciences of UNESCO;
- Mr Jixing Liu, researcher at the Institute of Theoretical Physics, Chinese Academy of Sciences, Beijing, People Republic of China
- Mr Abdallah S. Daar, currently Professor of Public Health Sciences and of Surgery at the University of Toronto, where he is also Director of the Program in Applied Ethics and Biotechnology, Co-Director of the Canadian Program on Genomics and Global Health at the University of Toronto Joint Centre for Bioethics, and Director of Ethics and Policy at the McLaughlin Centre for Molecular Medicine

Mr. Henk ten Have gave an overview of the activities of UNESCO in the field of ethics. The ethics programme started with the creation of the International Bioethics Committee (IBC) in 1993. Other areas of ethics such as science, outer space or environmental ethics have also been addressed since the establishment of the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) in 1997. Standard-setting activities have been one of the main activities, with the adoption of the Universal Declaration on the Human Genome and the Human Rights, the International Declaration on Human Genetic Data, and the current draft international declaration on universal norms in bioethics, that has been submitted to the 33rd General Conference. The purpose of this type of activity is to provide guidance to those Member States that want to improve their ethics infrastructure. COMEST is also engaged in standard setting activities. One example is the exploration of the feasibility of a declaration of ethical principles for scientists that could serve as a basis the elaboration of codes of conduct for scientists by academies, professional and regional organizations. On the issue of the precautionary principle, while UNESCO cannot take a position, a report has been prepared by experts in order to clarify the principle and its applications. A report on the teaching of ethics was also adopted by COMEST.

The same approach will be taken with regard to nanotechnology. Nanotechnology will have an important impact on most Member States, including those that are not directly involved. Hence, a more anticipatory approach than what already exists has to be taken, particularly to inform Member States of what they can expect. The output of the working group will be twofold: (i) papers by the experts to be published in a book series on ethics of science and technology, available in the six official languages of the organization; and (ii) a policy report drafted by the Division of Ethics of Science and Technology based on the discussions and recommendations of the experts, and that lists possible policy action.

Presentation by Mr. Gordijn: The Emergence of Nanomedicine

Mr. Bert Gordijn presented a paper on biomedicine and nanotechnology. The ethical debate so far, he started, has been dominated by sweeping statements about nanotechnology. It may therefore be worthwhile to focus on particular fields such as biotechnology and medicine in order to avoid having too general a discussion. Mr. Gordijn first described the field, then considered possible ethical issues, and finally international policy issues.

Contrariwise to what the term "nanomedicine" suggests, it is not a subdiscipline of medicine. However, it is likely to affect a number of sub disciplines, and its pace of development is quite amazing. The US are taking the lead, with for example the first academic society and the first national peer-reviewed journal focusing on nanomedicine. The first explicit views were dominated by ideas driven by very complex computers controlling nanorobots. But the field has developed in quite another way, and most structures are actually simpler. In this very broad field, Mr. Gordijn chose to present four activities:

1. Ways that are being explored for diagnostic purposes
2. Different methods of directing therapeutic agents to targets
3. Cancer therapy
4. Manufacturing implants with enhanced biocompatibility

Turning to ethical issues to be expected, Mr. Gordijn distinguished different periods. In the short term, improvement of prevention, diagnosis and therapy of diseases are the main areas concerned. In the medium term, one could expect a shift from the *restitutio at integrum* to *transformatio at optimum*, and nanomedicine may try and achieve a certain ideal human being. This is of course the development known in the bioethics literature as enhancement. In the long term, this enhancement project may change human beings to the degree that they will not be human anymore. In the short term, risk plays an important role. The "gray goo" scenario, presented in the 1980s by Eric Drexler, is now regarded as obsolete. Current worries bear more on the possible toxicity of carbon nanotubes. On the whole, risk research plays a very important role. A second issue of nanotechnology will be diagnosis: new diagnostic methods without the ability to cure may indeed raise serious problems. A third issue is changing attitudes towards the body. The body will be more and more a product of technology, and it will also become a part of technological systems and networks. In addition, the body and its structures will also be more and more imitated. A fourth issue is changing the image of man. While the traditional vision of nanotechnology is reductionistic, according to which different atomic configurations can be made to imitate all kinds of living structures, the development of nanotechnology itself may challenge this view.

Regarding the shift towards enhancement of the human body in the medium term, Mr. Gordijn focused on three fields. First, further development of nanotechnology will accelerate the development of predictive technology within medicine. Second, further development of tissue engineering and bioelectronics is to be expected, as current research on retina implants suggests. The third field is cosmetic surgery. Growing confusion regarding the concept of the body could arise, and it may become difficult to determine what a genuine part of the body is, as the body will be invaded by electronics. In addition, as we become more linked up with computer systems, it will become more difficult to defend our privacy and autonomy. Personal identity will also be an issue. What makes the identity of a person, what makes one good at certain things, what makes him or her unique will all be more and more influenced by medical

nanotechnology. How could one distinguish neurally accessible databases from personal memories? If smart drugs make you intelligent, are you intelligent? Another problem will be that of normalization: normal properties will be regarded as abnormal. And finally, it is quite likely that enhancement technology will be more available to the rich than to the poor, so that the gap between countries would be widened.

On the very long run, the development of more artificial bodies and anthropomorphization of technology could lead to an artefactization of life processes, thus raising the question where human life ends. In the end, the transformative power of technology may make it difficult to assess whether the result is human or not. Talking of "post-humanity" could be envisaged. Three scenarios are to be discussed:

1. Fusion of man and machine
2. Transformation of man
3. Scanning brains in order to digitalize the information, and establishing our software intelligence

Mr. Gordijn explained that his research on the international policy issue was still ongoing. Different issues, he said, are interesting for nanomedicine and international policy. One is the issue of copying life and its structures. Another is again the transformation of human beings: as the case of Prozac already illustrates, personalities can be changed. At what point is personality modified? And then what defines humanity, what is post-human future? Justice and injustice is another issue where clarification of concepts is needed about the nature of life and humanity.

Discussion of Mr. Gordijn's paper

One of the participants warned against science fiction considerations and emphasized that the issue of human enhancement is different from the other issues because its goals are defined from the beginning. The involvment of the military, he added, is equally to be considered in this regard. While ethical issues usually arise because there is ambivalence and different directions are allowed, ethical issues are to be discussed in the early stages. Another participant wondered indeed whether nanotechnology is contributing in a better way to resolve the persistent problems in healthcare or whether it is intrinsically different so that it addresses problems at another level. The issue of eugenics and the early diagnosis of "substandard" human beings, or "non-human" beings was also mentioned, having in mind that eugenics seems to be interesting for certain countries. Many of these ethical issues, it was said, are already being discussed in multidisciplinary foras, including in particular WHO. It is to be hoped that research on this matter reaches the public in time, unlike what happened with GMOs, and in this regard, it is a good thing that the ethical debate is taking place early. Another point is that some tend to present ageing as a disease, which could therefore be cured. Many cosmetic techniques are now seen as medicalization, and people unable to use this technology will be seen as neglectible people. The discussion on nanoscience and nanotechnology is a continuation of the debate on genetics. Mr. Gordijn stated that it would be a wrong approach to try to define what is particular to nanomedicine. Nanotechnology will influence a lot of fields in medicine. On the whole it will enlarge the transformative power of medicine. Prediction will become a more serious technology, mainly due to nanotechnology. About notions such as authentic decision or authentic memory, it was argued, we are already very familiar with machines. At what point are we going to have a debate? It was also said that the scenario that

was presented seems so scary that public opinion may be mobilized against nanotechnology, like with GMOs, preventing possible benefits. Is this technology intrinsically dangerous or is it only its possible use? One should avoid that some sort of paranoia prevents public benefits. Mr. Gordijn emphasized the strong influence of the gray-goo scenario in the public debate, despite its recognized obsolescence. Even if it was possible, molecular engineering in other ways would be more efficient. Some publications such as the novel *Pray* had huge influence anyhow, as had already been the case with genetics.

A participant argued that the first part of Mr. Gordijn's paper is disconnected from the second part. The second part is very stimulating and very speculative, and the distinction between short, medium and long term perspectives is quite relevant. Showing that these speculations are justified would have been useful, explaining for example how enhancement could came up, and why it is a reasonable and interesting speculation. The first part, this participant said, is a mismatch and the third should be part of the second. Concerning the setting of international standards, he added, humility is needed to avoid giving the impression that we are planning for things that will not happen. Another participant argued that, as clarification of concepts is indeed what is needed, the key person here is the philosopher. There is a danger of cultural imperialism, it was said, in every idea of enhancement. Who would define what ideal human beings are? Nanotechnology will also change the medical profession, leading to development of knowledge oriented systems and to self-medication. The ethical debate, one expert argued, is very much influencing scientific research. Nanotechnology are just a tool and a way of thinking for scientists. It allows the building of new material with new and unknown properties. While the thinking on the nature of humanity or justice is highly interesting, nanotechnology has only little relevance to it. As Mr. Gordijn mentioned, there are already nanotechnologies used everyday such as Prozac or caffeine.

Presentation by Mr. Singer: Harnessing Nanotechnology to Improve Global Equity

Mr. Peter Singer started by presenting his centre, probably the largest bioethics centre in the world he said. The centre does clinical ethics research and bioethics education. The Canadian programme has been working for about 5 years, and there was also some involvement in the United Nations Millennium Program, as with the Gates Foundation on global health. The focus of the center is currently being broadened to innovation in general, and the work on nanotechnology started in 2002. The first paper was entitled *Mind the gap… between science and technology*.

The main point is that the ethical notion of equity is to be put at front. That concept will be expanded. The structure of the draft paper presented here is that it first wonders what are key nanotechnologies for development, then what the developing world is doing, and finally what the developed work is doing to assist and finance these efforts. There is no focus on risk or health, and the starting point are the domains listed by the World Summit on Sustainable Development.

In the first part of the draft paper, the key empirical data is shown in Table 1 of the paper: it is based on a Delphi survey of 63 nanotechnology experts wondering which nanotechnologies are most interesting for the developing world. This table will be in the final paper, and there will be regional paragraphs emphasizing specific examples of particular relevance to a particular region, e.g. water in Palestinian territory. Real roadmaps, real scenarios, real problems are

discussed and the nanotechnology applications are linked to the Millennium Development Goals. The order is an order of priority, using Delphi methods for building consensus among groups: the experts surveyed were asked to re-rank and to give specific examples. It was a surprise that energy came at the top of the list. Scientists and policy makers were surveyed.

In the second part, and following Prince Charles' paper, the Centre also found a lot of nanotechnology in the developing world that actually undermines opportunities (see some criteria in Table 2 of the paper). Turning to biotechnology, a more in-depth survey was conducted in "innovating" developing countries, and was the subject of an article in the *Economist* in December 2004. From this Internet based survey, the Centre would like to go to a more country-level study involving 35 people from each country with a stronger participation of the private sector. The example of Brazil stresses incentive issues. The central question is what the developing world itself can do. In this regard the lessons of biotechnology, with particular focus on the domestic private sector, have been learnt and are more and more used. One last point would be the South/South divide between countries that are following an accelerated path of development such as China, India or Brazil and other developing countries. This issue, Mr. Singer said, is becoming a more urgent issue than the North/South divide.

Turning to what the industrialized countries do and can do, he said that nanotechnology should be seen as an accelerator. While the key issue remains what the developing world does, there is a number of proposals, where policy considerations may play a role. The Centre proposes a global programme of addressing global challenges using nanotechnology, essentially in line with the worries of the Gates Foundation, which is funding a significant part of the programme. A first idea is the development of a grant model and a funding facility. Sources of funding are not nanotechnology specific, but nanotechnology is rather the third wave of technology raising this kind of issues, after Information Technology and Genetics. Another issue is that of the Diaspora and how scholars can share their ideas and experiences about repatriating their knowledge. This could be particularly relevant to UNESCO. Issues of Global governance, codes of conduct, and bioterrorism, for example, would also be considered in this framework. Mr. Singer concluded that, while this paper was still a draft, the emphasis of his contribution would be on equity and the developing world.

Discussion of Mr. Singer's paper

One participant wondered about military use of nanotechnology. It is quite clear in developed countries that this is being considered. What will be the influence of this dual use when developing countries also invest in this field of military uses of nanotechnology? Mr. Singer referred to a few examples such as the MIT Nanosoldiers Initiatives and agreed that this point is not properly addressed in the work of the Center.

Another expert emphasized the importance of producing specific recommendations. He pointed out that there are several nanotechnologies rather than one nanotechnology. He wondered what audience was targeted to establish the top ten list of nanotechnologies, and he mentioned the issue of property rights and the funding of public domain by the private sector. Mr. Singer agreed to these suggestions and called for material on this matter.

The issues of equity and challenges for development, it was argued, are not nanotechnology-specific. Is there anything specific to nanotechnology in regards to how it is likely to affect global equity? Mr. Singer responded that the only specific thing may be the positioning of the

developing world. In nanotechnology, there is more activity in the developing world than there was in ICT or even in genetics.

Referring to Table 2 of the paper, an expert noticed that while a lot of data could be found about entrepreneurs getting richer, the impact on local health or well-being was not addressed. She also wondered how political will can be assessed, and how the private sector may use the financial help granted for the development of health biotechnology sector. Such monitoring, she said, is very important to determine whether nanotechnology developments are going to help reducing the global divide(s). Mr. Singer answered that the fundamental argument is about national governance indeed. He mentioned the example of the use of satellites and information systems for tsunamis and said that, while he could not find a similar example in genetics or nanotechnology, this was an important aspect to highlight.

Mr. Singer emphasized that a mix is needed of public and private funding. The real challenge, he said, is to direct the flow of funds in the right direction, and neither a pure private nor a pure public play will suffice. While sciences are common good, property rights are a condition of their development. Following a question pertaining to the risk of increasing poverty by developing nanotechnology, he mentioned the example of Brazil as a middle ground: its problem, like Canada, is that it provides lots of funding but little commercial output so far. A better collaboration between various institutions and private sector firms may be a remedy to that situation, in order to avoid nanotechnology to follow the same path biotechnology followed in these countries.

Presentation by Mr. Schummer: Identifying Ethical Issues amidst the Nano Hype

Mr. Joachim Schummer argued that there is much hype about nanotechnology as the next industrial revolution. There is also a hype in the scientific community: in some areas, 15% of papers have “nano” in their title. It makes it difficult for ethicists to identify ethical issues, and Mr. Schummer said he would therefore focus on the less obvious issues. His personal background and situation is that he has studied interdisciplinarity and history of science and nanotechnology in particular, and currently spending half of his time in Germany and half in the United States. The presentation was in three parts: the first part discussed recent scholarly activities, the second part tried to define nanotechnology, and the third one to identify ethical issues.

Recent scholarly issues include international conferences and books. They are often only indirectly related to ethics. There is also some research on the “prehistory” of nanotechnology, not mentioning the many commissioned reports and science fiction works. The general theses are notably: that Nanoscale research is historically more continuous than "revolutionary"; that there are many nanotechnologies rather than one nanotechnology; that the nano-hype is caused by national research programs, science fiction, fantastic visions, and investor markets; and finally that public debates are dominated by science fiction and fantastic visions rather than by actual research activities.

Giving a nominal definition of nanotechnology by necessary and sufficient conditions implies to include devices with critical lengths. The applications of nanotechnology should exploit the specific properties of nanosized materials and devices. The problem of such a nominal definition, however, is that it applies to almost any technology based on material. A teleological

definition would then be either specific or visionary as it would refer either to DNA repairing, molecular manufacturing, nanosoldiers, or molecular bearings. The problem with such visions is that they are often infeasible or at least scientifically implausible in the foreseeable future. Another problem is that they are meant to provoke emotions, hopes and fears instead of knowledge. They tend therefore to distract attention from ethical issues towards utopian or dystopian fantasies. We are hence left with the only possibility of a real, or extensive, definition consisting in a long list of instances taken from various government programmes. Despite its variation in time and space, such a list is the best definition so far. One of its advantages is to allow distinguishing between the various nanotechnologies.

Turning to ethical issues, there are three kinds of general issues. The first one is that governmental programmes tend to induce a shift from sciences to engineering that increasingly requires more ethical education for science students. The second one is that the nano-hype is based on science fiction promises and hysteria, is misinforming the public and creating unjustified hopes and fears, and draws attention away from political issues of science governance and actual ethical issues. The third ethical issue is that the impact of a particular nanotechnology on a developing country depends on its role as consumer, as producer, and as resource provider. Other ethical issues are specific to particular nanotechnologies. The military aspect is one of them, as a substantial proportion of governmental research funding goes into military research. The secrecy surrounding this research may obviously delay the identification of radically new ethical issues. Yet human enhancement programmes, anyhow, may threaten the human dignity of the soldier. IT aspects are another set of specific issues, related to privacy, ubiquitous computing, system dependencies. While no radically new issue has emerged yet, incremental improvement and miniaturization of IT devices may provoke qualitative changes. Biomedical aspects should also be considered by the relevant experts.

Environmental aspects of nanotechnologies relate to sustainable development and the potential toxicity of nanoparticles. Nanoparticles have specific properties in terms of biochemistry, thermodynamics, electromagnetism, including the ability to permeate through biological membranes. While there has been both natural and anthropogenic sources of nanoparticles for ages (volcanic ashes, combustion, abrasion), new industrial applications imply an unprecedented scale of production of nanoparticles, some of these particles being themselves new. In this regard, there is a lack of standards and regulations as size of materials is generally not taken into account; this lack of standards is partly due to a lack of knowledge, as we do not even know yet how to measure and to classify the toxicity of nanoparticles.

One last category of specific ethical issues pertaining to nanotechnologies are the economic aspects. One is the shift of world resources markets. This movement has been taking place for more than a century with the development of chemistry, as chemically engineered products substitute for natural resources: synthetic fabric, synthetic ammoniac or plastic substitute to wooden or metal objects are examples. With the development of nanotechnologies, new substances occur such as nanotubes replacing conducting metals, nanostructured ceramics replacing tungsten, nano-engineered catalysts replacing precious metals, or new organic semiconductors substituting for Silicium based ones. The problem here is that most of world's metal resources that are being replaced by nanotechnology engineered materials are located in developing countries: 88% of the World stock of Tungsten is in China, 75 % of Platinum in southern Africa, while the new substitutive products are largely manufactured in developed countries. Another economic aspect that is raising ethical issues is intellectual property rights. As new patent regulations in Europe and America develop, including much more liberal patent

criteria, the license income and patenting rights of universities have shown a clear shift in the late 1990s: while patents doubled, license incomes were multiplied by 6.5. As a consequence, knowledge, including basic engineering knowledge is moving from the public domain to the market, which raises the costs of all R&D-based industries, including nanotechnology-based ones, and eventually lead to a widening of the economic gap between countries with much and less research investment, the poorer countries being unable to afford the licensing costs of new engineering technologies.

Mr. Schummer's recommendations were presented in three categories: recommendations to the current working group, to all Member States of UNESCO, and to developing countries in particular. The group should delegate relevant issues to relevant other expert groups or committees – this applies particularly to ethical concerns in the field of teaching ethics, bioethics or environmental ethics. The discussion of science fiction visions that distract from proper ethical issues should be avoided. It should also be kept in mind that there is not one nanotechnology but rather several nanotechnologies.

All Member States should reinforce ethics education for science and engineering students; they should educate people about the diversity of nanotechnologies and the distinction between R&D and science fiction; they should establish research programs to identify specific ethical issues for each particular technology; and they should establish democratic structures of technology governance, reflecting upon what kind of nanotechnology is actually needed, instead of promoting science fiction-based nano-promises and hysteria. A more specific recommendation to all Member States is to focus on the possible toxicity of some nanoparticles, and to start working on international standardization and legal regulations prior to the industrialization and marketing phase. The issue of intellectual property rights should also be addressed internationally, and the current trend towards patenting of basic engineering knowledge should be reversed. Finally, those nanotechnologies that spare critical world resources and that improve environmental conditions should be favoured.

Concerning developing countries in particular, they should avoid copying the nano-hype of developed countries (which is due to internal science policy issues) and focus R&D activities on those nanotechnologies that: (a) meet specific public needs of the country rather than visionary dreams of elites like "anti-aging" or "human enhancement"; (b) increase traditional strengths in R&D that might be crucial as enabling technologies for further R&D. Furthermore, countries with material resources should focus R&D activities on those nanotechnologies that make use of domestic material resources and that could substitute for current technologies depending on domestic resources.

Discussion of Mr. Schummer's paper

One expert commended the paper and wondered what Mr. Schummer had in mind when he was mentioning "democratic structures for governance of nanotechnology". He also asked what his feeling was about the toxicity of nanotubes, as studies did not give answers yet, and it may take some time until toxicity appears, as was the case with asbestos. Mr. Schummer responded that many countries launched huge nanotechnology programmes without knowledge or discussion of what it is. There should be democratic procedures such as the ones existing in the Netherlands or the United Kingdom. It is not so much horror scenarios than proper governance and developing technologies that are actually needed. The phrase nanotechnology disguises this question. Mr. Schummer also agreed that the estimation of the

toxicity of nanoparticles is a very complex process, and admitted to be pessimistic about the time frame. One should start thinking, he added, about conceptual issues for toxicity of nanoparticles. This problem, he said, is probably bigger than the GMO consumer disaster, because it does not refer to one particular technology.

A participant stated his dissatisfaction with the so-called "real definition" and wondered why all these technologies would deserve the same label. Mr. Schummer agreed that this was not a definition, and that this list was to be the object of political negotiation, not based on a clear understanding of the concept. Another expert argued that a definition is not needed anyway. The first questioner wondered what the ethical issues were: toxicity, he said, is not really an ethical issue, rather a scientific one. The same is true with the shift of resources: this is a side-effect of every technology. Another ethical issue is the fact that the patent system seems to have problems adapting with emerging technologies. Mr. Schummer admitted that toxicity in itself is a technical issue. The ethical issue, he said, is possible harm, risk regulation and management. Powerful groups try to deny the possibility of toxicity of nanoparticles while talking about their novelty. It is a matter of political negotiations. About intellectual property, the issue is international inequity. The patent problems affect poor countries that cannot afford licenses, and the gap is growing. The importance of the toxicity issue was emphasized again: some nanoparticles produced terrible diseases in the past. Knowing what procedures will be followed in ethics committees, how and by whom clinical trials will be approved are important ethical issues. Sampling nanoparticles also seems to be a big problem. While some scientists are doing experiments on the issue, we do not have sufficient knowledge yet to even determine what we are looking for. The danger of hype was underlined again. Prospects of a cure for cancer are a huge promise, already showing its effects in the area of stem cells.

One expert said that the recommendations were a bit free floating, lacking evidence and arguments. Recommendations on democratic procedures seems to come out of nowhere but are actually linked to the first part. About the definition, he wondered whether Mr. Gordijn's view should be considered visionary. He wondered how taxonomies fit with the distinction of Mr. Gordijn between short, medium, and long term considerations? Taxonomies should be articulated with each other. He also asked why those specific issues were addressed. He argued that the considerations of intellectual property are not nanotechnology-specific. He also argued that it was not proven that the trend in this matter should be reversed. Turning to the issue of resources, there are winners and losers among developing countries. Furthermore, this point is also an argument for investing in knowledge in developing countries.

Mr. Schummer emphasized that most so-called properties of nanotubes are computer-operated simulations. An expert added that the properties of nanoparticles are in fact very poorly known, and very little is known about nanotubes. Hardness, for example, cannot be measured at the nano level. Making clinical tests also seems difficult, and scanning probe microscopics induce many errors and depend on the interpretation of the findings. Physicists working for physicians do not always produce relevant results.

An expert stressed that governments do not in general have very logical approaches, and follow hypes when they exist. Some kind of visionary view is necessary in funding, and the logical approach does not always fit the political one. Researchers often have to do some science fiction when looking at the future. In the 1970s, scientists were discussing some of the developments that we are seeing now, and it looked very much like hype at the time. Cultural diversity should also be taken into account.

Presentation by Mr. Fudano: Controlling Nanotechnologies - Responsible Research and Development in the Nanoscale?

Mr. Jun Fudano presented an outline for a paper on *controlling nanotechnologies*. He first discussed what ethics can be, using two definitions: "science of conduct" and "design of conduct". Science and technology have always changed society. As the case of genetic technology in the 20th century showed, new technologies make new conducts possible. To define ethical issues, it is at least necessary to agree on what we are talking about, and this is why various definitions should be examined. No single definition, Mr. Fudano said, can satisfy everybody. Working by examples is a possibility. Making a map of the field is another. Clear distinctions are needed among new science and technology that takes advantage of nanoscales and molecular machines. Military nanotechnology should also be discussed, notably the threat to arms control, as well as the possible misuse.

Mr. Fudano then wondered why nanotechnologies are unique. Some characteristics of nanotechnologies are the lack of knowledge, the confrontation between the physical world we live in and the one of the infinitely small, of physical and life sciences, of science and engineering; and of various established disciplines, as the members of ethics committees sometimes demonstrate. A taxonomy and classification of already identified ethical issues should take place here, as there is growing confusion. Nano-medicine, nano-materials, and other fields should be discussed, so that readers can see what is to be expected both in the short and the medium term. Distinctions should be made between inevitable opponent, evitable proponent, and evitable opponent, as well as between nano-radicals, nano-realists and nano-sceptics.

Another issue to be discussed is whether the Precautionary Principle should be applied to nanotechnologies. The COMEST booklet would be an input. There is no doubt that nanotechnologies present vast areas of scientific uncertainties such as toxicity.

Turning to issues for international policy, international collaboration in constructive technology assessment is needed, given what Rip calls the "co-evolution of nanotechnology and society". In particular, each Member States should be encouraged to include technology assessment components in their nanotechnology programmes; a nanotechnology observatory to collect various recommendations should be created; and recommendations 20 and 21 of the report of the Royal Society on Nanotechnology should be given particular attention. Codes of conduct should also be promoted, together with the education of basic principles of ethics of science and technology for current and future workers in nanotechnology-related areas, in connection with recommendation 17 of the Royal Society report. UNESCO could develop a text book. The proposed ISO Social Responsibility Guidelines should address issues concerning emerging technologies including nanotechnology, and UNESCO could collaborate with ISO in this regard to incorporate a number of guidelines on nanotechnologies.

Discussion of Mr. Fudano's paper

One participant wondered about cultural differences in Japan. In Japan, Mr. Fudano replied, there is almost no literature on nanotechnology ethics. There may be 10 to 20 people working on this issue. The country nevertheless is investing a lot of money in nanotechnologies development, but not in related ethics.

One expert noticed that three of the proposed papers address the issue of definitions, each of them proposing unique elements, such as the idea of surveying international recommendations or the applicability of Precautionary Principle in Mr. Fudano's paper. Mr. ten Have agreed that, to the extent that the freedom of each author is conserved, bringing some order in the book may be a good idea. He also expressed doubts that three experts can reach agreement on a taxonomy in the framework of the book, and said that cross references should be made as the book is intended to be easy to read. A paper on definition of nanotechnology, it was said, would still be useful for readers. In the case of the drafting of the universal declaration on bioethics and human rights, the IBC drafting group did not at the beginning have a definition of bioethics. Then many people deemed that one was needed, but eventually governmental experts did not want it. Having all options in one single paper, the first questioner argued, would still be useful to Member States. The new definition of the Precautionary Principle, it was recalled, was well accepted, and the group should not be afraid of proposing definitions.

The idea of mapping ethical issues pertaining to nanotechnologies also received support, with the idea that justifying existing classifications and setting the literature in one way is valuable. The taxonomy of ethical dimensions is a separate issue. It was proposed that this idea should be rediscussed when all papers are finalized. Mr. ten Have recalled that the initial idea for the book is to bring together different backgrounds, perspectives and visions, with possible overlaps, a more coherent view being elaborated in the Policy Document. An overview of the international situation is a prerequisite to classifications of all sorts. It was also argued that the overlap between papers was quite limited so far, with four different approaches. The introduction will be the place where the variety is shown, emphasized and discussed. Mr. ten Have argued that the difference between Mr. Gordijn's and Mr. Singer's papers has to do with the differences between Europe and America. It was also said that discussing too broad a domain presents a risk of superficiality, and that Mr. Fudano's paper could accordingly deepen one of his parts such as the overview of existing literature.

A participant expressed the view that, with nanotechnologies, the move is more from science to engineering than the other way around. There is a traditional distinction between strong basic research and focus on applications, and different historical perspectives on nanotechnology in the US and in Japan. In the Japanese initiative, it was said, there was no clear vision of what nanotechnology is, but rather the idea that we just have to compete because others are doing it: nobody likes to lag behind. Mr. ten Have argued that this kind of issues should be reflected in the book, explaining how Japan for example can go into nanotechnology and not in nanoethics. That will be the situation in quite a number of countries. In the late 1960s, it was said, there was not much discussion about ethics of intellectual property. The complexity of the debate is due to the development of science and technology, and there is now some confusion between the various ethical issues pertaining to science and technology. From a public and historical point of view, ethical debate is new, and its results are still unknown. Furthermore, an expert added, ethics in the past has been reactive, whereas the consideration of nanotechnology ethics is prospective and forward-thinking.

Mr. ten Have said the order of the book was still to be discussed, and recalled that its purpose was to give information to the Member States, assuming that most of them need information about the ethical issues pertaining to nanotechnology. The level should not be too academic, for readers have to make policy based on this knowledge. A participant shared her experience that UNESCO events are opportunities for policy makers to enhance their knowledge of ethical issues.

Presentation by Mrs. Andrade: Nanotechnology and Ethics

Mrs. Margareth Spangler Andrade expressed her perplexity regarding the kind of paper requested in this working group. Among the comments and questions important to understand nanotechnology that she brought together, she considered three aspects as particularly important, namely the multidisciplinarity of the theme, the role of scientists in the development of nanotechnology, and the consequences of nanotechnology studies in developing countries. The overall objective, she stated, is to identify the proper questions to be asked.

Interdisciplinarity is a reason why we cannot define nanotechnology. This idea started with what is generally considered the first presentation on the subject by R. Feynman. His ideas, Mrs. Andrade said, were not new in themselves, but the way he put them was innovative. The idea of making things smaller and try to reach even the building blocks and change them had been in the mind of scientists for quite some time, as the example of microscopes show. The era of nanoscience was made possible by the linking of a number of technologies in a common way. Feynman's lecture gave a big impulse to science fiction and shaped the opinion on the issue, including scientists. It gave the false impression that multidisciplinarity is easy. But after the invention of the scanning probes microscopes (SPM) things changed. Those equipments are so important firstly because they offered the possibility to see the atoms and move them one by one, which led everybody to start believing in the possibility to engineer atomic structures. In 1986, the Nobel Prize was awarded for this invention. The development of atom force microscopes (AFM) induced different ways to see the images. In 1957, scientists were already trying to visualize the crystal surface of Silicium using electron diffraction. Some people think that we were not actually seeing atoms but only virtual images through those devices. The development of these technologies was considered with quite some scepticism in the scientific community. Yet, as more people started working with SPM, the battle was somehow won. While scientists still have to separate artefacts from reality, they don't doubt the validity of these images anymore. Some experience is needed for the interpretation of the outputs of those devices, but SPM are cheap and easy to operate. Every laboratory working with nanotechnology has one SPM. The AFM was particularly interesting because it definitely turned nanoscience into nanotechnology, as it is mechanically probing surfaces and actually manipulating atoms one by one. With optical microscopes, the surface must be prepared in order to see the macro structure. Many papers were published in the wave of SPM developments, some of them having nothing to do with nanotechnology itself. SPMs allow a very fine perception of the properties of surfaces, which is particularly useful in the mining industry, for example. Nanotechnology will have its breakthrough when interdisciplinarity actually works, Mrs. Andrade stated. Integration of the various disciplines proves to be an issue in many research projects, as the knowledge is very specialized. Working together is not so easy for scientists of different disciplines, and here again SPM has influenced the issue. It can deal with different matters in a relatively easy way, as samples can be visualized in vacuum or air, or even in liquid, which is most important for biology and chemistry. Hence, interdisciplinary cooperation is fostered to the extent that scientists of different disciplines have to collaborate in order to use the device.

Scientists are often concerned to understand the behaviour of things without paying much attention to ethical issues involved, Mrs. Andrade, continued. It is most important, she added, that scientists start thinking about their duties in their work. There is little ethics education for scientists – at least in Brazil. Yet when technology is intrinsically linked to science, ethics should be more present in the life of scientists. The interdisciplinary framework makes it more

difficult to pay attention to the subject as a whole. The ongoing normative assessment should be suitable for this matter. One of the difficulties is, that the definition of nanotechnologies and nano sciences is very vague.

In Latin America, Brazil is a leader in the development of nanotechnologies, as it has good developments already in microelectronics, health sciences, biology and chemistry. There were only 10 SPMs in Brazil in 1995, she said, and there are over eighty of those instruments operating in the country today, a number increasing quickly. The equipments are involved not only in scientific research but also in industrial developments. Congresses on SPM are now multidisciplinary in a very interesting way. Physicists work with biologists; they make presentations together. International participation in congresses was also very fruitful. Brazil has nowadays three virtual institutes, four national networks and a high number of researchers involved in nanotechnology. These groups involve researchers from different states of Brazil, working together closely. This is clearly a continuation of the Brazilian work on microelectronics. Those interdisciplinary networks are focused on solving Brazililan problems, e.g. emergent viruses, malaria, Chagas Disease.

There is still no evidence that nano knowledge will be applied in industry by those networks, despite an obvious international competition in the commercialisation of nanotechnology-related products. Interaction between academy and entrepreneurs is still lacking. Yet the Brazilian Government is trying very hard to give an impulse to entrepreneurs to work together with scientists, she said. There are also a number of contacts with developing countries, and clear rules are needed for the sharing of knowledge. However, she put the question, if rules for nanotechnology are not clear yet, can developing and other countries really take advantage from their inventions? Mrs. Andrade referred in this regard to the proceedings and CD-Roms resulting from the 3rd Latin-American Symposium on Scanning Probe Microscopy, which give an idea of the situation in this field in Latin America.

Discussion of Mrs. Andrade's paper

One participant emphasized the importance of visualization in the emergence of ethical concerns. In bioethics for example, some argue that the concern about the unborn life was shaped by the first images of the intra-uterine foetus. More generally, it is important to understand why the ethical concerns are emerging. In this regard, the easy access to microscopes is a key factor. Furthermore, the interest of private companies and the difficulty to bring ethics to scientists are highly relevant to the mandate of the working group. Another participant argued that science fiction considerations of nanotechnology go back before the development of SPM, tracing it back to Democritus. SPM, he added, started as a very small special area, and surface science was a multidisciplinary area, which learnt that it gets more prestige when associated to nanotechnology. Atoms are not actually seen, just the nano structure. With the ATM, manipulation indeed arouse, but manipulation capacity is close to zero. About interdisciplinarity, this same expert added, empirical investigations show that there is no specific rate of interdisciplinarity in nanotechnology despite the common discourse in this regard. He also mentioned the Brazilian tradition of joint ventures to explore national programmes. Another expert wondered whether the best strategy for countries like Brazil was not circulating their knowledge and expertise but rather protecting them.

Mrs. Spangler corrected one of the experts that SPM now goes down to the atomic level, and not only the surface study. Only AFM allows to study the shape of atoms. You cannot study the

shape of atoms unless you have an AFM. Quantum dots can be assesed by SPM. Another arising problem in Brazil, she said, is the lack of jobs for PhD students. This induces a circulation of the scholars, both within (e.g. Amazonia) and outside the country (e.g. United States). Brain drain, a participant said, is an international issue. Brazil or New Zealand have huge problems retaining the best graduates because the salaries in Europe and America are higher than in their own country.

It is still not clear, Mr. ten Have said, why there is such a gap in Brazil or Canada between production of knowledge and its applications. One expert underlined the importance of the culture of innovation in this regard. An inter sector link is needed between research and industry, made of small businesses and a patent office. An entrepreneurial culture in science, he added, is even more fundamental. Some rich countries are low in innovation (Middle East), some developing countries are rich in innovation (India, China). Brazil is a very interesting case study as it is rich in university research but low on implementation, just like Canada. Furthermore, small enterprises are actually drivers of job. The United Kingdom, it was said, has a very bad record of commercialising university research. This concerns research funding now, which is very much directed to outcome research, against “pure science”. In New Zealand universities have built innovation centres. If scientists are to be more entrepreneurial, a participant said, new values need to be introduced in science. It was pointed out that Brazil produces 10000 new doctors a year, all with public scholarships, while the local market cannot absorb these highly qualified persons. They are consequently forced to go away. India and China send students abroad and ask them to come back. Only 20% do. But for Brazil, only 20% stay abroad. This is an aspect of brain drain. One of the reasons why there is no market for new doctors is that the private sector has no culture of innovation because it had to fight inflation for years. Another problem is that multinationals are not interested in doing research in Brazil. They just want to use the market, not to export high-tech jobs. This is another aspect of equity issues. Sophisticated enterprises product sophisticated products but cannot access developed countries’ markets. The issue of tariffs and trade barriers such as technical regulations is of course of particular relevance.

Presentation by Mr. Evans: Ethical Issues for Health Applications of Nanotechnology

Mr. Donald Evans explained that he will focus his contribution on health applications of nanotechnologies. He will make a presentation in five steps, each including a particular methodology and the study of specific examples.

The first issue Mr. Evans discussed was whether novel technologies imply novel ethical issues. While there are innovations, he admitted, it is hard to identify any new ethical issues related to these technologies. What is obviously different is the manifestation and expression of ethical problems. The methodology to be used in this part is to compare development of reproductive technologies and nanotechnology and see what have been the issues there.

The second part will compare ethical issues with each other and discuss which ones should be emphasized. Privacy and confidentiality are major issues with nanotechnologies. Mr. Evans shared his experience of a presentation, which he said he had at first found paranoid. The idea was that it was possible to have tiny particles that GPS can locate, as is already the case with cell phones. It would then be possible to have a cybernetic mosquito biting a person to inject him or her with the nano tracers and make him or her easy to locate at any time. Whereas

these scenarios are thought of in an espionage context, epidemiologists are very concerned about the issues of following-up cases and have a significant problem locating subjects in their studies. Therefore potential applications of such nanotechnology would not be limited to security or espionage. These patients, yet, might not be happy to be followed, and new guidelines on epidemiologic research should be monitored. This prospect, Mr. Evans argued, is quite worrying. Nanotechnology emphasize this issue of privacy more than some other technologies, but human genetic data raise the same kind of problem, and there are guidelines on this matter.

The third part of the paper will deal with nanotechnology and public health. Positive effects should be maximized and negative ones minimized. Some recommendations about the development of regulations, as in the case of human genetic data, may be needed. A recent consultation paper from the Ministry of Health of the United Kingdom suggested better planning for a range of diseases based on monitoring of children's DNA. Such an initiative would have a huge ethical cost, as it would be irreversible and is in a sense stigmatisation. Nanotechnology could be associated with such plans that present a huge cost for individual freedom. While the attractivity to researchers and the interest for public health can be understood, debates are needed and do take place for example in New Zealand. Once such a sampling is done, consent cannot be reclaimed when patients become adults. The conclusion of this part would be a set of recommendations.

Nanotechnology and personal health is the topic of the fourth part, with the same methodology. There is a lot of similarity between DNA and nanotechnologies. Diagnostic procedures are one of the common points. As diagnosis will become easily available for a growing range of diseases, self-diagnosis may become possible. Results mailed without any support or explanation, for example, could have devastating effects on the individuals: How many of us would like to know their genetic chances for 10 major diseases? Genetic profiling would change behaviours and be a burden for populations. Many diagnosis seem to be aimed that way. The downside of early diagnosis is control.

Finally, nanotechnology in developing countries would be the subject of the fifth part. Welfare of indigenous populations raises a few issues such as the question of cultural sensitivity. For instance, indigenous people in New Zealand have views on the nature of humanness that are quite different from modern western views (which by the way changed rapidly). Genealogy is important in their idea of identity. Genetic technologies interfere in the connection with life force of other species, in their view. This issue may be serious. Another area is constituted by possible exotic applications offered by nanotechnologies. For example, there is no help for reproduction in some African countries. But some applications may have a more immediate attraction to developing countries, e.g. water or energy supply, than early diagnosis, all the more so for populations who cannot afford treatment of diseases that are diagnosed. As malaria is the major killer in some countries, clean water is of prime importance. On the whole, some ideas will be discussed about what is needed for developing countries.

Discussion of Mr. Evans's paper

Mr. ten Have said it was important to emphasize why issues are important for all countries. Some countries argue that nanotechnology only concerns some countries, like is also done sometimes in the area of ethics of outer space. In particular, developing countries do not always recognize the relevancy of technologies for their own country. One expert said

suspicions about western technologies can be understood. Another referred to the United Nations Millenium Programme, emphasizing the relevance of nanotechnologies to development. Mr. ten Have reminded the group that the focus of UNESCO was on ethics of science, which explains for example why business ethics is not addressed. But Millenium goals do concern UNESCO as well, it was argued. There is an ethical basis to innovation in the developing world. The idea of turning knowledge into a product has probably more to do with benefits than existing problems. But, Mr. ten Have responded, there is a pre-existing value structure founded on human dignity, human rights and the rule of law, at least in the perspective of UNESCO.

A participant expressed the view that some young people are not concerned about privacy. Discussion about the Carthagène project in Canada, which aims at mapping predispositions of the population, shows that the issue is much more complex than is usually thought. As the people gain knowledge, their fears are reduced. But susceptibility tests still have profound effects, on mothers for example. About novelty, one expert argued that in medical consultations each individual case is novel. It was added that the same argument was already used with genetics, that none of the issues raised were new. Issues, however, do not need to be absolutely new in order to be ethically relevant. One may then wonder what the point is of saying there are no new issues. Modern embryology, Mr. Evans answered, raised issues about the nature of human being. But these questions are already asked in Greek mythology, Mr. ten Have argued. The question of when human life does precisely begin is not, Mr. Evans said. Aristotle mentioned this issue, another participant said.

Presentation by Mrs. Jean: The Example of the Work of the Quebec Commission on Ethics in Science and Technology

Mrs. Michele Jean proposed to have a sort of case study in the book with the example of the work of the Quebec commission on Ethics of Science and Technology, which has recently created a subcommission on nanotechnology. The report of this subcommission will be completed in 2006 following public consultations and debate. The composition of the subcommission is diverse: its chairperson used to have a small business in nanotechnology; some people are member of the commission on ethics of science; some are simple citizens. The mandate of the subcommission is to understand the field, to provide guidelines, to take stock of what is going on in Quebec, and to assess the level of knowledge. The rationale behind the mandate is that there are different views on assessment of nanotechnology. Avoiding possible rejection of nanotechnology as a whole based on poor information is an objective. Scientists have so far provided members of the subcommission with a view of their field and a review of literature is being done by the secretariat. The framework for discussion is in three parts so far, addressing separately the IT sector, the pharmaceutical and medical field, and energy issues.

A first assessment of ethical issues related to environment, pharmaceutical and medical fields has been conducted: transhumanity, transforming human beings, autonomy, informed consent, detection of diseases when there is no cure, possible impact on employment and discrimination are the issues that were discussed. Concerning the energy sector, the long term effect of new type of batteries was also discussed. General questions are also to be asked such as who will conduct the assessment process of whether these technologies will be accessible to developing countries. The report to be produced next April will cover the three sectors mentioned, and some ethical recommendations may differ from one sector to the other.

Different opinions already appeared in early discussions. The subcommission is for example split on the Precautionary Principle and whether the legislation should be modified on issues including human health protection, equity or right to privacy. Basically, Mrs. Jean said, this example could be proposed to the working group and for the book. This could in particular be of some help when addressing the issues of the timing of ethical debate in regard to research and the ability to start discussions and conversations with the public, for example about the Carthagène project of mapping genetical predispositions of the population.

Discussion of Mrs. Jean's paper

Mr. ten Have opened the floor for discussion by agreeing that this example could be interesting, notably for Member States. One of the questions the subcommission is asking itself, she said, is whether too much is being included in the report. The same expert wondered about the relationships with the programmes in the other provinces. The commission, Mrs. Jean said, collaborates with France, Italy and the federal government. Some other collaboration may develop depending on funding, as members of the secretariat are attending international conferences. A lot of events, she added, are taking place, notably in the United States.

Replying to a question about the impact on policy making, Mrs. Jean emphasized the importance of having knowledge about ongoing issues as well as public debate. Citizen participation is important and usual in Quebec. The important cultural differences between Quebec and the rest of Canada were also discussed, and Mrs. Jean mentioned the difficulty of having French translations as one of the issues the commission is facing. Quebec, she added, is the only province with such a commission. An expert asked how the members of the commission and subcommission are chosen. Rules are, Mrs. Jean replied, that there are three members of the commission in the subcommission, the chair being chosen among them because he or she has particular expertise. Members can be scientists, ethicists, specialists in genetics or cancer. The trend is to have more and more ethicists. Everybody can suggest names and then the chair would decide together with the secretariat. There is no competition and open recruitment, but inspiration is taken from the way public consultations are conducted in other parts of the world.

About the plans for public engagement, Mrs. Jean referred to her long experience since the early 1980s. It is easy to talk about public involvement, she claimed, but very difficult to do it with the right people at the right time on the right topic. The experience of the commission in this regard will be useful when assessing the best process in different occasions. One section of the report is meant to be readable for the lay public. Youth commissions were invited to discuss the topic. Their teachers had prepared them. It remains to be decided which process will be used. There is a possibility, Mrs. Jean added, that the work of the subcommission is not completed in time to be fully reflected in the book. Public consultations, a participant said, are a very difficult business. Commissions, Mrs. Jean stressed, are expensive and their results do not always please the ministers. The process, she added, is as important as the outcome. The importance of transparency was also emphasized. Mr. ten Have concluded that this is an example of possible early assessment policy.

General discussion

Mr. ten Have explained the plans for the continuation of the work. A two-days meeting is planned on 6-7 December, where revised papers will be discussed. They will become the

chapters of the book. A letter with instructions concerning the bibliographical system and other editorial guidelines will be sent in the meantime, and the deadline for the revised papers will be 4 November. The final papers will be produced soon after the December meeting. The book will be the third book in the series on ethics of science and technology of UNESCO, after women and bioethics and environmental ethics. The book may or may not be published on the Internet, but it will anyway be translated into the 6 official languages of the Organization. The Division of Ethics of Science and Technology will also draft a Policy Document. It will be circulated and discussed in the 2nd meeting and then finalized and discussed in the COMEST meeting. The Policy Document is intended for COMEST to make an advice for UNESCO. It will address the issue of what UNESCO should do. Education, awareness raising, capacity building will be the areas of activities.

Mr. ten Have then proposed the following structure for the book. After an introduction drafted by the secretariat there would be three parts. The first one would be on characteristics of nanotechnology, the second one on ethics and the third one on policy. The papers of Mr. Fudano, being the most general, would be the first chapter. The paper of Mrs. Andrade could constitute the second chapter, bringing an insider view on nanoscience and the explanation about visualization. Third chapter would be the one drafted by Mr. He, who could not attend this first meeting. The examples of Mrs. Jean and the paper of Mrs Choi, going explicitely into education, could fit in the policy part. The other papers would be in the section on ethics: Mr. Gordijn, Mr. Schummer, Mr. Evans, and Mr. Singer, although there could be a discussion as to whether Mr. Singer's paper belongs more to part 2 or 3. Mr. Singer expressed his preference for part 3, on policy issues.

There was a discussion as to whether there should be a conclusion, agreeing that, in that case, it should not look like recommendations. The issue of a bibliography was also a sensitive one as the multilateral context of UNESCO requests equal geographical representation within the bibliography. There will be some literature on the website, but the same problem will apply. Questions are to be expected about the criteria for the selection, and such issues may monopolize the debate.

There was no objection from the participants to publishing the book on the Internet. There would be no copyright, as was the case e.g. for the publication on cloning. Accordingly, the text can be brought to any website. The number of copies, Mr. ten Have said, will depend on the demand. The cloning brochure for instance was very popular and had to be re-printed many times. As this will be the first publication of an international organization on nanotechnology, it may be popular.

Mr. ten Have finally thanked the experts. This is one of the first times that UNESCO is using an anticipatory approach to identify ethical issues in science and technology, and reflection on nanotechnology is needed before the international community can develop feasible policies, he concluded.