



NANODIALOGUE  
Final Conference  
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**NANOTECHNOLOGIES AND NANOSCIENCES:  
A DISCUSSION ON ETHICAL, LEGAL AND SOCIAL ASPECTS**

First Session: **Nanodialogue project: contents, activities, results**

Chair: Catherine Franche

I will be chairing the first session of this Nanodialogue final conference. It was a fascinating experience for all of the partners that were involved and the public that followed this. I think the interest you're showing here is all so representative of the interest in this subject by the general public and by different stakeholders on 90 sciences and 90 technologies. I won't be describing the project, it will be done in a few minutes. I will start by introducing Luigi Amodio who is the Director of the 'Fondazione Idis -Citta della Scienza' in Naples, in Italy and who was the coordinator of this project. Luigi has a degree in Sociology. He started working at Fondazione 15 years ago. He also teaches Science Communications in different universities in Italy. Luigi Amodio will be presenting you the content of the project, the theoretical and the methodological approach also in order to afterwards be leading to the different results and perspectives that were opened through this project.

Speaker: Luigi Amodio

At the opening of this final conference of the Nanodialogue Project, first of all I want to thank you all for being here today, and everyone that has helped with the success of this project through work, suggestions and enthusiasm. This project has been a great challenge to us at Fondazione IDIS, not only for its planning and coordination, and for the number of partners involved, but for the themes and the wide range of developed activities too.

I'd also like to offer my non formal thanks to the DG Research of the European Commission, and especially the Nanotechnology Unit, that not only invested with Nanodialogue Project, but also behaved like a partner rather than a "contractor" through the passionate support of its officers, above all Ms Angela Hullmann.

The same thanks go to the partners of the project (too many to list!): their participation in the different phases of the activity was always very motivated and rich of contents. Their precious support enriched the project and the elaboration of its scientific and communicational content well beyond the commitments of contract.

Also, I must thank Umberto Guidoni and his parliamentary assistant Marco Furfaro; who helped us to realize this final conference, offering us the use of this prestigious location.

At last, it's only right to mention my colleagues who worked on this project, realizing it and bringing it to its successful conclusion: Guglielmo Maglio, Anne-Marie Bruyas and Jennifer Palumbo.

Now, allow me to say that my introductory presentation for this meeting won't focus on the various activities carried out in the project and their results; there will be other specific presentations to explain these topics and, however, a lot of material and documents are available.

Rather, I'll try to point out (reminding you all that this project was developed in a well defined context: the communication of science in the community of museums and science centres) to point out which have been the most important elements of the project, from a theoretical point of view, elements that represent perhaps the most innovative part of the concept.

First of all, I'd like to mention the innovative role of science centres and museums in connection to the changes in contemporary science.

In brief, we define with the tag of "academic science", what we think of when we use terms like "pure science" or "science" in general, the characteristics of which appeared in Western Europe during the Scientific Revolution in the 17th century and its rules, formalized by Robert Merton, are well-known: communalism, universalism, disinterestedness and humility, originality and scepticism.

The emersion of the so called "post-academic" science – that started just after the second post-war period and became evident recently – depends on both external and internal reasons to science, that is a faster and faster scientific and technological progress and a growing interdependence between science and technology.

As John Ziman says, the characteristics of this new condition of science are: collectivisation, limits to the development of science, exploitation of knowledge, politicisation of science, industrialisation, bureaucratisation.

But in this context we are much more interested in the fact that the participation of the actors and stakeholders in scientific work, in the post academic dimension, is ever more diverse. We can say that the relations between science, politics, industry and the public become entirely intertwined with the "making" of science itself; all these relations are important for its very development.

If all this is true, as many people think, and if it's just as true that the diffusion of new technologies of communication guarantees a circulation of knowledge that was unthinkable until a little time ago, so that we can define "invisible colleges" many scientific communities that do research and develop projects, keeping in touch and exchanging information simply through the internet; it's also evident that the need for communication between "science" and the outside world requires new meeting places for knowledge and society, which are versatile enough and open to satisfying this need.

It is not a case if science centres and museums live, today, a season when they play this role of "meeting place". If, on one hand, science centres (and some museums, let me think to the Deutsches Museum or the Palais de la Decouverte) always, naturally were perceived like "agora" for the scientists and the public because of their tendency to introduce science as a "show"; on the other hand, many

museums did the same thing just because place where scientific research was carried on.

But I would like to add something more.

The nature of contemporary science and above all the passage of paradigm given by the coming of new life sciences, gave a new relevance to the theme of the impact of science on daily life and on society.

The perception of current science is more and more connected to its possibilities to reach the very roots of existence, through modern technologies, nanotechnologies and so on, opening in this way new social, political and philosophical questions and concerns.

In this framework, limits and insufficiency are evident either from a technocratic approach, so that experts are the only ones considered as legitimate authorities, or from an exclusively “bioethical” approach, which leads only to the moral values of the individuals.

Moreover – like we said in the motivations of Nanodialogue – the increasing pace of contemporary research more and more asks for greater harmony in the relationships between science and society, so that the “paradox of innovation”, elaborated by David Collingridge (when a technology penetrates society it’s already too late for society to influence its future developments) is reduced or outdated.

Professor Bucchi, who will speak later, believes that “it’s important to understand that the participation of laymen in techno-scientific processes and the participation of scientific experts in public debate are to a certain extent two faces of the same coin, they have mutual roots and increase each other”.

One feels, in other words, more and more the necessity of the construction of new forms of dialogue and of a relationship between science and citizens, that is more structured than has been previously.

All this, obviously, has evident consequences also on the practices of communication in scientific museums. If, in fact, it’s possible to say that in the epoch of academic science the museum representation of science happens fundamentally in big scientific and natural museums and also in science centres; in the post-academic science epoch, with a massive use of information and communication technologies we look, in these institutions, innovations in exhibitions and new practices in the use of museum setting.

A good example is the Dana Centre of the Science Museum in London, where the real object of interest is dialogue. Opened in 2003, a few years after the opening of the Wellcome Wing, that used a hands-on approach strongly founded on new technologies and cutting edge science topics, the Dana Centre bases its activities on meetings with experts on “hot” subjects of contemporary science.

It’s portrayed by an informal atmosphere and is strongly “extended” in space and time thanks to its web site – with which it’s possible to participate in forums and chats on different topics –; in other words, the Dana Centre takes again the strong English tradition of passing time at the pub but using science, technology and their frontiers as the subject, instead of football or weather conditions.

It’s indeed possible to say that, in this, as with other contexts, the visitor, appropriately stimulated, constructs and is an active participant in the activities that take place. If in the tradition of the interactive scientific museum the participation required of visitors is above all of a “physical” nature (for example activating an exhibit through easy controls) in the dialogic context of contemporary scientific museology we have activities of a relational nature, through language and symbolic exchange.

This case is typical of a lot of projects funded by the European Commission through the “Science and Society” programme, in the Sixth Framework Programme, or other Programmes, like in our case. The successful Action Plan “Science, Society and Citizens”, by the European Commission in 2001, has marked guidelines and theoretic reasons that have led to the decision of assigning a meaningful share of the R&D budget for these kinds of activities. This decision will continue in the FP7, where greater emphasis is put on the role of science as highlighted in the new title of the programme, “Science in Society”.

These research-action projects involve a lot of institutions that belong to Science Centres and science museums community and that use participative methods of discussion (often adapting them to the given conditions) looking at the museum setting as an ideal place to carry out these participative activities. This is not only for the greater “neutrality” of the setting or for its scientific prestige, but above all for the possibility of giving the participating public access to material, expositive, human and informative resources, useful for filling the gaps (often investigated through surveys and research) in their knowledge on subjects of frontier science and contemporary research, that the media are not always able to fill satisfactorily.

In this sense, these kind of activities seem oriented towards a deeper and slower communication by museums rather than a faster one; where a faster communication is often considered a goal to reach, in a sort of competition with the speed of the delivery of information by old and new media.

Furthermore, as George Gaskell, from the London School of Economics, remarked during the Science and Society Forum – held in Brussels in march 2005: “all the proposals carried out in the last 4 years within the framework of the Science and Society Action Plan, are now well established in Europe and America. The public’s interests are changing and, maybe, we shouldn’t speak of communication but of dialogue and engagement”.

In short, it is possible to affirm that there is more and more the trend of considering museums and science centers as agoras, as places for meeting and exchanging ideas. This exchange is possible in different ways: in formal or not formal ways; with reference to exhibitions or not related to them; etc.

Nanodialogue tried to be a sort of synthesis of these trends, as Andrea Bandelli and Simon Joss will show us just after me. In detail, their talks will focus on two different aspects: first, the activities of scientific communication carried out by using the Nanodialogue exhibition; second, the results of surveys and focus groups carried out with the visitors. The latter is also the starting point for the conclusions Wolfgang Heckl will present, as a list of recommendations, at the end of the second session.

It is clear, anyway, that the public’s interest in our project is largely due to its theme. Nanosciences and nanotechnologies are not well known, not only by our general public, and they give origin to very different feelings. But a lot of people today know, at least, that they are an important opportunity for business and that funds for research in this field will increase over the next few years.

The main idea in developing and studying new materials, from the steelworks of the XIX century to the advanced formulas of today, is to get the control of material structures at different scales, towards a micro degree. By improving the understanding of nanomaterials functionality and the control of their structure, we gain new opportunities for creating innovative materials with new properties, functions and applications. For this reason nanotechnologies appeal to investors.

All the same, with this increasing of investments, the concern about the future of nanotechnologies is rising for some researchers, NGOs and other stakeholders.

These uncertainties are related to the effects of nanomaterials on human health and the environment, or to the effects coming from the parallel use of nanotechnologies and other technologies (biotechnologies, information and communication technologies, artificial intelligence). Other worries are linked to the effectiveness of the control systems for monitoring and predicting the developments of research, and the possibility that nanotechnology applications could be either beneficial or detrimental to developing countries.

Some of the concerns linked to the social and ethical effects of nanotechnologies mentioned before are not exclusive to this field. But this aspect doesn't mean we have to underestimate them. Past experiences with controversial technologies teach us that it is important to react very quickly when social or ethical problems appear, no matter if they are directly or indirectly related to nanotechnologies.

There are some ethics and social issues related to the development of nanotechnology that need to be studied more in depth, especially the issue related to who is responsible for the control of the development process (like Plato said: "he who discovers an art isn't the best judge of good and evil of what could happen from the practice of it") and who could benefit from the dissemination of the applications in the short and middle term. This is the only opportunity to implement an interdisciplinary research involving pure scientists and social scientists. The costs of these researches could be less than the costs of research on those nanotechnologies whose applications could have big ethical and social impacts.

It would be wrong to believe that the evaluation and control of nanotechnology's impact, a very complex and technical issue, is only an affair for experts from the scientific community, industry sector and governments. In fact some of the ethical and social concerns caused by some applications (let's think about the consequence that a mix of nanotechnology and ICT could have on privacy and personal freedom) are more complex than the pure scientific or technical aspects.

The recommendations sent to the governments (I'm thinking for example of the report: "Scientific research: innovations with control" by the Better Regulation Task Force, with some recommendations to the English government with reference to nanotechnologies) advised the governments to assist the public, through debates, in contemplating the risk that nanotechnology could have to themselves.

Other recommendations concern the clarity of the decision process, involving citizens, opening new ways of communication and managing all kinds of risks and problems that could happen in the field of nanotechnology. These recommendations are the same as the European Commission ones in the document "Toward a European Strategy for Nanotechnology", elaborated in 2004.

The aim of this involvement could be expressed by the words of Lord Robert May, past President of the Royal Society, when in the 2001 anniversary speech, he said: "Society needs to do a better job of asking what kind of tomorrow we create with the possibilities that science offers. Such decisions are governed by values, beliefs, feelings; science has no special voice in such democratic debates about values. But science does serve a crucial function in painting the landscape of facts and uncertainties against which such social debates take place."

On these and other subjects we will hear in the second session and in the round-table discussion after lunch, different speeches from prominent people in the scientific sector, social research, philosophy and politics, and in particular I would like to thank Philippe Busquin for accepting our invitation to be here.

Those are, in short, the contents and the theoretical and methodological goals on which the structure of the project was based in these last two years and, at the same

time, the main contents of this conclusive conference. Finally, I think the most important and original aspect of this project was absolutely the synthesis between industrial and scientific research, science communication and social research.

In particular, I want to remember again the important role of the DG Research of the European Commission not only in anticipating themes and subjects (as previously mentioned) that often are neglected, but also in giving prominence to the role science centres and museums and generally the community of scientific communicators may have, in promoting a vision of development based not only in quantity but also in quality. And this is – I think – what “makes” and characterizes Europe, its story and its culture, not only for its past, but for its future as well.

**Speaker: Andrea Bandelli**

Good morning everybody, I will give you today a short overview on what Nanodialogue has been in its location and on the wide range of shapes that it took across Europe.

I will start with a mention of the special venues where Nanodialogue was portrayed which contributed to its success and I'll tell you some words about the visitor experience and something about the science centres. They have been the engine of Nanodialogue and this project challenged and showed that science centres are perfectly suited places to have these kind of dialogues with society.

There is certainly a European value and this one in particular shows that with the support of the European Union. Only with activity at a European level we can achieve these results. And finally I'll tell a few words about the international aspect of Nanodialogue which is known and has been discussed well outside of Europe.

Luigi Amodio already mentioned the partners but I'd like to also thank all the partners of the project because I think it's important to recognize the amazing work they did to set up this project.

Let's see the locations. These were the first initial locations of the project: Naples, Barcelona, Lisbon, Munich, Grenoble, Mechelen, Gothenburg and Tartu. The project was devised as an exhibition model which was also about 60 metres squared. There was a range of activities that were performed almost every day in the different locations, which is really remarkable, because of the success of this format. The project is actually going on beyond the initial expectation and initial plans, and so for the exhibition. Although indeed the initial plan was to display the exhibition from March to September, the exhibition is still on show in Portugal. It is at the moment in a theatre in Udine, the north of Italy. It's been in Genoa at the Science Festival, it's touring throughout this region around Grenoble and it's also remarkable because it really goes to the different communities also small places where people have the chance to see and participate to the events. In Germany it's currently in Tübingen and is going to Bonn. After being shown in Mechelen in Belgium, it's touring throughout the Netherlands. It's now in Kerkrade and is going to other locations. It's become part of the permanent exhibitions of the Universeum in Gothenburg and in Estonia. It's toured through different locations through Tallin and Tartu and as well we'll see it's maybe been one of the most innovative ways to display the exhibition it's not been really to science centres but to shopping malls and places where people go, maybe for other reasons but it was really very much in touch with the community.

In terms of the special events, I'd like to remember with thanks to the proactive role of the partners, Nanodialogue has been featured at the ESO in Munich where it was seen by thousands of people. It's been portrayed, displayed and promoted

throughout the science week in Portugal; it's been part of the Science Festival in Genoa, an event which attracts 60,000 people in ten days. Also it's been the venue of "The night of the researcher", which is an initiative that takes place every year where young researchers meet the citizens and the interested people at night. In that night the setting of the exhibition - a table where people can talk to each other - was the perfect venue for such activities.

A good example of what the exhibition has been in visitor experience is visible from this picture from Portugal, where really people talked to each other discussing and raising questions about Nanotechnology. The round table with enough space to walk and sit around was really optimal to facilitate conversations. Sometimes young people were sitting around the table to take part in the focus groups or play the decider game in school project developed by Nanodialogue.

It's really nice to see the exhibition went beyond its body; It didn't happen only in the exhibition model itself, it took place in the most suitable places.

Groups of young and senior citizens, in Sweden as in Portugal, discussed about technology and played the decide game.

So, just to give a summary of the range of activities beyond the exhibition, there were countless seminars that were organised usually with the participation of well known scientists who talked about Nanotechnology and there were public talks in different venues, not only science centres but in theatres, schools of course.

Every location had every week or twice a week either Phd students or young researchers from university and industry to come to the exhibition to demonstrate some of the projects, some of the research results of Nanotechnology and this was extremely interesting not only for the public but also for the university and industry, who had the possibility to really display and get feedback on what they are doing. There were, of course, guided tours of the exhibition and theatre performances which succeeded all over Europe and outside of Europe as well. The very quick performance took place in a café in a pub in the evening and a few experts, knowledgeable people speak about the topic. Then there's a discussion and debates with the participants of focus groups that were organised in the framework of Nanodialogue. The total number of people who came in contact with the exhibition programmes across Europe is about a million, hundred, thousand people and this I think is a remarkable success for this project.

One thing I'm really happy about is the synergy of this project with other European projects and I'd like to mention four of them which are particularly significant.

One is the Pencil Project which is a major initiative on education, science education in Europe. Nanodialogue was the opportunity to develop curriculum activity for schools- primary, junior and high schools on the topic of Nanotechnology; also to develop formats to engage students in different forms of debate and participation according to the age groups. It was really remarkable indeed how the results of Nanodialogue fit into the Pencil Project.

The other project was Nanologue which was a project to develop and design future scenarios at Nanotechnology. A major event was held in Munich in October and the coordination between the two projects was remarkable because also Nanodialogue provided also the setting and the venue for some of the discussions of Nanologue.

Cipast is an European project to develop tools for citizen participation and Nanodialogue was also a perfect venue for discussions which aren't maybe academic in structure but provide very valuable results, although debates are organized in the form of games around the different topics.

To give you an idea what I mean by synergy I can just talk about the Decide. The Decide has six different topics on contemporary sciences. The amount of events held for the five topics were around 350. The ones on Nanotechnology which is one of the six is 1100, which means by the collaboration of the two projects there is an incredible boost to both projects. Nanodialogue and the partners could profit from an ever existing tool which was well tested and could even spread it across Europe and Decide project had indeed a major boost in terms of participation of number of people who come in touch with that.

The press coverage of the events covered all the eight countries of the exhibition. There was a wide variety of articles and announcements of the exhibitions to the school project; it was really interesting to see also that Nanodialogue was displayed in tourist guides, leaflets, brochures and publications for the tourists. There was a special issue of the Ecsite newsletter which is sent to all the museums, science centres in Europe and abroad. There was a special feature on “Nature” and one of our partners, Elizabeth Schepers wrote a piece for it. And if you just ‘Google’ on Nanodialogue you’ll find more than 11,000 results.

I think this shows that science centres were not only the receivers of this exhibition but really the catalyst that made it possible to launch their own initiatives of Nanotechnology. This is the case for example of the CCSDI in Grenoble which is having now their own exhibition of Nanotechnology which was inspired by some extent by Nanodialogue, because Nanodialogue gave the possibilities to test some of the activities to connect with the industry and the research institution. In Estonia, for example, for the first time the industry was really reaching out to the organisers of Nanodialogue because it was the only possibility to be in touch and connect with a local community where they are based but they don’t have contact with.

Funnily it was a very important process internally for the museums because it challenged the authority of the museums. There was an exhibition and a programme where people were raising questions and where the knowledge didn’t come only from the museum but also coming from the participants of this exhibition. There were also internal discussions in some of the institutions with what the role of the museum is, and most importantly to which extent the museum has to listen to what the public says and thinks and I guess Nanodialogue was one of the most successful examples of this listening process undertaken by museums.

As I said the European value, it is really true that this could have been only a European project in the sense that it’s a high risk and high return project at the beginning. Many of the things that you’ve seen now were unknown, we didn’t know if the exhibition was going to travel, we didn’t know how successful these events and programmes would be, we didn’t know to which extent the science centres and the organisers were ready to develop their own programmes and activities and build on the existing. But certainly it was a success and it shows that there is a need for this kind of seed money to start activities and, as I mentioned, several of the partners have built on Nanodialogue and continuing to organise their own activities based on the experience they gained during this project.

Finally in terms of international value you maybe aware of the Nise network, which is the biggest project at the moment in the United States about the public communication of Nanotechnology. It is a project funded by the National Science Foundation for \$20.000.000. As in Nanodialogue, but not with the same budgets, the partners are Science Centres and Science Museums. At the last annual conference in November there was a special session on Nanodialogue because of the example that Nanodialogue is of combining together exhibitions providing information and programmes where people talk and discuss. This indeed was quite remarkable that

they were looking at this project as an example. The other one was the Science and Society Conference in Boston last January. This was the first such conference in the United States and curiously enough it was one of our colleagues in the Science Museum in London, not one of our partners, who talked about Nanodialogue as an example of value in the science and society dialogue. I think it's pretty remarkable when our colleagues who are sometimes our competitors talk about a project that is not theirs and it was really very nice to see that.

And finally there is the South African Agency for Science Centre Technology Advancement, a branch of Minister of Science and Technology for Science Communication, which is launching this year a major project of Nanotechnology and is again interested in Nanodialogue the programmes and the exhibition content for South Africa and the African continent.

**Chair: Catherine Franche**

Thank you very much, I think you've made your point quite strongly. This project was built physically around an exhibition but the life of it was the people and the reaction it created and the new events and new types of dialogues and discussions that happen between the public, stake holders and Science Centres.

I will now introduce Simon Joss, who is the Director of the Centre for Study of Democracy at the University of Westminster in London, UK. He has a PhD from Imperial College that was on the Science and Technology Public Policy and he currently works in the CSD which is the Centre Study of Democracy, a public accountability project. He has many publications in the purchasable government's issues dealing with public spheres and science communication. Simon Joss was involved in this project through the citizen's feedback assessment because many activities were a very structured feedback from the citizens.

**Speaker: Simon Joss**

Thanks you Catherine and good morning to you all. So, I'm now going to talk about the summary of the results in the third strand of this project. The first strand being the exhibition itself, the second strand being the various lectures and public events that took place in the exhibition spaces and the third one was a small piece of social scientific research, using mainly the visitors to the Nanodialogue exhibition.

The aim of the social scientific research was to collect and analyse the citizens' perceptions, self reported knowledge and expectations concerning Nanosciences and Nanotechnology and using this analysis to hopefully come up with a few recommendations regarding the present and future research and development of N&N in the European Research Agenda, related policy-making and its ethical assessment.

Our methodology comprised of two main components, the first one being a questionnaire which we distributed randomly to a total of 800 visitors, that was the target, a hundred visitors to each of the eight centres and, as I said, this was done on a random basis to achieve a good representation of the visitors to those eight centres and the questionnaire itself included three parts. The first part was to obtain information about their socio demographic profile, the second part was trying to find out what the visitors perceptions and expectations were about Nanoscience and technology and the third one was to ascertain their assessment of the potential benefits and risks.

The second part of our research included focus groups. We basically invited a small sub group of those who completed the questionnaires to join us in small group discussions at the end of their visit of the exhibition in order to dig a little bit deeper and in order to find out what their more detailed reasoning and detailed responses they gave to the questionnaire. So these focus groups tended to involve a small group of 8 to 10 people who spent about 20 minutes discussing their experience of Nanosciences but also their experience of attending the exhibition with a moderator.

I mentioned that our target was to have about 800 questionnaires to be analysed, we achieved 706 and we managed to get 16 focus groups in these 8 locations: Belgium, Estonia, France, Germany, Italy, Portugal, Spain, Sweden.

We managed to get equal number of male and female respondents. The majority of the respondents were from young people under the age of 24 (45%) and therefore and not surprisingly the majority of respondents were still in the education process, 48% studying or at college or at university. Finally a large proportion of the respondents (40%) came from large cities or towns which seem to suggest a bias to young people but also a bias towards people living in urban areas and we need to bear that in mind when analysing and interpreting the results but I suppose it's also a reflection on the site of these exhibitions which tend to be in large cities and urban areas.

About the perceptions and expectations - that part of the questionnaire was carried out before people went through the exhibition - a majority of respondents reported a low level of understanding. It's important to state that this is self reported knowledge and some 55% said that they had a very low understanding or fairly low understanding with only 14% comfortably reporting that they knew a lot or a fair amount about Nanosciences or Nanotechnology and interestingly a relatively large proportion would not be sure about their level of understanding and knowledge.

We then asked them about if they have heard of Nanoscience and Nanotechnology, what kind of sources they have heard about them and the majority of respondents have heard about Nanotechnology through either television or magazines or newspapers. Interestingly the internet only accounted for about 10% of people reporting having heard about Nanoscience or Nanotechnology. Then asked them about their expectations: some 60% reported very positive or fairly positive effect of Nanotechnology and Nanoscience and this question was an interesting one because we plagiarised it from the Euro barometer carried out in 2002 and 2005 and, while this sample here came up with a 60% report in very or fairly positive expectations in the Euro barometer, in 2002 it was 30% which then went up to 48% in 2005. Another survey which was carried out in 2004 on behalf of the royal society in Britain reported a 68% of respondents stating they expected a very positive or fairly positive effect. Again, is interesting that there is a relative large segment of respondents stating that they don't know what the effects are going to be. We then asked them about whether or not they wish to see a moratorium on either research or commercialisation on Nanoscience or Nanotechnology and some 47% favoured a moratorium, whereas 28% were against such a moratorium.

We then asked them about what if any form of public participation in decision-making they would expect in, some 62% answered that public should be involved in decisions about the research and development, some 59 % in decisions about the regulation and some 60 % in decisions about the commercialisation.

People said Nanotechnology and Nanoscience are more likely to lead to: greater personal security and safety, rather than concerns about privacy and civil liberties; new threats which are harder to detect and counter, rather than increased national and defence capabilities; new and better ways to treat and detect human diseases,

rather than the uncontrollable spread of mechanical, self-replicating 'nano-bots'; enhanced human physical and intellectual capacities, rather than stigmatisation of those without enhanced capacities; improved quality of life, rather than changes to what it means to be human; displaced employment from one sector to another, rather than a stronger economy and more jobs; new and better ways to clean up the environment, rather than interfering with the building blocks of nature; the development of new, cheaper materials and devices, rather than the creation of a 'nano-divide' between rich and poor countries; regulatory controls which stifle innovation and restrict development, rather than regulatory controls which expose human health and the environment to unnecessary risks.

In focus groups the keys more interesting for participants were science fiction, research and development, regulation and control, current or future uses and applications, human health and the environment, economic aspects, information and understanding, ethical, legal and social aspects.

About science fiction, Drexler's vision of self-replicating nano-robots was perceived positively if used as servants for, and controlled by, humans and nano-robots were viewed negatively by others because of the potential to become uncontrollable and infiltrate the human body.

Generally agreed that research and development should proceed with precaution rather than being curtailed by a moratorium. There was suspicion of research and development being 'controlled' by private interests rather than for the public good, and that private research would lead to the development of N&N for military purposes.

About regulation and control prevailing view was that of seeking ways to balance scientific freedom with risk-averse regulatory parameters. Participants recommended an international body to oversee regulation across national borders and control by a not-for-profit body that is informed by an ethics committee to ensure accountability to the public.

Participants had overwhelmingly positive perceptions of current or future uses and applications and they said that Nano-materials will better our way of life improving detection and treatment of serious illnesses and assuring more effective drug delivery, more successful organ transplants, better prosthetics. Some participants supported a moratorium on the use of nano-materials for human enhancement or for military purposes.

A large proportion of participants believe in potentially beneficial of Nanotechnologies to enhance health and longevity and to improve the environment with cleaner and more efficient technologies. However long-term effects of nano-particles are unknown, so more research needed on risks to human health and on altering the building blocks of nature (comparison to GM).

It's generally agreed that more information on N&N should be made available to the wider public; the media and the school curriculum were singled out as ideal vehicles for information dissemination and there is lack of opportunities to engage in dialogue with scientists, technologists, policy-makers and stakeholders at local, national, European and international levels.

About ethical, legal and social aspects, future use of 'nano-chips' to monitor criminals, terrorists and children was seen as both a good thing and a negative prospect of the technology and the majority were in favour of promoting a precautionary approach through regulation and labelling of N&N products.

In conclusion analysing and interpreting the questionnaires, it results that objectivity and level of information of the exhibition was appropriate, although participants with some knowledge were not satisfied with the depth of information.

Exhibition left too many questions unanswered, revealing more uncertainties than definitive information. Policy-makers and politicians would take into account the opinions of citizens but it was considered to be illusory by some; others hopeful that the citizens' feedback would encourage the creation of a European ethics committee on Nanotechnologies.

## Second Session: Nanotechnologies and their implications in Society

### Chair: Umberto Guidoni

I would like to give the floor to Bengt Kasemo, professor of physics at Göteborg University. Please.

### Speaker: Bengt Kasemo

I have the real pleasure to chair a committee in Norway to develop **a national strategy** for nanoscience and nanotechnology. In every area of science, mathematics, physics, medical sciences and engineering, topics come into play, and this also means that as enabling technology this is something that will effect every field, as we saw in information technology in the new chips it is already there, for a long time, in biotechnology biosensors there are really not nanosensors, gene chip is not a nanotechnology device it is a micro-technology device but it is moving into nanotechnology, so it is an enabling technology, which attaches matters from everywhere in science and will impact all areas of engineering and technology, the timescale is up to thirty years from one to thirty years.

So let me go into some very specific examples. Imagine that you go to the doctor twenty years from now, what will happen, what might it look like, you will face gene chips as you do today protein chips, cell chips, even artificial or externally made tissue chips that can act as detectors for your health status and that sounds wonderful, you will get something like ten to a hundred answers, from the size of a stamp if you imagine an intel chip, if every transistor was a sensor there would be something like ten hundred million answers from that chip. But how do you face the situation to getting so many answers about your health status and how does a doctor handle it? And if they handle it, there is something that has an ethical aspect in high capacity diagnosis **medical implants**. The next generation of medical implants, as outlined, in the strategic research addenda for medicine from an mp3 will have all kinds of nanostructures to enable the implants to heal him better faster, to make functions which you cannot see today. This also leads us into tissue stem cell engineering, I'm just going to show a couple of pictures from my own group, the only ones, so the basic idea, is that single stem cells might be grafted on a surface, to influence their differentiation pathway. If that happens, we might be able to steer stem cells into desired directions, this proves the concept that you can steer stem cells by nanostructures, the question is what is the ethical aspect of this, should you say this is the business of stem cell research, but naturally nanotechnology gets into the ethical business by association with the stem cell research, that's the point I wanted to make with this example.

**Nanodrugs:** this a second priority area in nanomedicine, worked out by Renzo Tomellini, Uta Faren, their colleagues. This is a slide I got from Kataoka, the basic idea here is to make a nanodrug which is so stabilised, that it doesn't open up its content anywhere, except in the diseased area. It's a tremendous challenge to do

that. It might be too stable and never release, to little stable and release too early. But if you can make this and there is intensive research now, you will be able to have much more targeted drug release, much better efficiency, and less negative effects. So these are a number of nanodrugs and the challenge here is what Doc Arctic has said there was some evidence for nanotubes, entering, crossing the brain blood barrier, this is the kind of problems one faces with nanodrugs, so the battle is there, the challenge is to understand that negative effects of all the drug capsules all the drug carriers here, and to evaluate that before you apply this, so we need to learn how to test these materials. **Environmental technology**, it's a favourite topic, I've been working for many years in this area. And as you all know, this has been a fantastic success story, cleaning out first Los Angeles, smog, worldwide, orders of magnitude cleaner exhaust from cars today and so improvements are going on from upper left we see to the right to the right upper the small small particles that do the job in a catalytic converter, they are in the range, one or a few synomy<sup>1</sup> drop, some ten synomy. One question here, which is not asked too often, is where do these particles go, what kind of environmental effects and what health effects do they have. Accumulated experience does not point to any serious effects, but these catalysts continuously change, so it's worth some recognition.

**Energy technology**: this is a fantastically interesting area. After the climate paper, the climate report, and alarming reports of peak oil and actually there is not a peak oil, it's a very slowly sloping decline, so we have coal and we have oil for many many years. And we need to keep a track of the CO<sub>2</sub> effect and the climate effect and so on, in the meantime, making an inventory of the potential of nanotechnology for energy, you get a very long list. This is a picture I got from a former astronaut, Richard Truly, it shows the energy consumption per capita versus the GDP per capita and vice versa, enormous linear correlation, it is a very scary picture, because if all the red dots down there, were China and India, were up in the right corner, where we are, since this is a logarithmic clock, we would have to increase the supply of energy to the world by a factor of five, which obviously is not possible, and I think this what made Richard Truly change his job from being an astronaut, to be a director of the US National Renewable Energy Laboratory in Colorado.

This shows the number of publications per year in the nanotechnology area related to energy so this is really an exploding field and why is that so? It is because we can use nanotechnology for solar technology, harvesting, for hydrogen production, for hydrogen storage, for solar cells, for solar thermal, for fuel cells, and so on. It's even a very promising technology to convert coal to gas to hydrogen and so on and fixating the CO<sub>2</sub> on the way, enormous potential for nanotechnology for energy, and I guess this is one of the reasons why Norway put this on high priority. So these are three examples, so to the left artificial photosynthesis, which requires some biomolecules, or maybe some inorganic molecules, to do the job. The middle one is hydrogen production, by so-called Honda cell, Gretzel cell, and the rightmost is the supergretzel cell for electricity production but many many of these concepts that one works upon today are built upon nanoparticles, and these nanoparticles sometimes will go into the wastebasket and are going to produce in factories, we need to pay attention to the whole process there.

So on what timescale will nanotechnology impact society? As I said in the beginning, it follows the nanotechnology curve, an impact curve of any technology, how do you start with Einstein's  $E=mc^2$  or the transistor 47 or the laser 58 and so

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<sup>1</sup> Word not recognised

on, it's about thirty years before it has penetrated whole society and that's what nanotechnology has to face, assume we have already passed ten years, before we have something which is really penetrating society. So I think we have some raw material which may already be nanoparticles, we have to **pay attention to the safety** there. These products will be made and processed in some kind of work environment, they will be transported, there will be sales demonstrations, they will be used by the customers whether it is industry or private use, and there will be a waste and a waste management challenge. This is for something which is very small you can't see it, so actually one of the big challenges is that there are actually no methods for field use that can test nanoparticles in an affordable way, you need big electro-microscopes which cost some thirty three million Euro or so, or a scanning probe microscope which costs a least a few hundred thousand Euros, so the very smallness of nanoparticles is a problem and that is also a problem which is pointed out very frequently on surveillance. If you have sensors that you cannot see in an optical microscope, it might cause some concerns, traceability is a challenge generally, work environment, the waste as I said and the environment it is both the ecosystem and other system, I just put it, just to broaden the thinking, clouds are very much formed of nanoparticles, they are for condensation nanoparticles, that would be new type of nanoparticles in cloud formation, as you may know one of the big trickiest challenges for simulations of weather and climate. So what does it say at the bottom? The consequences for the insurance system, the insurance companies are very worried, how are they going to handle the nanotechnology systems. There are all the general ethical aspects associated with the complex high tech area, so that's business as usual, but the smallness is a specific problem, as I mentioned, traceability, fabrication of good model systems, lack of analytical tools and so on. That is a real problem in the nanotechnology area. There are definitely ethical aspects related to non-labelling, I criticise myself and some of my friends with the next loss, I notice sitting in review panels for research proposals, and almost everyone tries to find a nanocomponent in their research proposals, even if there not the slightest nano there. And I think that is actually an ethical aspect, I also came to think to stick my neck out a little, to my friends, in a friendly way, in social science, and how ethical is it to scare people with nanotechnology, I think it's a balance act.

**Chair: Umberto Guidoni**

Well Professor Kasemo gave his prospective from a scientific point of view. I don't know if we have all the elements to answer the original question. Is it a revolution or an evolution? And more important, what would be the effect on society, I think the next speaker will try to address this question, Professor Nordmann, Professor of Philosophy and History of Science, at Darmstadt Technical University in Germany, he is dealing with the contemporary debates about models and simulations in science, he also studies the formation of new scientific disciplines and their implicit conceptions and objective knowledge. In 2000 his attention turned to nanotechnology, as a symptom of larger changes in the culture of science and in relation of science and society. You have the floor.

**Speaker: Alfred Nordmann**

Thank you very much. Earlier in the discussion someone raised the question about success, what is the criteria for success, in a exhibition like the Nanodialogue initiative and of course one criterion would be to say that we are reaching out to a lot

of people, informing them about nanotechnology in society. Another criterion of success clearly would be to say that we are finding something out about what people think, finding out about sentiments and positive and negative attitudes. But another criterion of success might be what are we actually learning about what the ethical and societal aspects are. Are we actually finding out about those and how can we gain a deepened understanding of those and this is the question I want to turn to right now. So I want to ask about the methodologies like the **Nanodialogue methodology** and see what we can actually learn about the ethical and societal dimensions. And so deepening understanding of ethical issues of emerging technologies was actually somehow the label under which all of this took place and there are obviously different things you can mean by that, what do you mean about deepening understanding? Well one thing you could mean is that you initial only have superficial issues and then we deepen them by finding out more by sustained reflection and that's often done by philosophers for example. The other way of interpreting this, deepening understanding, is somehow encouraging people to participate in the dialogue, they might still have rather superficial concepts to work with, but at least there are more of them and they can all bring in most of their experiences and in some ways this is an important outreach activity. So these are different models that we might think of. The first of these models might give us something of a scientific advance of knowledge and understanding. On the other hand we have many individuals who achieve and form opinions. There might be a third way to go beyond these two possibilities and I want to talk about that. The third way would be to say let's try actually recruit the expertise and perspectives of various publics and thereby really achieve the goals of both involving many people in the debate and actually advancing and deepening our understanding. In this case for example we would say that it no longer the business of philosophers, or social scientists for that matter, to articulate the issues. Others have to come in and bring in their expertise, and secondly we would say it is only a beginning, a valuable and important beginning, what was done in the Nanodialogue initiative, namely to inform and get feedback, but we need to go beyond that and actually engage and draw on specific expertise and not just help that and not just summarise that in questionnaires for example and statistic but actually help that feed that into the debate. So I thought, maybe to characterise, and this is perhaps appropriate at the final conference of the Nanodialogue initiative, is to say that it has moved from a and b, the first two options, to this third integrative way, and now I think there are two projects that I want to quickly tell you about, which actually want to go on from here and do some wondrous engagement. And then finally I will give you just two examples, how this is actually beginning to pay off, of how we might actually be getting a deeper understanding.

Ok, the first example I want to show you and here I'm borrowing slides from Peter Von Rookheuser, who is sitting there and is the coordinator of the project, is **NanoCap**, a European project helping non-government organisations formulate positions about occupational environmental and health and safety risks in regard to nanotechnology and ethical aspects of nanotechnology. At the same time, these organisations, environmental organisations especially, and trade unions on the other hand, have a lot of experience and expertise, not so much about nanotechnology but about lots of other things which are deeply relevant to the issues here. And the program is to engage this expertise and experience into a dialogue with the philosophical reflections, and the societal reflections. There are fifteen partners involved, sixteen with the coordinator, and it consists of a mutual learning

environment for environmental groups, trade unions and universities, and the universities again, divide up between those who provide input on occupational health, on ethical and societal issues or on the basic science. So this is an attempt to mobilise the specific experience of all the various actors and make it fruitful for deepened understanding.

The second initiative I want to tell you about is part of the same program, it's called **Deepen**, it's a much smaller consortium, it's only four partners from Portugal, Netherlands, the coordinator is Phil McNaughton at Durham in the UK, and then there is also Darmstadt involved, my university. And here we have a slightly different set-up, again you have a really integrative engagement. And on the one hand they are social science, and social studies of technologies, and actually it is a way of finding out how values play into the scientific research agenda. When do you talk to scientists, when do you appeal to ethics and why, and how do values actually play a role in the way they articulate research programs or present things to the public and organise their research and so forth. What is the role of values in the practice of science and research? The other question is what does the lay public actually think? This very much picks up on the Nanodialogue project and it's an attempt to unravel lay ethics. I mean what are values of concern? And again we are not just trying to find those out in this project and then just document them, we actually want to bring some questions back to the public after we have learned from them and after we have learnt from each other, and sharpen the questions and get a more detailed answer, and the the third pillar of this are the normative aspects which have been brought in by philosophy. So we are trying to create a dialogue here. And so why do we do this? Again here the project of deepening understanding is very explicit, that there are some limitations on the way we approach these things because we often rely upon limited conceptions of integrity, privacy, protection from physical harm, and avoidance of risk and so forth. And those of course are the things which come to mind first and they are extremely important, but when we talk about nanotechnology specifically, we might look also deeper at the in-built meta physics, let's say of nanotechnology research programmes, the way nature becomes technologised further, or other hard technology appears as something almost natural. Then at the same time we might look at the rhetoric of nanotechnology and the hubris in it, the questions of intellectual honesty, as were raised here, what does it mean to label everything as nano and so forth. So the limitations of **standard frameworks**, how can we get beyond them? And why do we need to get beyond them? Let me just give you a quick example, this is the first approach and this is how it works and when we are doing ethics of emerging technologies all we can do normally is take a very limited list of received categories and just see how it applies to the special case, so we run through the list, especially having to do with health, safety, privacy, these are the things which come back all the time, and we now try to see how does this work with nanomedicine, how does this work with nano and so forth? And then we add a footnote at the end and we say that we are aware that there are more real more specific issues and they will have to observe over time and that we will have to keep observing them and this is how it is normally done and this is normally all we can do, but the questions can be moved beyond this, without just waiting for things to happen. And I'll give you two examples of how these things might be playing out in these kinds of methodologies that pick up and continue the nano dialogues, one is actually from nano dialogue, I went to one of those meetings at the museum in Munich and I found it very interesting that when participants were asked to identify questions of concern, they raised the question will nanotechnology serve to reduce or increase conflict? Now interestingly this is not a question which appears on our

list of ethical issues. I could talk about military applications, we can talk about dual use and so forth, but those again are very very limited ways of looking at it. I think there is something much deeper to ask more seriously about. What does it mean for technology to make society more stable? To create conflict or to reduce it? So it might be expressing some fears about what does it mean to move to such small technologies? Does this maybe have a destabilising effect? How can we compensate for that? Of course it is also a question of who benefits, who pays, and the nano divide and so forth? There is also here, interesting unintended consequence, which I think is very powerful and positive, so why do people raise this question, I think it is partly because they were invited to the discussion in the first place, if people come to the exhibit or any kind of focus group on nanotechnology rather innocently not knowing a lot about nanotechnology but they are confronted with people who are deeply concerned with ethical questions and are deeply concerned that society know about the ethical and societal dimensions. And so people are going to ask very sensibly well, why all this interest, is there perhaps some conflict ahead, is there perhaps something to worry about? So in some ways of course these kinds of initiative also produce an endless array of possible conflict and possible issues that wasn't there before but at the same time I think this might be an interesting dynamic in helping nanotechnology become sustainable, the second example and last example. So we've been talking about nanoparticles, this is an example taken from our NanoCap discussions, if you are talking about nano particles, when you take the normal approach and you come from it from the approach of ethical and societal implications of nanotechnology or from toxicology, you are always oriented towards this new kind of development called nanotechnology, you are oriented towards the future and the novelty of it all, say you are looking of course at not naturally occurring nano particles, but you are looking at engineered nano particles but in this discussion which we had and remember there are lots of trade unions, environmental groups present, occupational health experts said, nanoparticles are probably the cause of many known respiratorial diseases at the work place, so if you look at welder's fumes and the kind of problems which they cause, it's probably due to nanoparticles, non-engineered nano particles, but accidental by-products that are in these fumes, well this is of course now challenges us and we ask ourselves are we now going to close the door, and say well we are only interested in engineered nano particles? Or we actually finding here through this kind of input the question is being widened and we get a very interesting unanticipated benefit, here the unanticipated benefit of the nanohype is the drive for industrial innovation and the keen interest in the toxicology of engineering nanoparticles might actually help us solve some problems that are much older and have much more to do with old industrial routines. Ok, now these two examples just very first traces of these very young projects attempts to deepen understanding of ethical issues. I often argue that we think we have to mobilise social imagination for the benefits and the problem solving potential of nanotechnologies, you have to look at it in a more imaginative way and what you can do with these technologies. At the same time we also need to mobilise social imagination for the social dynamics, in which nanotechnologies are developed, diffuse the procreated, the kind of problems they might cause, the kind of conflicts that might arise and so forth and thus to altogether to get beyond the stereotypical lists of ethical concerns to a more specific understanding. And again if we take the example of the question, how will nanotechnology reduce or increase conflict in society I think it is really exciting to see where this question will take us, both in this positive imagination, what kind of nanotechnologies could we envision, that would be beneficial, but also in the sense

of conjuring some scenarios or conflicts. So all the better I think if these questions all go hand in hand and that's why I say Nanodialogue is only beginning and the further dialogues will have to help kindle the fires in which sustainable nanotechnologies will be forged. Thank you very much.

**Chair: Umberto Guidoni**

Well I heard in the very last sentence a very nice definition, sustainable nanotechnology. I think that would be one additional step to move forward. The third speaker is Professor Bucchi, Professor of Sociology of Science at the University of Trento, Italy, he has published several books on science and media, an introduction to social study of science, he is a member of the scientific committee of non profit centre of Server Science in society and of the international scientific committee for public communication for science and technology. Please.

**Speaker: Massimiano Bucchi**

Thank you. How not to engage citizens in science lessons for the nanotechnology debate is of course one of the reasons why we are here today, many actors in nanotechnology and research policy do not want what happened with biotechnology and nuclear energy, or anything similar, to happen again with nano. So what I'm going to do is try to draw some lessons from the past and on that basis rethink our **models for science communication** and ask the question which communication models if any for nanotechnology, and arguing that in this light we can even rethink the old bad deficit model, so this is a little bit of background about our institution producing reports and research about science in society issues. So everybody says that at face value the deficit model is dead. If you talk to research institutions, policy makers they say we don't do the deficit model any more, we don't do science communication, we do dialogue, we do participation, but sometimes you are a little bit skeptical that they are doing the deficit model by other means or rephrasing the deficit model in a new fashion. This is a quotation I took from a technology review about nanotechnology, it has one of the quintessential elements of the deficit model, that people don't understand science, the reasons of science and for this reason they are worried about the risk and so if only we could tell more, these people would change their mind and this is a very schematic representation of the deficit model with science on one side and the public on the other side and through communication we are supposed to close this gap and trigger more positive attitudes. Now one of the problems of the deficit model is that it considers public understanding of science as the same as scientific literacy, so perceiving science or thinking about science is the same thing as knowing the very content of science, this is an even stronger assumption, this understanding once achieved will guarantee favourable attitudes towards science and technological innovation. It has the tendency to problematize the relationship between science and the public only with regard to the latter term of this relationship, the public. It is a model which has to do with one way, top down paternalist communication with low mobilized, low interested public hostile, ignorant society, alarmist media coverage, consensual science speaking with one voice to society and politics and it is couched by and in large in technocratic scientists' knowledge economy. Now some of these elements are certainly inadequate to understand most of the interactions between science and the public, some of them are adequate to certain specific situation so if we look back to twenty years of public understanding of science and the many problems that we

know that people in Europe still feel uninformed about science according to the Euro-barometer, young people are not willing to study scientific topics at university. Conflicts about science are increasing and so on. These are just some of the lessons that probably we can learn. And the first lesson is that it has never been proven that communication is not the same as knowledge and knowledge does not necessarily imply support. These are a few data published by a study in *Nature* a few years ago, you can see that people who are more exposed to science communication in the media do not have a very different response to items measuring their knowledge about biotechnology, but you could react to this and say this is a lot of junk in the media, but then when you put in relation the level of knowledge with biotechnology with the attitudes to certain applications of biotechnology and you see in certain cases the people who know more are more critical of certain applications by biotechnology, you start to be suspicious about this model and this is from a recent study a few years ago, one of the few systematic studies of public perception of nanotechnology in the United States which found out that half of the Americans with a good level of knowledge about nanotechnology are pessimistic and emphasising the potential risks rather than the potential benefits of nanotechnology. Now a second lesson that you can draw about the past is that **communication is not just about talking**, but also about listening which doesn't mean that simply once you want to communicate about a certain topic or a scientific topic, it's important to know your audience, the context, in which your communicative initiative will be set, but also means by the old actions by Paul Vatslavay, that there is no such thing as non-communication, that communication doesn't start and doesn't stop when you decide to communicate, if your institution remains silent during a crisis, like the mad cow, you are communicating, you are giving a very strong message to the citizens indeed. The third lesson that I want to propose that there are several **types of knowledge** and several types of rationality involved in the science and society relationship. For instance if you think about the Chernobyl accident, it is easy to say today, looking to the past, that it was not only a technology disaster, but it was also an informative disaster because people perceived a total lack of transparency and information for the many political reasons that we know. If we think for instance to the GM controversy we have several examples of this, for instance, we have clear examples, when people are thinking about risk of GMOs they are not only thinking about safety risk or risk for health, they are thinking in terms of cultural risk or risk of losing tradition in food preparation, in culture, in biodiversity. There was a very interesting case in Italy, there was a place where they were experimenting transgenic rice, so when the population came to know this, there was a very constructive meeting with the research and so one researcher was explaining the benefit of this transgenic rice, so one citizen asked at the end of his presentation, if the parasite doesn't want to eat this rice, why should I eat it? And you can find same things if you look in one of the many comics about nanotechnology, if you increase the magnification another million times, you can see the safety regulation, there are different logics of safety involved. The fourth lesson is that **public perception of scientific expertise** and its role for policy decision has changed. And the evidence for this you can draw this is from a study that we published in *Science*, showing that an increasing number, more than seventy percent of people in Italy are seeing scientists as divided and not agreeing on the issues of GMOs and incidentally the more people perceive these divisions the more they are likely to be worried about GMOs. The fifth lesson is that citizen engagement cannot be switched on and off at will, depending on specific policy needs. If you think about two very different, but very significant types of public involvement, in

science and technology issues, like protests, or like patient associations, you have two examples of citizen engagement, which haven't at all been triggered by engagement or communication initiatives. So back to my question, which communication model for nanotechnology, is it the deficit model, is the dialogue model, is it a participation model? Sometimes I have the impression we see these models as an evolution, so that as I said, no the deficit model was something for the past, for the royal society 1985 report, then we came to dialogue and now we are looking to public perception. Now I would like to try to question this idea, for instance what is the difference between the deficit model and the dialogue model? It is of course that the emphasis of the first is on transferring knowledge and it is a one way process and dialogue is about consultation negotiation so it is a two way process which emphasises the discussion of the implication of research while if you look at participation or as some scholars call it co-production then you have to do what is called up-stream citizen engagement, which has to do with not just discussing the implication but setting the aims and shaping the agenda of research. So how can we make sense of this? I don't think there is a right model to explain what is going on between science in society but I think we have to see under what circumstances each of these models even the deficit model in very specific circumstances has something to offer. And if we start from the bottom, we define participation in science and technology as the set of very diversified situations and activities more or less spontaneous, it is a very broad definition organized and structures where non experts become involved and provide their own input to agenda setting decision making and policy forming and knowledge production processes regarding science, then we can try to draw a map, the axis would be the intensity of participation in the knowledge production and the degree to which, forgive the simplification, this participation is either spontaneous or sponsored by a certain institution for instance. So here actually you can map from the most elementary forms of participation, like responding to a survey, or to a poll, on science and technology issues, to the case of patient association, of community based research where you have a high intensity and high spontaneity of participation, and here surprise you can also place the deficit model because if you have specific situation where you have a low degree of participation in the knowledge production process, and a low degree of spontaneity, then the deficit model becomes your zero degree of participation, to some extent, if you want to use a physical metaphor, it becomes the degree zero of public participation and I'm going to conclude by saying why nanotechnology in my view, why discussion about nanotechnology shouldn't focus on a single model, there are several reasons to think about this is, and one of the reasons is that nanotechnology is not something specific, it is a umbrella term, so you could have a variety situation for nanotechnology, if you go back to the map, that could be put in this space, about a specific issue, or about a specific point in time, during the process in which for instance a discussion about a certain nanotechnology will unfold. Thank you.

**Chair: Umberto Guidoni**

Well we are almost at the end of our session I think we have some time for question after our next speaker Doctor Wolfgang Heckl. Dr Heckl is the general director of the Deutsches Museum and Professor of Experimental Physics and Nanotechnology at University of Munchen, with a special interest in the field of organic cell assembly and the origin of life. As a dynamic and charismatic science

communicator he received the communicator prize in 2002 and was awarded first with European Descartes prize for science communication in 2004.

Speaker: Wolfgang Heckl

Well thank you very much. I'm here to present these situations of the Nanodialogue consortium. But I would also like to present a suggestion, what could be done in the future, what could be a practical next step forward? Just an example. So as kind of a mission statement both of the museum or the Deutsches Museum and the Nanodialogue is to showcase European achievements right across the scientific spectrum and to build an open forum for debates, especially through the nanodialogue researchers and scientists as well as the general public are provided with, and you have seen this morning, with an adequate platform for exchanging views and discussing the challenges. We promote, foster and maintain contacts between all stakeholders in the field Europe wide and Earth wide. Finally in the political field we assist policy makers in consulting relevant scientists on issues affecting society, including the governments of science, of course. So the situation is, we have to break barriers between science and the public, to foster the development of science and technology and I think for all of us, it should be for the benefit of prosperity also in Europe. And already at the invention of fire, society had to ask the question, is it good or bad? It's neither good or bad, I'd say. It depends. So specific recommendations, the Nanodialogue consortium taking into consideration their experience as part of the scientific community and the results of the social survey carried out within the museum visitors from these eight different European countries, offer the following **eight recommendations to the Commission**. First: consider support for social and economic implications, research studies on nanotechnology a high priority. It is also an example for studies in the field of science in general. These studies should include, we think, surveys and improve public participation, the word you just gave us, participation, in the process of developing nanotechnology research programs. So also ask the people, what do you want? Which direction should we go? Not just try to explain them why it is good, but ask them what do you want? It is important, we think, that the results of these studies should be communicated to the public. I think it is true to say that technology doesn't develop so much in the lab any more. It develops in a culture. Just as an example, the smart energy home, this really affects everybody and its cultural differences which may one way or the other set priorities. Europe is not just one general body, there are different cultures within Europe, different approaches to science. Second, we think that it is important to establish and promote processes to inform and educate and involve the public regarding potential impacts of nanotechnology. We have to train young nanotechnology scientists and researchers and include social, ethical and legal implications in their studies. This is actually a point which at least, when I think of the situation at the universities in Germany, is not done at all. So if you are typical PhD student or a typical physics student or biology or chemistry student you have no one hour lecture in social, ethical or legal implications. You have lectures on mathematic and algebra and physics, quantum mechanics, everything. Not even you have lectures on how to present your work to the public, how to ask yourself why are you doing this? This is why we think that to include a spirit of communicating science to the public in formal training of all researchers and students working in this field will be important in the future. So we have to change curricula. Fourth we should develop specific curricula in programs even for secondary schools to design, introduce, nanoscope concepts into

mathematics, physics, chemistry and so on. But the important thing is to give the students, the youngsters an interdisciplinary perspective. Don't do this solely on the basis of mathematics or chemistry, a comprehensive study to determine distinctive issues related to school educational programs in nanotechnology we think is needed. This may be different in different countries in Europe. But if we want to take the lead we have to organize this in a rather rational way that we come together with our experiences of the universities, of the school systems, in different countries. Local information centers we think for the public, for teachers, for industry and scholars should be created. And of course museums as well as other places can be good places where this may happen. You have seen already in the morning this approach of a theatre we have played in the museum. The actors play different scenarios where nanotechnology can lead to. A bad one, a good one and a so-called middle one. And this was very well received by the audience. Fifth we think introducing in school curricula and programs of study the so-called disruptive technologies. We should deal with the main problems and the benefits occurring in the world major technology transformations as a real bold subject in the curriculum. This should be done, in order to change the common negative stereotype of the scientist who don't care for the consequences of their research. This is an old issue of course, it's not true any longer, but it should be strengthened I think in the future. Six, we want to create a knowledge base and it's additional infrastructure to evaluate nanotechnology scientific and technological and social impacts. For instance in the Deutsches Museum we have a small exhibition created on supermarket products and nanotechnology, what you already buy, use in terms of nanotechnology products you even don't know most of the times. I mean the industry is also split between the fact that is a positive attitude if you advertise a specific nano inside your product or is it negative? So the industry is partly on the one side and partly on the other side. Based on its independency we would say museums, consortiums are an ideal place since they combine these stakeholders, the access to university, the access to industrial research, and of course the broad access to the public. And we think that's an ideal way to present, to make as independent places museums are recognized with these issues. And seventh we again say interdisciplinary projects between natural science and the humanities should be fostered. Humanities, what we call Geisteswissenschaften, must be forced to leave the historical science perspective, in order to contribute to the future, especially in Germany, where I know the situation of history, we are too much looking backwards, I think we have to force some of the humanities community to take part in this discussion. For instance the Jahr der Geisteswissenschaften, year of the humanities, in Germany this year is a big experience because it's not natural for humanities to present themselves in a way the natural scientists usually do this. I come to the second part now. **The making of science.** This is a big issue in our museum already. What could be done, what could be the next stages within the European framework agenda. We think that it might be a good idea to bring together the three stakeholders. The nanoscience researchers, the social scientists, or the scientists from the humanities, and the public. And what should they do, they should demonstrate the making of science, how the progress is being performed, we have set up as a practical plan demonstration sites, where first of all laboratory scientific research is no longer hidden in the Elfenbeinturm of the university or industry buildings, so go out, go to the public spaces but not just one day, the open day at the university, but for the whole year, when nanotechnology research is presented directly to the public, both nanotechnology research and social science research, is being conducted together at the same place, it works like that. The PhD students in physics, they do their

normal work, but now in an open area, in this area where an open science lab is. The students are forced to interact with the public because the visitors of the museums come by and say what are you doing here and he says I do science and they say what is it and they have a problem first of all to say what science is what they are doing, why are you doing this. Our experience is that my PhD students first of all tend to say well I'm collecting a current and transfer it to an image, I do data collection and they concentrate on very specific topics. And people say I haven't understood anything. What is it when you say you are making science? What is the process of data collection from these machines into the forthcoming of the view of the world? When we do publication, what does fraud in the publication scheme mean? Why is it that you have to struggle against peers if you want to publish a paper? How is this going to affect society? What do you do personally here? And this is a learning process on both sides and the third stakeholder in this process is the social scientist. They sit there and observe what is going to happen. They ask afterwards for instance the visitors how did the PhD students perform, did you understand anything what he was trying to explain to you? And we see that there is progress to made. They also try to investigate what is the process of science if you sit here and to have a job to perform a PhD thesis within 3 years and then want to contribute to the benefit of mankind. How could this be done? It looks like a open research lab that we have built now at our centre of new technologies at the Deutsches Museum where we do nanoscience research life, typical for instance is a Scanning Tunnelling Microscopy laboratory, microscopy is always good because people are interested in images, in pictures, of the world. And when it comes to the unknown, to the smallest things they are most interested, how do atoms look like, how do molecules look like? But this is not the sole point. What do we understand if we think we see an atom? What do we understand if we think we can manipulate a gene, a molecule? So museum visitors observe and interact with the scientists while she or he is doing his research/her research. And as I said before the social scientists observe how science is made and how it is communicated to the peers and to the visitor. They kind of do an evaluation process. Is the **Glaesernesforscherlabor**, the open research laboratory, really successful new method in order to come to from the deficit to the dialogue to the participation model. In a sense we have two laboratories in one place. Natural science and humanities. This is how it looks like, it will be open completely in two thousand square metres next year in Autumn. The UFO has landed was the headline yesterday in the Sueddeutsche Zeitung newspaper yesterday. The UFO has landed the unknown science doings people, these eggheads from universities have gone out of their Elfenbeinturm and landed. So what we want is participation. We want to of course to convey a sense of fascination of science, we also act for young people who are in the process of deciding what they are going to become in life, what they are going to study, which subjects are most important for them. We want to make transparent the long way from raw data to what the visitor finally reads in the newspapers, because we all know that is just a little bit and may not be the right part even. We want to enhance an equitable dialogue between the science and the public also making the scientists behind the science visible. It's persons who you trust, it's not so much the newspaper or the general science, it's the person. We want to explain also the stages of knowledge in a concrete example. Kind of demonstrate the value chain as I said from data collection, interpretation, discussion and publication within the scientific community, intellectual property management, a big issue, should I publish or should I perish, somebody said, no? Should I go the patent office? Which is restricting, we don't have the European patent yet. Patent versus publication. The

ethical involvement of the scientist in the consequences of his, her research. The transfer of pure science into application. Of course at the end of the value chains, we probably want to have products. Interaction of the scientist with industrial demand. Industry is here for making money. Prototypes. University spin offs. Financing schemes. Startup money schemes. Marketing. At the end of the day we want to create jobs. We are in a very difficult competition in a globalized economy. So we are between this technology push, market pull and society demands. And even the very small and sole PhD student is in that situation. It's not just the philosophers, Professor Nordmann. It's actually everybody. This is a slide from Renzo Tomellini. I think learning from nature can shown very well at the nanotechnology because one the aspects of self-assembling in my field is that nature has obviously used self-assembly techniques to make everything which we see around here, every single crystal, out of atoms, every very sophisticated piece of living tissue and as Professor Kasemo showed us a very modern and very difficult to understand science and society, physics and biology, medicine issues. So times have changed the wide world is no longer small, thank you.

**Chair: Umberto Guidoni**

Well thank you to all the speakers. I think we had a very interesting session. There is probably room for a couple of questions, so who wants to speak first.

**Question:**

My name is **Doug Parr** from Greenpeace, I was slightly puzzled by all the presentations given that we are sitting here in the European Parliament, that if there was a mention of government, I think I missed it. We talk about universities, researchers, participation, schools and so on, and yet the context for nanotechnology regulation, funding, rules, cultural signals, a huge number of these come from government. So I wonder if our panel of participants could just reflect on where they see government fitting, sitting in all that and why they didn't see it was worthwhile mentioning it in their presentations? Who wants to go?

**Answer (Massimiano Bucchi):**

It's not an answer of course, but I think the whole issue of governance of science and technology is in the background of everything I said, and to put it more explicitly, nanotechnology is not an opportunity to find a solution. A communication solution for European science and European democracy, to think about multiple knowledge, different expertise and also something I was trying to implicitly to say, it is very difficult, everybody says we have to discard the deficit model, but it is difficult to discard the deficit model, remaining with the rhetoric of for instance of the knowledge economy, because if you have this, you find it everywhere in the European Commission documents, for instance, that you say that science is for progress, and science is for economic growth, and sooner or later citizens have to accept biotechnology, nanotechnology otherwise economy won't grow, of course I'm brutally simplifying, then how you can you talk about participation, because if your emphasis is on democracy like for participation model, then it is difficult to bring in the deficit model. If you emphasis on technocracy, knowledge economy, rhetoric, then it is difficult in my view, and this is why you find, in many projects, it is not certainly the case of the Nanodialogue project, but in many projects and many

documents you see the words, participation and dialogue but actually meaning propaganda, if you allow me the word, and I am really grateful to our Professor Heckl who showed in my view the strongest version of the deficit model that I have ever seen. I just maybe quickly to that, I think there is a more systematic reason why we often are not talking about government, and I think it has a lot to do with the fact that with early stages of the development of nanotechnology, everything we talk about is the scientific accomplishments, the crucial concepts that are being developed in a university laboratories and all the fascination that comes from nanotechnology and all the promise is still located within the science realm and we tend to forget that most large scale societal technological developments are actually not so much science. Science is only a small part of the picture in the end. And I think we tend to forget that. And I think there is now a lot of emphasis integrating ethics into research and I think that is very laudable and Professor Heckl just pointed that out, as one of the recommendations, but I think it also tends or leads us to overemphasise how much is actually happening in the labs and how much more really happens when we start looking at what kinds of problems we want to solve, who's talking about that, why we are actually finding nanotechnology in the first place, and then of course all the way down to commercialization, so that in that bigger picture, of course science is way overrated at this point.

Question:

**Dominique Pois** from France, Nature and Environment. One question about trustability, because it's very important I think that everyone knows if there is nanotech or not. So if any of you want to explain more about this view on trustability it can be interesting.

Answer (Bengt Kasemo):

In the research perspective on nanotechnology I usually use a triangle, where fabrication, characterization and application is the triangle. And the real bottlenecks for nanotechnology today is the loop between characterization and fabrication to see what we really understand what we do, because things are so small. And if we take advanced research on electronic circuits, even smaller transistors, and the Intel transistor which I mentioned, the usual outcome of an experiment making these transistors is that you make a thousand and one works. And partly of that is a failure of fabrication, but very much also of characterization analysis. To get to your question, this loop will also develop methods for traceability, it is vital progress, in order to know what we are doing, even if we are not interested in traceability but we are interested in making commercial products. We have for quality control, we have for follow up, for improvement of a product, have instruments that can trace all the small particles. But there will be and your concern is right there will be a time lag when these are available at very advanced laboratories at very high cost. And available at affordable cost for the public, for interest organizations, so it is a very viable question, the methods will come but there will be a time lag between all those small products and the traceability.

Chair: Umberto Guidoni

Well I want to conclude the session thanking all the public. I leave the floor to Mr. Busquin who has the next speech.

**Keynote Speech: Philippe Bousquin**

Ladies and gentlemen, thank you for the opportunity today to speak as chairman of scientific technological office assessment of the European parliament. I am of course delighted of Stoa's high level of engagement in the field of nanotechnology. Nanotechnology and nanoscience as you know are a revolution for a civil society. Civil society as you know is not sufficiently aware of this revolution. Competitiveness in this field of application from materials and energy application to nanonet scene NAN, exist already in our daily life. They are a new industrial revolution of the 21<sup>st</sup> century. As you have seen, we use network methods to connect scientists and institutions other civil society stakeholders in a constructive way. This event is an inspiring example of how we can bring people together to think about science challenges. It also a good example of collaboration between natural science and humanities as demonstrated by Professor Heckl. At the environment level to stimulate debate in civil society, I have a program, as my colleague, Mr. Guidoni, we have higher budget for the same science and society. Science and society can help to improve collaboration in different states, different initiatives with civil society upon different subjects, but subject as nanotechnology of course. Science and society has budget of three hundred and thirty million Euro, voted by the European parliament, last November 2006. Three hundred and thirty million Euro. It is possibility improve activities with other associations civil societies, non governmental association, about subject in relation between science and society. We have also higher budget in this new R and D field, nanotechnology, the budget is three thousand three hundred million Euro in this field for materials but also nanomedicine and also energetic solutions. I think we have a new perspective in this field, it is perhaps a good opportunity if we are ever to develop a new technology in nanotechnology can be a good example in this field. I am also in the parliament in charge of the nanotechnology opinion in the committee environment, and we have make report about this question, and I think in this report we say clearly the necessity, to encourage information among European citizen, on this matter, the ambitious information campaigns, I think we must support them. Nanodialogue is a good example, but we must become able to have a direct contact with all citizens in all member states and to have a national European initiative and be to able to coordinate this initiative. The debate must be serene, I think it very important that you can be able to have a serene debate. We know the debate with genetically modified organisms was not a good debate because it was not serene. I think nanotechnology may be better if we can be given more information, more decision and to have an open debate about this subject. To create a climate it must also have citizens involved and concerned about nanoscience. What do NAN bring us? The potentialities. The advantage the research of cancers, genetic diseases, energy and other field and the potential risk of NAN. Uncertainties. It is important to say that there are risks and to be able to discuss about the level of risk. In the sixth annual programme it was also a project about nanosafety. It must be explained to the European citizen at the end of this program. I hope in one year we have finished. Nanosafety is a very important program of the commission. But I think it is important to have ethical committees, centred in this perspective. The importance of risk must be efficiently assessed, our parliament has a role to play in this purpose. That in our department of scientific and technological assessment, we try to create a cluster of

different European national parliaments. And we have an association and the name of this association is ETAC and we have similar institutions in Germany, in different country, with the same basis of information, and to have the opportunity to initiate in different member states a similar discussion and similar contacts with the citizens. The corporate responsibility of business stakeholders must be shown to contribute to an improvement in citizen life condition. We speak much about corporate responsibility. We also have some study, some workgroup in European parliament, about this question of corporate responsibility. We must make a specific effort to be stricter, to give information, to discuss also corporate responsibility, because it is important to involve people can be able to know the risk and the potentiality. I think it is important to have a good cooperation between the different European institutions, in the commission and the parliament have a good collaboration. This meeting is good example of this very good collaboration between commission and parliament and I have explained you have make an effort to have more possibility of collaboration with different national parliaments, to be able to have common view, in all countries of Europe. I also and in this case I thank very well the specific unit of the commission the nanotechnology unit for action plan, because it's an action plan 2005 - 2009. This action plan be actualized, but I think is very good example of the way to work in the commission and to work with the parliament, to work with the citizen and I thank this committee for this open view about this question and the participation of all actors of civil societies in Europe. As a conclusion, we need ethical and sustainable nanoscience and nanotechnology which must respect environment and be well accepted by society, taking into consideration both Lisbon and Gothenburg objectives, for sustainable development and how we need sustainable nanoscience and nanotechnology. Europe of knowledge, Europe of innovation in a realist and humanist perspective is my hope and I think you can have the same vision probably too and very happy the nanodialogue was a good example and I hope we can continue to work in this same respect and thank you for presence. Thank you to the European parliament.

**Chair: Umberto Guidoni**

Well I thank very Mr Busquin for his address, also based on his experience, as former commissioner in the research. I think we can close the morning session at this point. Thank you very much.

**Third Session: Round table on Nanotechnologies today and tomorrow: current research and possible future concerns**

**Chair: Renzo Tomellini**

And to start the afternoon session, ladies and gentlemen, dear friends, I have just to say one phrase of initial statement and I think that you already guess what I will say that the Commission has since the beginning defined a strategy for Europe and to the entire world for nanotechnology development and then for use to be safe, responsible and the development to be integrated, integrated in Europe means we have to think about everything that can be a factor of success, or can be a factor of failure, everything means we have to invest in knowledge gaps so research, infrastructures, in human resources, researchers, engineers, technicians, in rules, from whatever it means from patents, to

property regulation and financing for the new ideas, for supporting innovation, eliminate all the bottlenecks that can impede the virtual cycle to take place so from the generation of knowledge to the generation of wealth, we have in our history some success stories and some failures and we have to learn from both, so we have to ensure that nanotechnology is for European citizens and European industry a golden occasion, for improving our quality of life, our way of doing things, in our integrated approach the Commission immediately indicated societal dialogue, and to be in phase with society as a key issue since the very beginning so not waiting that that questions or even polemics arise, but immediately since the beginning generate a positive dynamism so that those who develop nanotechnology, are in phase with citizens as much as possible. This was addressed in the morning this was addressed by the project nanodialogue, of course that has been funded by the European Commission and the sixth Framework Program. And this is not only the policy of the commission that initiated and proposed it, it has been endorsed by the council, by the member states, by the parliament, by the European Economic and Social Committee, by those who wanted to reply to an open consultation that we have launched a couple of years ago, so we can consider this as being a European approach and as being European policy. In a commission this policy is expressed in two policy documents the communication on the strategy on nanotechnology and the action plan. And it's followed by interservice group that gathered all the officials and all the services which deal with nanotechnology. In particularly interesting is that the frame of program contains funding which can be used and spent to support actions within the policy which the European commission has set out and so to the speakers of today of the panel, I can say more positive than what I hear it said in the police movies. In a certain point a policeman says to somebody "Remember whatever you gonna say can be used against you." More positively I say to the colleagues, remember whatever you say could be taken into account by the commission to propose new actions and new initiatives to spend money in the framework program and this can be in the program part dealing with nanotechnology and nanoscience and converging technology and converging sciences can be science in society, can be information society part, and the other parts of the framework program. We have some speakers who I think you know, Maria Buxò, Professor of social anthropology, University of Barcelona, Observatory of Bioethics and Law from Spain of course. Domenique Grand who is deputy director in the CEA, Commissariat à l'Energie Atomique in France, Wolfgang Heckl, you already know him, by the many things that he does, but also because he was active in the morning session, who is director of the Deutsches Museum in Munich, in Germany. Simon Joss from Westminster University is also known because he presented his findings this morning. Doug Parr, chief scientist of Greenpeace UK and who was also active in the nanojury in a certain moment so something which is in line with what Simon Joss has presented this morning and Vinod Subramaniam, who is Professor of Biophysical Engineering in the Netherlands and he is a personal reference of the Dutch nanotechnology initiative. With your permission I would like to propose to our speakers to have a five to seven minute statement, presentation dealing with relationship between science and society, addressing nanotechnology which is our core business. Looking at the future in particular, also try to respond to some of the questions, the many questions that we raise today, remember that Simon Joss was saying more information should be made available, ok which kind of information, to whom, by whom, so which is the role in particular that the European Commission could play, and this also replies a question that Doug has asked this morning. So after this first round we can have some questions, then we can address another topic which is now already mentioned, a point of interest in the morning session, so if you agree with this, I would like to ask Maria Jesus to start.

**Speaker: Maria Jesús Buxò i Rey**

Thank you, I am going to bring up some of the discussions which I have had with my doctoral students in a course of new technologies and social relations and also in a master of bioethics and law. So what I am just planning to say is what they are questioning themselves in relation to nanotechnology. Students debate, been into arguments and identify similar problematics on the way nanotechnology is introduced into society and they distinguish among 3 aspects, epistemological, prospective and ethical. First of all they note that we use and have used too much dualisms and dichotomies, and its promulgation into metaphors and values, producing mainly all kinds of contradictions, oppositions and distinctions and is notorious in presentations and series and articles and sorts of things. So on the one side there are uncertainties and on the other side good things, safety and so on. To move away from this dualistic pattern and towards an interactionalist and development approaches. To begin with they say that it would probably be better to bring up a more transitive a more symmetric epistemology allowing to accept ambivalence and uncertainty as working criteria and to recognize at the same time the symmetry of substance and accident. Each new scientific and technological advance brings with it an accident as a possibility. They are beginning to understand risk in some other ways; it is well accepted that risks are a substantial part of technological lifestyles. So this puts an accent on the need for conceptual and value innovation to substantiate arguments according to new technological advances. A second problematic point to focus is the development of methodology for futuristic scenarios; in some institutional documents it is recommended to give credit to fiction and use scenarios for nanotechnology comparative assessment. Through that science fiction and scientific data blending brings up wonderful futuristic scenarios and raises my enjoyment to begin with. But however at the very end, the discussion leads to intellectual discomfort. For example, let's exemplify this into the first person, I belong to one generation and the students' group they belong to another one. Is a multifunctional high connected push pattern. While my generation is still trying to explain and digest the concept of artificiality, youngsters are already trained to use it through cyberspace and virtual reality. What appeals then, it is already is the symbiotic interaction that exists between technology and organic life, consequently it is not problematic for them to think about the fact that nanotechnology is going to push forward evolution and overcome natural limits. That's exactly what they expect, otherwise what is all this about? No doubt scenarios are a good exploratory methodology to foster discussion and awareness, however, despite its possibility for the lack of contextualization, values are incorporated into scenarios as remote moral ideas that prevail at any time and at any reason, so sometimes they see that this does not promote progressive dialogue. And sometimes they are more afraid of the concerns of bioethics than of the scientific advances. So while this nanological debate demand is the use of scenarios to focus the present. Precisely where the threats and problems lie and values are situated. That instead of working with conjectures, they conceal its more important inner theological process to focus controversies, of personal approaches featuring real application, the state of the art, the nanotech divide, to give social and ethical meaning to nanotechnologies. The idea is that if we are now able to deal and identify social and ethical, economics problematics, at the basis, and give alternatives, any technological advance in the future will have better prospects. So technology is not the problem, but values and attitudes, that fill up economy and policy. And this present takes us to the third problem which they identify, the invitation to technology from the political court of parliament. This places for them some premises of doubt. Even though this invitation comes from an inconvertible democratic institution, we all agree that dialogue is an open door to participatory democracy, and a good provision for the kind of knowledge which is

needed nowadays. However they understand, but they don't quite see, why they are invited to dialogue, is dialogue just a way to give comfort to experts that need conquer public acceptability? Dialogue is strategic for generic knowledge that needs providers and users either for funding or for future clients, an invitation to a dialogue is a way to give confidence to a general society, that keeps asking for transparency. Or dialogue is done to conform approval acceptance and manipulation of consent. So that they understand in a technologically based market economy that needs to promote public dialogue we have to clarify why we are asking for that dialogue. Not just for public understanding of science, what else is behind this? Invitation to dialogue then implies that we have to understand something else, we have to understand what lies under the proposals we are making nowadays and in the future. So while this dialogue or the dialogue we have done shows that we have a lot of shortcomings so as this morning we are talking about success, I think that better than knowing what success we have had, is to know about shortcomings. We cannot stick to all concepts, we cannot stick to all values and the limitations of a standard framework. So the idea is bring up a new moral imagination, this morning we are talking about social imagination. Kind of moral imagination that helps to value renewal, responsibility, reframing and to increase participation that may fill among other things the gap between different generations. Thank you.

**Speaker: Vinod Subramaniam**

I guess the way I think about science and society and nanotechnology in society is to try and bring it back to the present reality. Nanotechnology is not the future. It is here now. With the possible exception of my friend David Bennett back there, I think everybody in this room carries a mobile phone and that essentially encompasses many elements of nanotechnology. This not tomorrow folks, this is here, now and it's been here for a long time and it is here to stay. And so the issue very clearly is to start talking to people. People are usually nanotechnology whether or not they actually know it. If you think about the food industry for example. The food has been working with colloids and nanotechnology for years. So when it comes to engaging in a public debate about nanotechnology, it's is a question of what should we be asking, what should be talking to the people about? We have to define these things in far sharper terms. We had a discussion this morning about the ethics of nanotechnology, the risks and so on. But I think we have to break this down further. It's basically a Herculean task to start thinking about establishing ethics for a whole technology because that's just far too general, we are going to have to start talking about more specific things. The notion of nanolabelling, you would not believe how much the milk you drink every morning has nanotechnology in it. So are you going to label that a nanoproduct? Is that the level at which we are discussing? That's the level at which we start to engage with our constituents. So the question is how do we go about doing this? Of course we have a very large range of people we need to engage with. There's our future. There's the kids in school. How do we do that? The way I do it for example, in a very small way, is that I open my lab up to the school children. I say you know we have an open day, you can come in, you can check out what we do, in bionano for example. My students and I go out to local high schools. Through the auspices of the network of excellence that I am involved in, we go and try to address high schools. Colleagues of mine at the university do the same thing. We are working in many different ways in some aspect of nanotechnology. And we try to address the students. Is it because, of course we have a bias here, these are the folks who are actually going to be the students of the future. These are the folks who are going to be in our labs working. We have to engage them now. We can't let them go find out for themselves. But then of course there is the other end of the spectrum. There are the people who are older, who are seeing this

technology, who are reading about this in the media, looking at this on television, and saying is this really going to make a difference to my life, is it going to affect my life, is it going to be harmful? So these elements of risk we need to address. But I think each aspect of nanotechnology we have to address individually. I don't think we can make this global sort of statement, we have to break the problem down into smaller more reasonable parts. And something we can actually offer reasonable solutions too. That's what I'd to share at this point. Thank you.

**Speaker: Doug Parr**

Right thank you. Whenever I enter into a discussion about nanotechnology, it's good to acknowledge what's actually out there, shaping the discussion in the first place. I don't think it's a bad idea to talk about nanotechnology, far from it. The fact that we are all here today, talking about framework programs which include nanotechnology is in part a strategic response to change in the economy. The change in the way that Western economies are now running. The decline of manufacturing, the challenges from the far east. The way in which the knowledge society is becoming a much more mainstream way of looking at the future of Europe. So while it is certainly true that science and new technology can and will come out of nanotech, many of drivers behind us, even having a discussion about this, on having nanodialogue projects, nanologue projects is because it is seen by political and business world as a way of addressing what are underlying political and economic strategic issues. Now of course Western governments and democracies have to make some kind of response to that, but it seems to be naïve to be talking about this, as if it were just a technology. It is something which is of interest to developed economies, in trying to counter trends which are de-industrializing them. Whether it is in the US, Japan or it is in Western Europe. And so with that in mind, talking about nanotechnology, it seems to me that it is perfectly possible to put together a research program which doesn't start off with technology. Along with a number of other NGOs and individuals I did so at the start of the discussions around the seventh framework program. And you can start off with goals rather than technologies. Things like protecting the environment, improving health, especially by public health interventions. Conflict resolution, instead of militarization, etc where nanotechnology may indeed play an important role in delivering those goals just as we've heard in the previous session, possible interventions by nanotechnology on energy and renewable energy. But it is a rather odd starting place to start with the technology and not say what are we trying to achieve? And why is that important to probably everybody in this room is because in my opinion, the controversy about GMOs was not so much about risk as it was so frequently portrayed. There were conflicts of visions and values about the future of the world as it would develop. About where agriculture was going. About where industrial control was going. In the responsibility of science and government in delivering science and technology which merited trust, now reducing that complex controversy to simply one of risk certainly risks repeating exactly the same type of mistakes with nanotech. And if there are controversies over nanotech - and it's not a given - if there are controversies over nanotech, they will not be of the same form as those over GMOs. They are bound to be different because nanotech is a platform technology. GMO technology is a one trick pony. There is a lot more than can come out of nanotech and it will be in different forms, in different ways and in different places. But in my engagement in the political process around the lessons from GMOs, I have to say by and large these elements of visions and values about the future have largely been ignored. And it comes to fore in this whole discussion about participation. I help to run a participation process, called Nanojury, in the UK. It was with the University of Cambridge Nanoscience Institute and my experience was

that the government and industries who were interested in that process had considerable difficulty in understanding and taking up the lessons that I think flowed from that. Some of which were that actually nanotechnology is no different from any other piece of science technology, the issues which emerged around institutional trust, around people having a voice, around information to discuss, the new technology, they were pretty similar. There were of course particular things around nanotechnology, specifically the health and environment risks from nanoparticles. That's a very specific thing. And I think it is actually quite difficult to have discussions about what kind of future we want, and how nanotechnology can and should be used. While that risk dynamic in the nanoparticle issue is not being properly addressed as I would argue it is not. So my conclusion as I come to the end of my seven minutes would be to say justify in the first instance why nanotechnology and not any other kind of technology, after all sometimes I hear about nanotechnology delivering clean water, well fantastic, the Romans managed to do that 2000 years ago. If the technology isn't being implemented, there are whole sets of other barriers which come into play, just in the same way that any of the possibilities around nanohealthcare are not about technology in the end, they are probably also about what's the capacity of health service systems or insurance companies being willing to pay the expensive costs of implementing the technology. What if you've got a diagnosis technique, for which there's no cure. Or method of intervention. These are commercial and political and ethical economic issues, from which the technology is merely one small part. And I would argue that at this stage, I would like to see a reorientation of R and D goals. Yes it might contain nanotechnology, but to be more goal oriented. And I'd like to see the institutions of government and business try to get a grip on what participation is starting to us. Information, finally, is something which always comes out of communication or participation projects. People want information, they want to know more, but in my experience again, the sort of information which allows a discussion about the broad technological project, where it is taking us, to what ends, with what purpose, with who in charge, is almost never available. You go on the internet, and look at nanotechnology and there's reams of stuff about research projects, but something that gives an overview of that kind of where's it all going, what is it going to contribute to my life, is almost completely absent, at least in any intelligible form. And so we have an awfully long way to go, not to have participation exercises, because we can do those right now. But to be in a position to properly debate nanotechnology and all its implications. Thank you.

**Speaker: Dominique Grand**

Hello, and thank you for your invitation, I am very glad to be talking to you this afternoon. Well as we can see from the preceding presentation, technology is indeed in larger issues. I'm going to talk for the introduction about departments in Grenoble, to situate what is going on in the historian's perspective and to see how the debate with citizens is done. City of Grenoble is a small city in some sense. Far from the old commercial roads, so its development started around the middle of the nineteenth century with hydroelectricity, and since that the city has been very driven by development of different technological ways and so it started with hydroelectricity and electrical engineering and electrotechniques and more recently development of research round the middle of the twentieth century with electronics and then with microelectronics. And so I will say a few words about Minatec, it is in some ways a milestone in the history of Grenoble, with large university and research, fundamental research, and the arrival of CA fifty years ago at the initiative of the scientists of Grenoble. The CA started development in nuclear energy fifty years ago and among the different techniques developed was electronics, which give rise to the first French technology transistor in the seventies and

the launching of a laboratory for microelectronics. And also the initiation of the first spin-off of this time of this public laboratory. Plus in the meantime about thirty start ups, which were initiated from this research laboratory. So the initiative of Minatec taken in 2000 by the director of CA Grenoble, was in fact to address the challenge in the field of microelectronics and more generally micro-minaturised devices for the next ten years. And the concept developed which was after a while used in other places at least in France, which was quite innovative, at least for France, in this time, was to have a goal and that means to gather all competence and means in one place, of innovation, the main idea was to develop sustainable jobs on innovation and it was not for research per se, as it was said this modern, it is in the post academic research, I would say, or technological research, and on micronanotechnology that is focused on the question of this particular thematic and technology. That's true, that technology in itself doesn't address all the possibilities, especially in these miniaturised technologies, but they can feed a lot of different applications of course for the technology of information and communication but with nanodevices oriented toward health we have seen an example this morning about the health issues and also it was given very well in the presentation about energy issues when you think of possibility of catalysis. So when you look at nanotechnology, as was said previously, it's not one thing, it's different technologies. At least we can think of three main technologies. First one is nanodevices coming from the nanoelectronics and microelectronics, the other one nanomaterials, with the possibility of application for chemistry or environment. And the third one are nanobiotechnologies that is the crossing which as we have seen address questions between the devices and biomolecules or life science. So what's all this project of been done in the last five years with construction of Natech and with citizens maybe not at the beginning directly with public debate because I don't think there was any evident need or question about that, but it was definitively done with the representatives. That is to say, this project, and again for the first time in France, it was not only national oriented, but it was really built up from local governments, and the local governments did make decisions, make very courageous decisions to support this project and of course there was presentation of the project and now there was follow up of the project which are done with a representative with the councils. In the meantime also and also because in Grenoble there was some active groups addressing or contesting strongly the project, the question of opening the debate with public started to develop and I think we were very glad to have the nanodialogue exhibition coming to Grenoble and in the area, as it was said, and afterwards, and with the science centre, we worked together on the preparation of the exhibit, of course the definitions of the content of the exhibit, is total responsibility of the science centre, and we are here for as providers of information, to fill their content, so I think I am maybe out of my time, so I will close for now. Thank you.

**Speaker: Simon Joss**

At centre of today's discussion is essentially governance of nanotechnology and nanosciences and that is also at the centre of wider discussions not just relating to nanoscience but to science and technology in general. And I suppose what we are all trying to come to grips with is how to achieve public governance of nanotechnology and nanoscience. That is a form of governance which recognizes the public interest and which places the public at the centre of governance processes and governance structures and I just wanted very briefly to throw into the equation of governance, the issue of the public. In the morning session, Alfred Nordmann emphasized the importance of the process of social imagination for the benefit and problem solving potential of nanotechnology and at the same time he added - and I entirely agree with that - it's also about the process of social imagination concerning the social dynamics, how we go about governing nanotechnology.

And it seems to me that if we want to talk about governance, we ultimately need to come to grips with what it means to achieve public governance, what do we mean by the public, and I'm not here to offer simple solutions because I think how we conceive of the public is at the very centre of how we think of democracy and democratic governance and it is something we need to seriously and deeply engage with. And what I want to put forward is that instead of trying to conceive of the public in a monolithic way we should really try to develop concepts as well as practical approaches to the public in a much more pluralistic fashion. I think it is problematic to talk of the public in singular terms, I think it is important to develop notions of the publics, in plural terms, to recognize that the public comes in different forms and shapes and that therefore developing governance modes needs to recognize there's a plurality of the public, that is the first point. The second point is that publicity, the process of governing in a way which achieves publicity again has to be conceived of in a pluralistic fashion. So publicity I think has to include a number of related components, including the construction of understandings, or social imaginations, in our cases, of nanosciences or nanotechnology. A process that ultimately so the normative aim helps to increase the communicative competence and deliberation potential of those involved in the publicity. Another function, quite a different function of publicity, is to achieve monitoring. Public scrutiny of proposals, policies of regulation and so on. That's a different kind of publicity which calls for a different kind of measures and processes. Yet again another aspect of publicity is to gain social integration. That is the function of publicity is not just to monitor but ultimately also to achieve integration, with a view to be able to develop a technology. And finally and lastly I suppose one of the reasons why we emphasize the public so much in today's discussion but also, more generally, in the discussion about the science-society relationship, is because the public as a dimension, as a concept, as a social category is recognized to be ever so important in order to achieve legitimacy in policy makings. So, thinking about public and publicity, we need to do so in a more pluralistic way and that would then also point to a more pluralistic understanding of the structures and the processes of publicity and I suppose you are here as science communicators or as representatives of science museums or science centres or if you are here as the representatives of the technology assessment office, or if you are here as journalists you will have different approaches to engaging with the public and to relate to public, publicness and publicity. There is no one size fits all, and I think that is important when thinking about how to develop governance processes, so what I'm basically calling for, is that we need a more fine-grained picture that we need to develop vis a vis the public, when thinking about governance of nanotechnology. Thank you.

**Speaker: Wolfgang Heckl**

Ah well I'm afraid everything has been said. But not from everybody. I think one of the results of our citizen dialogue is that there are different levels of agreement and that there are different levels of engagement of people. If we think of blue nanotechnology, I mean the materials science, the microelectronics, the way we get these windows which you don't have to clean any more, it's good agreement that we would wish this, it's not a big problem maybe, if we think of white nanotechnology we would also agree that some way or another this will help to solve the energy problems, it will do good for the environment, water supply has been mentioned. Of course, there is always the counterpart, the means, by which technically speaking how do we do this, how do we achieve this? The goal is good, but the way we do this, is this the right way? I mean do we do more harm to the environment when we use fuel cells instead of diesel engines or is it the other way round. Then it gets a bit more complicated, we have kind of red nanotechnology. We could divide this, people divided this into pharmacy, pharmaceutical applications, like sun protecting

creams, it's ok we don't want to have a sunburn, but on the other hand, who knows where the particles go. The big question always. Then we have medical applications which are absolutely needed, which means if people are sick, having cancer, brain tumours, they would really love a new treatment based on nanoparticles, based on hyperdermy, based on magnetic heating of nanoparticles which specifically enter the brain and attach to the cancerous cells. When it comes to green nanotechnology, then it's the biggest concern, do we need nanofood? Of course you have spoken about nano supplements in our food which we have since long time. Of course the origin of life is a process of nanotechnology when molecules on mineral surfaces, self assembly, to transform dead matter into living matter, this is a process of nanotechnology if you wish. It's in-built in life. The self-assembly of a simple thing like a mineral crystal is a process of nanotechnology self assembly. Even the process of building living objects. But it comes to food, we should be more cautious, when it comes to the opinions of the citizens participating in the nanoforum. It comes all the question that Doug Parr asked, should we start with goals. I would agree intellectually that it is good to first define goals. Where should we go, what do we want, what should lead to more prosperity, equal distribution of prosperity especially on earth? On the other hand the history of science and technology the history of mankind shows that at least in my opinion most society changes most revolutions started with some technology which just came up in a laboratory for instance, when people decided to use transistors to make information technology possible, and afterwards people thought about is it good to have the niveau of information technology, is it good to have a citizen who is under surveillance all the time by cameras? So the models which have been discussed this morning, the deficit model, what you don't know, bring the good things to the silly people and then there is next level of better the dialogue model, the public acceptance, where are chances and risks? Maybe the best model, the participation model, what do you want, what do you expect from the future? What do you want the decision makers to make practical laws about? What should Renzo tell us, what should he pose in terms of new programs? I think we cannot really separate this, if you don't know about what the technology is, you still have to have some glimpse of what it is, the deficit model. If you only know where you want to be and you don't know how to go there, it's not enough, you need to dialogue about, well I would like to have a diesel engine running my car, this is a good chance to go faster from a to b. But the risks may be that we have a hundred years model of incorporating nanoparticles. How many cancers are caused by diesel engines? The situation for me at least is so complicated because nobody in the world can ever understand everything. Specialists on that, specialists in medicine, specialists in nanotechnology, specialists in social things, and for me what I found the only answer can be and I think this is what we need what I want to propose, we need people, testimonials, ambassadors you could call them, real persons who stand there and say well believe me, I am a good guy, I think this is the right thing to do, I try to explain you, I try to give you my rational why I think so but at the end of the day we need a certain amount of trust, trust in the players. And this only can be achieved, through the process, I firmly believe, which we do, which we have done in the nanodialogue consortium, this is one example of course only, that people go there and stand at the discussion but not mixing it with the idea of after the day of discussing, everybody will go home and say I understand now, everything, I am the same level and I agree completely with what you told me. At some point we have to have trust in the key players. Thank you.