Welcome to the third newsletter from the observatoryNANO project

If you would like to find out more about the observatoryNANO project, participate in the engagement process or establish a liaison with the project, please contact the coordinator: Dr Mark Morrison (mark.morrison@nano.org.uk)

1. Scientific and Technological Trends

Annual reports for the science and technology developments in the ten broad technology sectors, split into 61 sub-sectors, are now available (updated Aerospace, Automotive & Transport reports will be available in June) and can now be downloaded for free from the observatoryNANO website (www.observatory-nano.eu).

Aerospace, Automotive & Transport	Technologies to produce bulk nanostructured metals; Technologies to produce polymer nanocomposites; Technologies to produce and apply tribological nano-coatings.
Agrifood	Agricultural production; Food processing and functional food; Food packaging and distribution.
Chemistry & Materials	Carbon based nanomaterials; Nanocomposites; Nanostructured metals and alloys; Nano-polymers; Nano-ceramics; Nano-fabrication technologies.

Construction	Cement based materials; Coatings; Living comfort and building safety; Sustainability and environment; Civil- and underground construction.
Energy	Photovoltaic; Thermoelectricity; Fossil fuel; Energy harvesting; Nuclear; Renewable technologies; Fuel cells; Hydrogen production and storage; Batteries and supercapacitors.
Environment	Air purification; Wastewater purification; Drinking water treatment; Groundwater remediation; Soil remediation.
Health, Medicine & Nanobio	Cosmetics; Diagnostics; Novel bionanostructures; Implants, surgery and coatings; Therapeutics; Regenerative medicine.
Information & Communication Technology	Integrated circuits; Memory; Displays; Manufacturing; Photonics; Beyond CMOS.
Security	Chemical Weapons and Industrial Toxins Detection; Biological Threat Agent Detection; Radiological-Nuclear Weapon Detection; Explosives Detection; Narcotics Detection; Neutralising CBRNE effect; Decontamination; Forensics; Personnel Protection; Equipment and Infrastructure Protection; Condition Monitoring of civilian zones; Anti-counterfeiting; Authentication; Positioning and Localisation.
Textiles	Nanostructures; Fibre production; Finishing treatments; Textile products.

These reports encompass the results of three stages of science and technology monitoring: review of publicly available information such as peer reviewed journal articles, technology roadmaps and research project output; liaison with organisations involved in the development of nanotechnologies; and gathering expert opinion on science and technology developments.

Each report has the following structure:

- Definition and short description
- Keywords
- State of R&D
- Additional demand for research
- Applications and perspectives
- Current situation within the EU
- References

This work is further supported by a broad patent and peer-reviewed publication analysis, showing trends in each of the sectors which are also now available on the observatoryNANO website. The publication analysis draws on a database of 544,440 records of nanoscience and nanotechnology (N&N) publications in peer-reviewed journals between 1998 and 2007, which were identified using published algorithms. On the patent analysis, over 130,000 entries in the 'Worldwide Patent Statistical database' (PATSAT) since 1972 are relevant to nanotechnology. The output from this analysis shows trends in total nanotechnology patenting per year and per country, as well as trends in the ten different technology sectors. See figures 1 and 2 below:

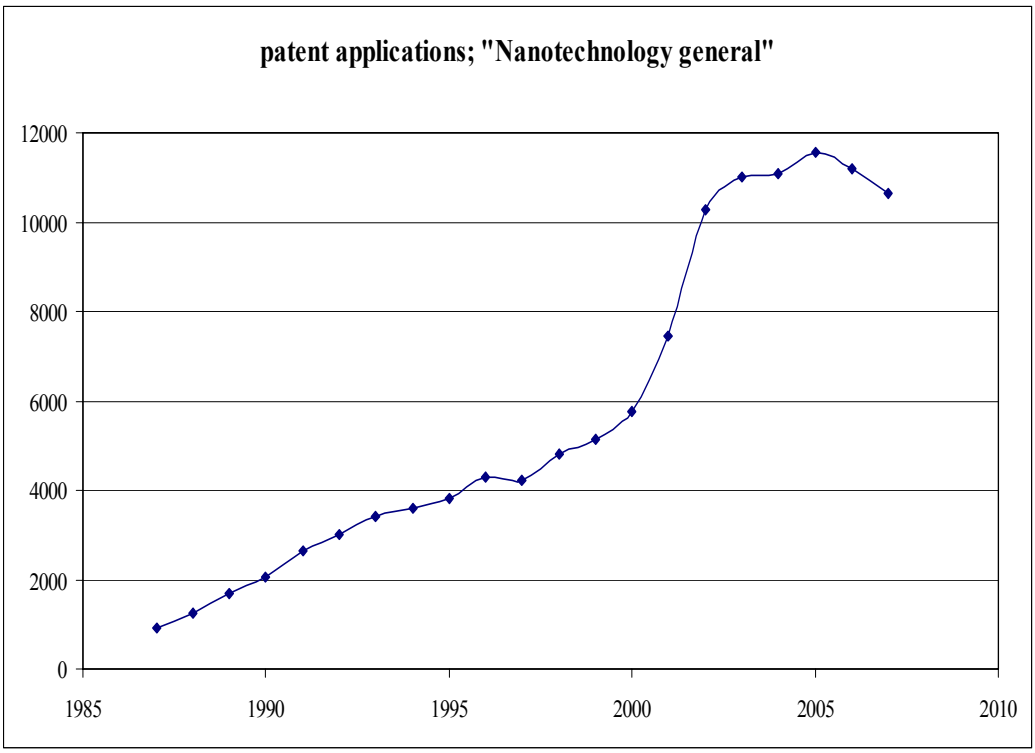

Figure 1. Trends in patent applications in nanotechnology between 1987 and 2007.

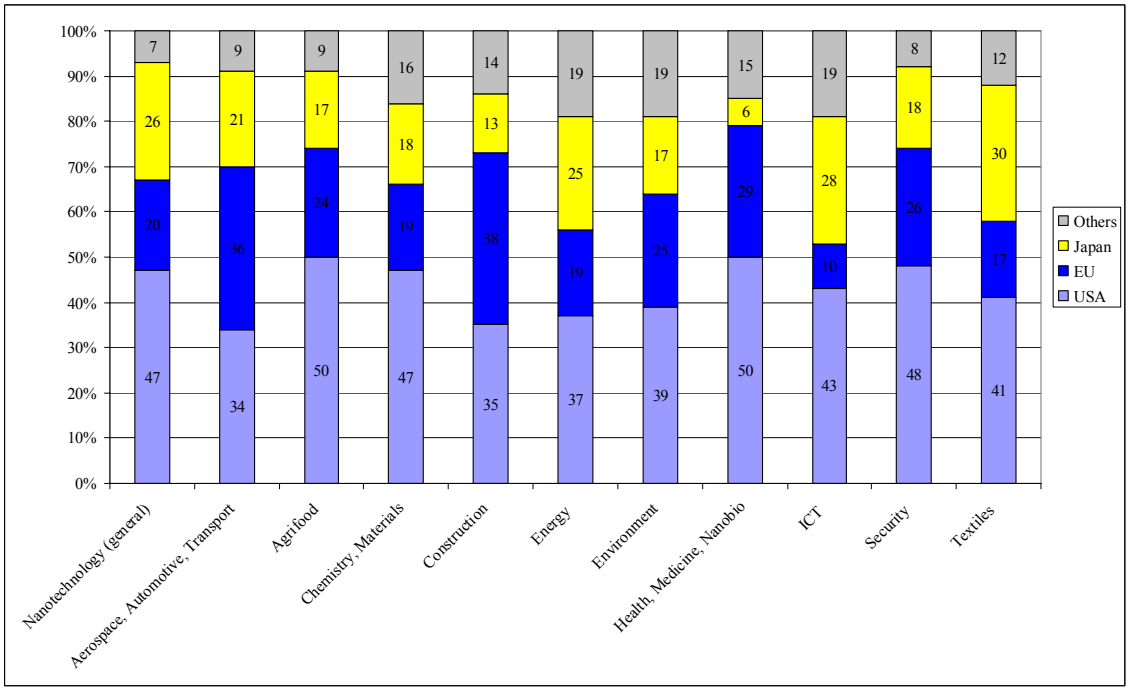

Figure 2. Share of nanotechnology patents per global region in general, and in each of the ten technology sectors.

This work is led by VDI-TZ, and includes IoN, CEA, B&W, Spinverse, Empa, AIRI, and MERIT.

2. Economic Analysis

In addition to the Scientific and Technological Trend reports, analyses of economic impacts, based on market segments, have been produced. Most are available for download from the website now, with the rest in the first half of June 2009:

Aerospace, Automotive & Transport	Structural parts/airframe; External panels/surfaces; Powertrain; Engine (ICE)/turbines
Agrifood	Nanocomposite packaging; Coatings for packaging; Edible coatings; Biodegradable nanocomposites for packaging; Delivery systems for nutraceuticals
Chemistry & Materials	Nanomagnetic materials; Carbon nanotubes; Nanodiamond; Intrinsic conducting polymers
Construction	Cement based materials; Ceramics; Paints; Windows and doors; Insulation systems/materials
Energy	Photovoltaic; Fossil fuel
Environment	Water treatment; Soil remediation
Health, Medicine & Nanobio	Bone replacement materials; Dental nanomaterials; in vivo imaging; Drug delivery
ICT	Memory; Displays; Materials
Security	Detection
Textiles	Water repellent/self-cleaning; Moisture absorption/wicking; Anti-static; Anti-bacteria; UV protection

Each report has the following structure:

Definitions and methodology
General market description

- nanotech impact
- drivers and barriers
- sector segmentation and applications
- possible future products and time range

Application profiles

- short application description
- functional requirements
- boundary conditions
- product examples
- economic information and analysis
- selected company profiles

In addition to the market reports, reports benchmarking nanotechnology R&D within the EU compared with the rest of the world, and reports describing public and private funding of nanotechnology R&D have been published on the website.

This work is led by B&W, and includes Spinverse, NMTC, Technology Centre (Prague) and MERIT.

3. Ethical & Societal Issues

This work is a practical implementation of the co-evolution of technology and society. The objective is to monitor both the ethical and societal impact of N&N and the impact that societal developments and ethical reflection can have on N&N developments. The first annual report 'individual and collective responsibility for nanotechnology' describes developments in governance (including codes of conduct), risk issues and the precautionary principle, divide between developed and developing countries (including how intellectual property rights are affected).

The first iteration of the toolkit for ethical reflection and communication to allow scientists to consider the larger societal and ethical implications of their research, and how these impact different sections of the community can also now be downloaded from the observatoryNano website.

This work is led by MTV, and includes CEA, and Aarhus.

4. Environment, Health and Safety Issues

Baseline studies have been completed which identify the key reports and provide a category analysis into human toxicology, ecotoxicology, exposure, fate & behaviour, occupational hygiene and risk assessment & management. Summary documents of other relevant observatories (SAFENANO, KIR nano and OMNT) are also available from the website.

To ensure that the observatory is kept appraised of global developments in EHS research the partners have established liaisons with a variety of different organisations: publicly funded projects (many of which include observatoryNANO partners); government and quasi-government organisations; other observatories and non-governmental organisations. Full details are available on the website.

Within the second year of the project a report will be published that examines the scientific and technical analysis from the observatory and assesses whether there are any health, safety or environmental implications.

This work is led by IOM, and includes CEA, RIVM, and Empa.

5. Regulations and Standards

Work in regulatory and standards agencies is being reviewed to identify developments that will impact EU industry. An annual report has been published that describes approaches to legislation and hard regulation (in the EU, Member States, USA, Australia, Canada, Japan); self-regulation (such as the EC Code of Conduct, EPA-NSMP, DEFRA-VRS) and standards for nanotechnologies (including ISO TC 229, CEN TC 352, OECD).

This work is led by AIRI, and includes IoN, and RIVM.

6. Other Activities

The long-term goal of the project consortium is to establish a permanent European Observatory on Nanotechnologies. To do so it is reviewing similar initiatives, and establishing an advisory board of international experts and policy makers who can assist the consortium in developing its vision. A report has been published a detailed review of eight initiatives in France, Germany, UK, Austria, New Zealand and the Netherlands, plus some smaller activities. This report provides information on the institution, its staff, funding model, foci, scope (e.g. national, global), whether it employs permanent expert groups, mode of observation (e.g. databases, workshops), target groups, and output (e.g. raw or structured data, recommendations).

The project has produced its first annual general report, describing (in broad terms) developments in nanotechnology and their impacts on the EU. Presentations from a dissemination event (held in London in March) are also available for download from the project website (in the 'Communication' section).

7. Interview with opinion leaders

In the most recent of our regular series of interviews with opinion leaders on the individual and collective responsibility for nanotechnology Ineke Malsch speaks with Professor Richard Jones, the strategic advisor for nanotechnology to the UK funding council for Engineering and Physical Sciences (EPSRC).

Professor Jones has contributed extensively to the debate on responsible nanotechnology. A key piece is "Public Engagement and Nanotechnology, The UK Experience" (Jones, 2009), in which he reviews public engagement activities with nanotechnology in the UK including the EPSRC attempt at integrating engagement in decision making on priorities in funding for Grand Challenges in nanomedicine. He proposes to investigate "whether embedding public engagement more closely in the scientific process actually helps to produce better science."

Ineke Malsch: You have written extensively about issues of responsibility and public engagement. Are there other things you are contributing to responsible nanotechnology?

Richard Jones: As you know I am the senior advisor to EPSRC on nanotechnology. I take part in extensive discussions on what should be funding priorities in the UK nanotechnology programme. That is the main place where I contribute to putting responsible nanotechnology in practice. I am also involved in other organisations that promote responsible nanotechnology e.g. in the Institute of Nanotechnology, I am the chair of its advisory group. I am also involved in the development of the Responsible Nanocode. This was an initiative of the Royal Society, Insight Investment, the Nantechnology Industries Association and the Nanotechnology Knowledge Transfer Network. That was an interesting experience, seeing that nanocode being developed. Out of that group comes another initiative, the Responsible Nanoforum, which is trying to create a space for discussion on responsible nanotechnology involving different stakeholders, and to make a space for diverse information that the public will be able to trust.

Ineke Malsch: Are you planning new activities in the future?

Richard Jones: Personally I am probably going to be less involved in this, because I am stepping down from my role in EPSRC in a couple of months. In general the big news is that the government will respond to the recent report of the Royal Commission on Environmental Pollution sometime around April. The Royal Commission published their report on 12 November last year. The UK government has already released a press release which did not make much of a splash but is worth looking at, on what the ministerial committee on nanotechnology is planning. It is a restatement, perhaps even a new strategy on responsible nanotechnology development. The coming response will be a high profile statement which will come out in the next few months, followed by a consultation.

Ineke Malsch: Different groups are taking responsibility for the development of nanotechnology, including the scientific community.

Richard Jones: Perhaps it's more accurate to say that many different groups are making contributions to the development of nanotechnology, rather than any one group solely taking responsibility.

Ineke Malsch: Which societal groups or organisations should take responsibility for the development of nanoscience and nanotechnology?

Richard Jones: There are two distinct aspects to this. The funding of basic research and innovation in nanotechnology, which is typically done by research councils, by those government bodies more concerned with commercialisation, together with commercial companies who are researching in nanotechnology and potentially releasing products. All of those need to exercise responsibility in different ways. In addition to that there is the regulatory framework - the kind of science needed to underpin regulation, and the government departments that look after regulation on national and EU level. Those are the key people who bear the responsibility for research directions and commercialisation and making sure regulation is in place and research to underpin those regulations. Then there are groups which have an interest in the responsible development of nanotechnology, including consumer groups, trade unions on the one hand and trade associations on the other, who have different stakes in the matter and will have different views on what responsible nanotechnology constitutes.

Ineke Malsch: So the first are more able to take decisions on what constitutes responsible nanotechnology development and the others should participate in discussions?

Richard Jones: They should have influence. If you ask how you are going to prioritise funding for nanotechnology research, you are always in a situation where there are limited amounts of funding available. So you will always have to make decisions on priorities. So you will have to have some basis for making those decisions, whether, for example, we spend money on nanomedicine or nanotechnology for health concerns or for military purposes etc. These decisions are currently made with a lot of input from the scientific community, and from people with commercial interests. Increasingly one sees involvement from civil society organisations and the public directly, through public engagement activities of the kind I have been involved in. That is taking place at the beginning of the chain. Further down the line you are going to have decisions about what the appropriate degree of regulation and freedom is that the market should have. Stakeholders and the public should play a bigger role in the beginning of the chain than in the past. That is what I have been concentrating on achieving. In the past, people have seen the largest role at the end of the process, and this remains important.

Ineke Malsch: Is there a specific role for the scientific community? What instruments do scientists have for taking their own part in the responsible development of nanotechnology?

Richard Jones: The scientific community is one of the main agents deciding on what research gets done. Research proposals are generated by the scientific community. Research themes are generally prioritised by the scientific community through their advice to research councils. The scientific community does the peer review deciding on which projects are funded. They do have a considerable responsibility on that end. Nanotechnology is typically more goal oriented than more traditional areas of research. Other areas of research are couched in terms of priorities that come from the disciplines. As soon as you couch priorities in goal oriented terms, you will have to articulate reasonably clearly whose goals they might be. You will have to say: "I want to develop this particular type of technology because it might lead to cleaner energy or better healthcare." In order to be responsible, one will have to articulate more what these goals are and be reflective about what social assumptions you have for deciding what desirable goals are. There is also an element of responsibility of the scientific community in not overstating the possibilities, in being realistic in what are the likely outcomes of the research.

Ineke Malsch: Do you think there is a need for training the scientists in setting more realistic goals?

Richard Jones: You could say that there is a need for more training, but it is not obvious who would do that training. Thinking of ways which would allow scientists to be more reflective is a good thing, but it is not totally obvious to me to think how they could be trained in a more formal sense. I think it is unrealistic to think that there are people who have the last word in reflectivity in scientific practice and who would be able to train scientists. What we are talking about here is public engagement, dialogue. It is positive that scientists, social scientists, designers, product people who are more upstream developing products, clinicians in the case of nanomedicine, and of course the general public too engage in dialogue. Such dialogue is required, rather than some central course everyone ought to be sent on. But I don't think anyone yet knows for certain how it should be done.

Ineke Malsch: Is the policy in the UK sufficient to stimulate more reflectivity by scientists or should there be more funding or other resources available?

Richard Jones: Funding is available. What we are talking about is to some extent cultural change rather than the direct outcome of policy instruments, it is difficult to say that it is happening straight away. There have been important structural changes. One of the things I would highlight particularly is in EPSRC: they have this new high level advisory committee, the Societal Issues Panel, whose function is to advise directly about these aspects. I think that is an important development. Cultural changes don't happen instantly, but this is an example of the sort of mechanisms you could have in place to achieve those changes eventually.

Ineke Malsch: So you are optimistic that reflectivity will be more integrated in decision making in the future?

Richard Jones: Yes, I am optimistic. But there are several ways in which thing may go wrong, so I don't think it is absolutely certain that things will go better, but there are some encouraging signs. We will see. I have talked about the UK. You have spoken with Arie Rip, he will have told you about encouraging activities in the Netherlands. We are both occasionally going to Norway and talking to their research council, which is also incorporating these things. Slowly one sees some movement, but it may not be terribly fast. There are some deep seated cultural changes that are required.

Ineke Malsch: There is no need for new instruments at this moment?

Richard Jones: I think the key question that a funding body needs to ask is: does it have the formal mechanisms for taking these questions and issues and feeding them into policy decisions at high level. What makes public engagement not work is if there is no connection between public engagement and policy making. Institutions have to change to be able to incorporate that. Every institution involved in science will have to ask itself that question: Does it have those structures in place to do that? EPSRC is an example of an institution that has made enabling it to move in the right direction. Each institution must ask those questions and find a suitable solution.

Ineke Malsch: Are the research council the main institution which can make those changes?

Richard Jones: It all depends on the national system. Every country has a different system for doing this. Research councils and agencies that are responsible for more near market innovation based research. Those are the national institutions and then of course there are the appropriate supranational institutions in Europe, the European Research Council and the Framework Programme.

Ineke Malsch: Could the EU code of conduct for nanotechnology research play a role in more reflectivity among scientists in priority setting?

Richard Jones: It would do in as much as it is taken up by individual member states. That remains to be seen how much that would happen.

Ineke Malsch: Do you think the EU code will be taken up in the UK?

Richard Jones: I think there are some potential difficulties with it in the UK. For various reasons which are too complicated to go into, I don't think the EU code will be formally adopted by the relevant institutions. It will have an influence in the background, but I don't think it will be formally adopted.

Ineke Malsch: There is also the Responsible Nanocode. Will that be more influential in the UK?

Richard Jones: The Responsible Nanocode is not so much addressed to researchers, but more to the private sector. It is a different market. It is much more an issue of Corporate Social Responsibility rather than the duties of academic researchers. In the UK there is actually an ethical code for scientists, which is much broader. That code was championed by the last scientific advisor to the UK government, Sir David King. It has that force coming from the government office of Science and Innovation. I expect that code will be more widely applied. The reason for that is: We are talking here about responsible nanoscience, but we should be talking about responsible science of all kinds. Many of these issues have arisen for the first time in a pointed way in the case of nanotechnology. Now we see many other areas of science where the same kinds of issues arise. There is obviously a lot of interest in synthetic biology at the moment. Many questions are arising about that at the moment. Further along, but not less important issues are arising about geo-engineering in the future. There are general problems about energy supply, how one gets sustainable and reliable energy. And there is the continuing saga of both agricultural and medical biotechnology. It is easy to focus very narrowly on nanotechnology, but one has to step back occasionally and realise that it is part of a much larger picture of fast developing science with significant societal implications. Arguably codes which are drawn more broadly than just specifically for nanotechnology will become more important in the future.

Ineke Malsch: Is there a clear difference between the Ethical Code for Scientists and the European Commission Code?

Richard Jones: Yes, the Ethical Code for Scientists is much shorter and is focused much more on universal principles that might apply in all areas of science, rather than being limited to nanoscience.

Ineke Malsch: Is it also a matter that it is originating from the UK? At European level they have to make something for all EU member states, and there may be cultural or organisational differences.

Richard Jones: Yes, there are some issues there.

Ineke Malsch: The European Commission wants member states to report annually about monitoring the implementation of the Code. So I suppose there will be some discussion about it. But you don't think it will be very important in practice in the laboratories?

Richard Jones: Because it probably won't be formally accepted or ratified by the Research Councils, I think it will have less force, and I say this without any comment about whether I think this is a good thing or not. I try to think about mechanisms for making scientists comply. Scientists are employed by universities. So a funding council would have to make it a condition of acceptance of research funding that you would recognise the code. I see no sign that the research council would make such a recommendation. People can be made aware of it, but it won't carry the force of a formal recommendation.

Ineke Malsch: There are different groups with different responsibility. Arie Rip has pointed out that such a situation could lead to "organised irresponsibility," because everybody thinks someone else will take responsibility. Is this a problem in the case of nanotechnology?

Richard Jones: To be honest, I am actually more optimistic. Some of the agencies you might expect to take responsibility have not been very fast in doing that. One could imagine a rather minimalist definition of responsible nanotechnology, based on the simple requirement to introduce it in a way that does not break any laws, or contravene any regulatory framework. But because, for various reasons, regulation has not kept up with the development of nanotechnology, this has made this minimalist view rather harder to sustain, and as a result there is a tendency for people actually to be more responsible. It is up to people who commercialise the technology and people in universities who develop the technology to take more of the responsibility themselves. In a slightly perverse and counterintuitive way, this slowness of formal regulation has actually promoted real responsibility amongst the people developing nanotechnology. You have seen many organisations enter with calls for responsibility. I have not even mentioned insurance companies, which have been quite influential. The Swiss Re Report has been very important. Insurance companies have been raising questions about the sustainability of technologies introduced by companies that may want to buy insurance of them. There is a rather diverse patchwork of agents, which has had the opposite effect of what you are suggesting. There are a lot of people assuming responsibility for various aspects of nanotechnology development, which I think is quite positive.

Ineke Malsch: Do you see any problems in commercialising nanotechnology in the future?

Richard Jones: There are always problems in commercialising technology. There are long time horizons until the technologies reach a phase in which they are commercially viable. Nanotechnology is not much different from any other technology. It remains to be seen whether any piece of technology will actually fulfil the need it was developed for.

Ineke Malsch: So it is not necessarily the risk discussion that could be a bottleneck, but also that nanotechnology may not be the right answer for problems in new product development?

Richard Jones: Exactly. The biggest risk that stops a new technology making it to the market is that it does not do what one hoped it would at an economic cost. One hopes to develop something practical and useful. Issues of potential toxicity and potential environmental risks are important, but there are more potential barriers for technology getting to the market.

Ineke Malsch: Are there other issues we should discuss which we have not touched upon yet?

Richard Jones: The crucial issue really is identifying what the pressing needs of society are. As a scientist, it is very clear that there are pressing needs. We need technical, political and social solutions to the serious problems we are facing. It is important to make sure we are being very clearheaded about assessing new technologies and their potential to meet the needs we have.

Ineke Malsch: Not only precaution, but also trying to address society's needs?

Richard Jones: Yes. Precaution is a good principle if the situation you're in is sustainable. Since we're not in a sustainable situation, inaction is not responsible.

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Role in debate on nanotechnology, ethics and society:	Richard Jones is an experimental physicist investigating properties of polymer molecules at interfaces and ultrathin polymer films. He is the Senior Strategic Advisor for Nanotechnology for the UK's Engineering and Physical Sciences Research Council. In 2004, he published the book "Soft Machines: nanotechnology and life," popularising nanotechnology. He maintains a weblog discussing issues including responsible nanotechnology.

Relevant recent publications of Richard Jones

Richard Jones: "The Economy of Promises," in Nature Nanotechnology 3 p65 (2008), reproduced in Soft Machines weblog, 8 February 2009, http://www.softmachines.org/wordpress/?p=449. Nanotechnologists should be responsible in what they promise their work will mean for society in the future.

Richard Jones: "Public Engagement and Nanotechnology, The UK Experience," (book chapter) Soft Machines weblog, 13 January 2009, http://www.softmachines.org/wordpress/?p=443. He reviews public engagement activities with nanotechnology in the UK including the EPSRC attempt at integrating engagement in decision making on priorities in funding for Grand Challenges in nanomedicine. He proposes to investigate "whether embedding public engagement more closely in the scientific process actually helps to produce better science."

Richard Jones, "Can nanotechnology really be green?" in Nature Nanotechnology February 2007, Vol 2, No 2, pp 71-72, reproduced in Soft Machines weblog, 22 August 2008, http://www.softmachines.org/wordpress/?p=423 He argues that sustainable nanotechnology is a necessity.

Relevant other publications referred to in this interview

Royal Commission on Environmental Pollution, "Novel Materials in the Environment: The Case of Nanotechnology," RCEP, 12 November 2008, http://www.rcep.org.uk/novelmaterials.htm

European Commission Communication on a Code of Conduct for Responsible Nanoscience and Nanotechnology Research, 27-02-2008, http://ec.europa.eu/nanotechnology/pdf/nanocode-rec_pe0894c_en.pdf

Responsible NanoCode, http://www.responsiblenanocode.org/

Universal Ethical Code for Scientists, CST, 2006, http://www.cst.gov.uk/cst/reports/#Ethics

8. About the observatoryNANO

The observatoryNANO project is funded under FP7 for four years from 1st April 2008. Its primary aim is to support European decision-makers with information and analysis on developments in nanoscience and nanotechnology (N&N). It will collate and analyse data regarding scientific and technological (ST) trends (including peer-reviewed publications, patents, roadmaps, and published company data) and economic realities and expectations (including market analysis and economic performance, public and private funding strategies). The ST and economic analysis will be further supported by assessment of ethical and societal aspects, impacts on environment, health and safety, as well as developments in regulation and standardisation. Although much of this work will be performed within the consortium, the project is working cooperatively with other initiatives to ensure that effort is not duplicated and that resource sharing and output are maximised. To date liaisons have been established with international organisations including the EPO, OECD, and ISO, and will continue to be established with other relevant organisations such as European Technology Platforms (ETPs), ERA NETs, and other EU-funded projects.

The ObservatoryNANO project is led by the Institute of Nanotechnology (IoN) (UK), and includes: VDI Technologiezentrum (DE), Commissariat à l'énergie atomique (CEA) (FR), Institute of Occupational Medicine (IOM) (UK), Malsch TechnoValuation (MTV) (NL), triple innova (DE), Spinverse (FI), Bax and Willems Consulting Venturing (B&W) (ES), Dutch National Institute for Public Health and the Environment (RIVM) (NL), Technical University of Darmstadt (TUD) (DE), Associazione Italiana per la Ricerca Industriale (AIRI) (IT), Nano and Micro Technology Consulting (NMTC) (DE), Swiss Federal Laboratories for Materials Testing and Research (EMPA) (CH), University of Aarhus (DK), MERIT - Universiteit Maastricht (NL), Technology Centre AS CR (CR).

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