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“Small technology - Big Consequences“: Building up the Dutch debate on nanotechnology from the bottom

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The debate on nanotechnology within the Dutch community is of recent time, the last two years seeing it take off slowly but steadily. In this complex arena the Rathenau Institute has played a central role, collecting data, collating thinking, building up arguments, and organising interactive activities such as workshops, focus groups, meetings and newsletters. These all led to the first major public meeting on nanotechnology entitled “*Small technology - Big consequences*“ held on 13 October 2004, and organised in collaboration with the parliamentary Theme Commission on Technology Policy. Nanotechnology in the Netherlands is receiving political attention.

This article reviews various activities of the Rathenau Institute in the field of nanotechnology and highlights their results. It also seeks to give the reader insight into the (inter)national context in which the question of nanotechnology is being debated and the factors influencing current views on the subject.

1 1995 to 1998: conception

In 1995, a Dutch technology 'foresight' commission, the so-called *Overleg Commissie Verkenningen*, carried out a short study on nanotechnology. This was followed by a comprehensive foresight study between 1996 and 1998 coordinated by the Netherlands Study Centre for Technology Trends (STT), in which most relevant Dutch and Flemish nanoscientists participated (Ten Wolde 1998). This initiative eventually led to the establishment of a Dutch national nanotechnology research consortium, named *NanoNed* (see Box 1).

Box 1: Research consortium *NanoNed*

The Netherlands hosts three dedicated nanotechnology research centres: the University of Twente (with the Mesa+ research centre in microsystems technology and nanomaterials), Delft University of Technology (with the Dimes research centre on nanoelectronics) and the University of Groningen (with BioMaDe focused on bio-nanotechnology). These form the core of *NanoNed*. However, four other universities, and TNO, the Netherlands Organization for Applied Scientific Research, are also represented. *NanoNed's* director is David Reinhoudt (University of Twente). *NanoNed's* first research program was entitled NanoImpuls (2002) budgeted at some 45 million Euros from both public (Ministry of Economic Affairs) and private sources. A second research program is now running, budgeted at 102 million Euros of public money, which, somewhat confusingly, is also called *NanoNed*. Technology Assessment (TA) is an integral part of both NanoImpuls and *NanoNed* with up to three percent of the budget invested in TA research, co-ordinated by Arie Rip of the University of Twente.

During its research, the STT asked itself whether discussions on societal aspects should be part of it. STT saw significant opportunities to associate the technology with societal demands. It informally consulted the environmental organisation Natuur & Milieu (Nature & Environment) on the issue, which expressed the wish to first have a discussion on whether society actually wanted nanotechnology. The Rathenau Institute was asked whether it would be able to organise a debate at the end of the STT project. For reasons unknown to the authors such a discussion did not materialise during the STT study. It was only six years later that nanotechnology was put on the Rathenau's working program (2003-2004). Just in time (or just too late?), as 2003 saw the topic reach the public agenda. The Canadian ETC Group (Equity Erosion, Technology Transformation and Corporate Control Group) can be credited for this.

2 Spring 2003: birth

In April 2003, a Member of the European Parliament told us that the ETC group and the 'Greens', were organising a meeting on nanotechnology, to be held in the European Parliament on June 11. Immediate cause of this seminar was the report *The Big Down* published by the ETC group (2003). It described the rise of nanotechnology in terms of government incentive programs, private R&D, patents and product applications and posed the legitimate question as to what the benefits and risks for society would be of this new technology. It also pointed at the many uncertainties with regard to the health impact of nano-particles. *The Big Down* contained 'emerging' criticism directed at nanotechnology, which reminded a commentator in *Nature* of the debate on genetically modified food:

“Nanotechnology is set to be the next campaign focus of environmental groups. Will scientists avoid the mistakes made over genetically modified food, and secure trust for their research?” (Brumfield 2003)

The ETC group also drew public attention to a workshop held in December 2001 entitled *Converging technologies for improving human performance*, organised by the National Science Foundation and the Department of Commerce in the United States (Roco, Bainbridge 2002). The workshop discussed how the convergence of nanotechnology, biotechnology, ICT and cognitive sciences (referred to as NBIC) could improve the physical and cognitive capabilities of humans, both individually and collectively.

At that time - Spring 2003 - hardly any public debate on the social significance of nanotechnology had taken place in the Netherlands. The only people engaged were nanoscientists, commercial firms, and some social scientists involved in *NanoNed*. The latter were setting up a national network and creating ties with a growing international network of social researchers engaged in the burgeoning field of nanotechnology.

A quick round of phone calls at the time showed that the health risks of nanoparticles were not on the policy agenda of either the Ministry of Health, Environment or Social Affairs. The Dutch branch of Greenpeace and Environmental Defence Fund (*Vereniging Milieudefensie*), were not even aware of the term nanotechnology. Media attention to nanotechnology was also close to zero.

To conclude, at the time the *21st Century Nanotechnology R&D Act* was introduced in the United States (June 2003), which demands *inter alia* research into the social and ethical aspects of nanotechnology, the debate on nanotechnology in the Netherlands was more or less non-existent. This, combined with the arrival of the debate in Europe, caused the Rathenau Institute to accelerate its activities on nanotechnology and give the subject a higher priority.

3 Autumn 2003: crawling

In September 2003 we wrote an internal paper covering the fields of application and related social issues involved in nanotechnology and an overview of the public debate and related TA activities in that field in various countries. In Europe, the nanotechnology debate has clearly started in Great-Britain, and was coming very slowly to the Netherlands.

On the European level, the European Commission started by setting up the High Level Expert Group (HLEG) *Foresighting the New Technology Wave* to explore the potentials and risks of converging technologies (NBIC, see above) and its meaning for Europe's R&D policy. The director of the Rathenau Institute, Jan Staman, was invited to join the expert group, which gave the institute a direct link to the international community involved in the societal aspects of nanotechnology. [see also the report on the HLEG's meeting on September 14-15, 2004 in this issue, pp. 118]

On June 11, 2003, the Royal Society and the Royal Academy of Engineering, commissioned by the British government, initiated a study on the possible benefits and problems which nanotechnology might introduce. Inspired by that political move, the Dutch Minister of Education requested the Royal Netherlands Academy of Sciences (KNAW) in August 2003 to launch a *Working Group on the Consequences of Nanotechnology* to analyse the status, further developments and social consequences of nanotechnology. In contrast to the open and consultative process in Britain, the Dutch KNAW working group was an expert committee, consisting of prominent nanoscientists and one social scientist. Based on this working group's report the Minister would decide whether further steps should be taken. In our view the closed expert committee approach did not address the need for involving different social actors in the debate on nanotechnology and start up a dialogue. Clearly there was a task for the Rathenau Institute to fill that gap.

But how to do that was not fully clear at the time. We saw a real need for a Dutch meeting to discuss the health risks of nanoparticles as this topic was receiving ever more international attention, while awareness in the

Netherlands was still thin. Accordingly, we decided to organise a workshop on the issue (see 5.1). We also decided to publish the discussion paper. For this, we would make use of current reports, as those of the Economic & Social Research Council (Wood et al. 2003), and Greenpeace UK (Arnall 2003), and international studies that we knew would soon to be published. For example, our German sister organisation TAB - the Office of Technology Assessment at the German Parliament was finishing a broad study on nanotechnology (Paschen et al. 2003), and kindly allowed us to use their results before publication. Finally, a so-called NanoTeam was set up within the Rathenau Institute consisting of specialists from various distinct fields, like biomedical technology, ICT, agro-food, and communication. Its prime task was to produce a common project proposal.

4 Winter 2003 / 4: a concept agenda

At the end of February 2004, the workshop on *Opportunities and Risks of Nanoparticles* was held, and the publication and project proposal were both ready. Moreover, the parliamentary Theme Commission on Technology Policy [1] had shown interest in organising a public meeting on nanotechnology together with the Rathenau Institute.

Publication 'To value the very small ...'

The publication was written with the help of Ineke Malsch (an experienced consultant in the field of nanotechnology), and Arie Rip (coordinator of TA activities at *NanoNed*). It was entitled in Dutch *Om het kleine te waarderen...* (Van Est et al. 2003). The Dutch verb 'waarderen' (to value) means on the one hand evaluate, quantify or assess, and on the other appreciate or enjoy. The title refers to the need to simultaneously look both to the societal risks and opportunities of nanotechnology. The publication received attention in various national newspapers (cf. Van Calmthout 2004), which meant that for the first time nanotechnology was introduced to a wider audience.

Om het kleine te waarderen... provided an initial concept agenda for public debate, and, logically, also for the Rathenau project on nanotechnology. Table 1 summarises the main (groups) of societal issues and related dream and horror scenarios that the study identified. It is striking that nanotechnology touches upon so many familiar social issues, from ICT and privacy, predictive medicine, the ethics of war, and sustainability to social guidance of innovation and North-South issues. Relatively new issues related to nanotechnology include human engineering or enhancement, the (im)possibility of self-reproducing nanobots, and the borders between living and non-living material. The most current topic is the health effects of nanoparticles.

Project proposal

The basic idea was to organise a public event, in which politicians would play a central role. Its goal would be to find out whether it would be necessary to organise a large public debate on nanotechnology (like the debate on genetically modified food) in the Netherlands. And if not, what (if any) kind of actions should be taken?

Om het kleine te waarderen... was positioned as a background paper in preparation of such a public meeting, to be organised in Autumn of 2004 (see 6). We used Table 1 to structure our project. Consequently, we organised workshops on the health effects of nanoparticles (5.1), nanoelectronics (5.2), and biomedical nanotechnology (5.3). Around military nanotechnology no workshop was set up, but the issue was taken up as part of a study on military technology in general. Since agrofood is an important Dutch industrial and R&D sector, but was treated only in a very concise manner in the study, it was decided to also organise a workshop on nanotechnology in the agrofood sector (5.4). Table 1 shows a great many potential controversial issues that surround nanotechnology. To get an idea on how people perceive nanotechnology, several focus groups with Master students were organised (5.5).

Table 1: Societal issues and dream and horror scenarios for different fields of applications in nanotechnology

Field of application	Societal issue	Dream scenario	Horror scenario
Nanomaterials / industrial production	Health- and environmental issues	Sustainability	Nanoasbestos
	Self-(re)production	Universal assembler / personal fabrication	Grey Goo

Nanoelectronics	Privacy	'Smart' products and environments	Big Brother
Bio-electronics	Engineering of humans	World without 'handicaps'	Discrimination of 'handicaps'
	Mixture of living and nonliving	Coupling to the internet (free from mortal body)	Dehumanisation and alienation
Nanotechnology in medical spher	Predictive medicine	Early diagnostics Tailored medicine	Genetic coercion and / or exclusion Split in health care
Military technology	Arms race	Safe world	New weapons and arms race / proliferations (use by terrorists)
	Ethics of war	Zero-casualty / remote control war	Killer robots / space war
	Engineering of humans	'Invincible warriors'	Cyber soldiers
General / innovation	Patents	Equal distribution of profit and wealth	Monopolisation of knowledge and profit
	International development	Equal distribution of wealth	Nanodivide
	Steering / dialogue	Societal steering	Technological determinism
	Economy	Growth of economy and employment	Shrinkage of economy and employment

Source: Van Est et al. 2003, p. 54

The goal of the workshops was to involve nanoscientists, industry, NGOs, social scientists, and policymakers in the social debate on nanotechnology. An electronic newsletter was set up that summarises project activities and publishes the latest news on nanotechnology by other (international) organisations. In this way we tried to engage as many people as possible in the itinerary towards the first Dutch public debate on nanotechnology in the Autumn of 2004.

5 Spring 2004: first steps

In this section we highlight some outcomes of the various preparatory activities. [2] In particular, the many and distinct societal uncertainties involved in various fields of application of nanotechnology are illustrated.

5.1 Nanoparticles - many unknowns about health effects

The workshop *Opportunities and Risks of Nano-particles* was held on February 17, 2004 in The Hague and confronted nanoscientists for the first time in public with the attitudes on this emerging political topic.

During the workshop it was clear there were many uncertainties as to health effects of nano-particles. And there is uncertainty still as to what artificially created nano-particles might do in the body. For example, the mechanism by which aerosols cause damage to the lungs is still unknown. Precautionary measures have been taken for researchers in laboratories and production employees who work with nano-particles, but it is not yet known whether these are effective. An additional problem is that it is not clear how to measure nano-particles. It is also uncertain whether the standard rule applicable in toxicology - that risk is the product of the level of exposure and intrinsic danger - applies to nano-particles. Finally, current clinical studies may be not suited to deal with the health effects of nano-particles.

5.2 Nanoelectronics - uncertainty about consumer demands

Surprisingly, privacy was not the main issue at the workshop *Nano-electronics and ambient intelligence*, held on March 25, 2004 in Eindhoven. The most important issue put forward here was the uncertainty about consumer demands. For decades technology development in the electronics sector has been described by Moore's law. Accordingly, roadmaps have been designed up to 2015 (and beyond) that almost predetermine technological progress for the coming decade.

In sharp contrast to the predictability of the technology, it is impossible to predict which applications will end up being a commercial success. This means huge investments must go into product development without the certainty that it will produce results. Innovation is thus economically vulnerable. Moreover, society and government are confronted with an endless stream of unforeseen and potential culturally 'radical' innovations, like the mobile phone.

5.3 Health care - unclear relation between (early) diagnosis and disease

Early diagnostics and tailored medicines are the two dream scenarios mentioned in Table 1. The first scenario got most of the attention in the workshop on *Biomedical nanotechnology*, which was organised in Utrecht on July 7, 2004. Combined with early detection of disease risks based on genetic profiling (DNA diagnostics), molecular imaging (nanodiagnostics) seems to offer the possibility to detect diseases earlier and more effectively than hitherto and fight them with fewer side effects.

During the workshop several social risks were identified. Early diagnostics may lead to both a far-reaching medicalisation of normal life, as well as unnecessary medical interventions. Defects are constantly occurring in the body which the body itself repairs. In the background to this problem is the fact that there is no unequivocal relationship between a defect occurring and the occurrence of a disease. The earlier the diagnosis, the less clear the relationship. A related issue is reliability. Who would be liable if a false prediction were to be made? Liability issues could lead to only a limited number of tests being offered. Strict admission procedures apply to (the use of) new medicines and new treatment methods. Applicable protocols generally focus on clinical practice: the treatment of the actual disease. It is still unknown how the clinical trials should be handled with regard to early diagnostics.

5.4 Agro-food sector - uncertainty about social acceptance

Among the participants of the workshop *Nanotechnology in the agrofood sector* held on April 8, 2004 in Wageningen, there was huge uncertainty about the social acceptance of food in which nanotechnology has been applied. This could be met with the same rejection as genetically modified food because nanotechnology also involves 'artificial' intervention in 'natural' food cycles. Furthermore, it is unclear what the possible health risks of nanoparticles in food are. They are often produced differently to particles occurring in nature, which could mean they are less degradable. It was also said that several realistic risks lurk behind the so-called *Green Goo* scenario, which is the fear that the use of self-reproducing nanoparticles in nature may lead to an artificial micro-organism that could alter the environment into a green, uniform mass.

5.5 Public perceptions - positive expectations and worries about regulation

There is much speculation as to how lay people see nanotechnology, but not much is known. To allow a more informed discussion, three focus groups were organised with Master students. In the study *The double message of nanotechnology: research into rising public perceptions*, Hanssen & Van Est (2004) compare the results of the Dutch focus groups with focus groups organised in the United Kingdom and Denmark, and public surveys held in the United States and Europe. The following two main features emerged:

- *Limited familiarity, positive expectations*
Quantitative research shows that the general public in Europe and the United States has limited familiarity only with nanotechnology. A British and American survey showed that 29 and 32 percent of people questioned, respectively, knew what nanotechnology was. The public is mainly positive towards nanotechnology: 68 percent of the British expect nanotechnology to improve the quality of life and 40 percent of Americans see more advantages than disadvantages. These findings are confirmed by the results from the focus groups in Denmark, the Netherlands and the United Kingdom. Participants see possibilities to fight diseases, and for a better environment. They hope that nanotechnology will be applied to these ends. Not many people are waiting for improved or cheaper consumer goods.
- *Uncomfortable with regulation*
Next to positive expectations, people also have worries. In particular, the focus group discussions showed that people are not comfortable with the regulations on and control of nanotechnology. The industry's growing influence on how technological developments are controlled play a role in this. People also worry about the risk of nanoparticles ending up in the body or environment, a new arms race and

the loss of privacy through new electronic methods of detection. Finally, many people fear that the benefits of nanotechnology will only benefit the West and will ignore the Third World.

Recommendations of the KNAW Working group

At the time the public meeting on nanotechnology was held, various committees that had been set up over the previous year to study the societal risks and opportunities of nanotechnology had finished their job. In the UK the Royal Society and the Royal Academy of Engineering (2004) presented their advice to the government in July 2004. The report expects that the concerns in the short to medium term will focus on two basic questions: (1) who controls and (2) who benefits from uses of nanotechnologies? Therefore, it is recommended that

“...a constructive and proactive debate about the future of nanotechnologies should be undertaken now - at a stage that it can inform key decisions about their developments and before deeply entrenched or polarised positions appear.”

In August, the Royal Netherlands Academy of Sciences' working group Consequences of Nanotechnology (KNAW 2004) came up with similar types of recommendations (see Box 2).

Box 2: Recommendations of KNAW Working Group

- The government should develop new regulations within the existing legal frameworks for introduction of new nanoparticles in society.
- More research should be done on the toxicological qualities of nanoparticles and their kinetics in organisms and environment.
- A moratorium on nanoscience and technology is very undesirable based on the principle of proportionality.
- The Ministries of Education, Culture & Science and Economic Affairs should encourage the general public to be informed on nanoscience and nanotechnology. It is crucial that the general public is actively involved in the discussion on the future of scientific research and its applications.
 - The government should start a structured open discussion on risks and benefits of nanoscience and technology based on the lessons learned on the introduction of genetically modified food.

6 Autumn 2004: Public meeting in Parliament 'Small technology - Big consequences'

The first public meeting on nanotechnology in the Netherlands was held on Wednesday afternoon October 13, 2004 in the Dutch parliament building in The Hague under the title *Small technology - Big consequences*. The goal of the meeting was to inform politicians and other social actors about developments in the field of nanotechnology, and discuss related relevant political and societal questions.

One of the objectives of the Parliamentary Theme Commission on Technology Policy which was involved in organizing the meeting was to experiment with new types of methods. Instead of opting for the classical hearing, it was chosen to organise four interactive debates between stakeholders from different societal domains, like social scientists, nanoscientists, businesspeople, societal organisations, government, politics, and the public. These different groups of stakeholders got a distinct place within the debating arena (see Photo). In this way the public meeting was thought to present an early reflection of the rising public debate.



Some 120 participants debated the following four themes:

- Nanoscience or nanofiction? (Debate about the relevance of nanoscience, and about which expectations are and are not realistic)
- Nanotechnology, motor of the Dutch knowledge economy? (Debate about the relevance of nanotechnology for the Dutch economy, and how innovation can or should be fostered)
- Nanotechnology in the same track as biotechnology? (Debate about what societal issues are related to nanotechnology, and whether the debate on nanotechnology will become polarised)
- What to do next?

Big expectations, uncertain future

The public meeting showed that nanotechnology is expected to face a big, but uncertain future, since it is - at the moment - not clear in which directions it will develop. The extensive and far-reaching promises of nanotechnology make it hard to get a comprehensive and concrete picture of it, and develop a well-grounded opinion on it. But at the same time, developments in this field are felt to be going very fast. To seize the opportunities and problems of social acceptance, as in the case of GM food, it is important to involve citizens and NGOs already now in the debate. It is the role of the government to facilitate an open debate between politics, citizens, firms, science and societal organisations. Such a debate should not only focus on risk issues, but should pay attention to ethical dilemmas and beliefs too.

No sense of urgency, lack of involvement

Few people were in favour of organising an extensive public debate, like the Dutch debate on GM food "*Eten en Genen*", which was held in 2001. There exists too little awareness on nanotechnology among citizens to justify that, moreover the issue at the moment lacks a sense of urgency. In particular, this was proven by the absence of many NGOs at the public meeting, although a lot of effort was put in beforehand to get them there. In particular politicians regretted that only the 'in-crowd' was present at the meeting, and expressed the need for more involvement of societal organisations, since it would offer politicians a good view of the pros and cons of nanotechnology.

7 Concluding remarks

"The starting point is to acknowledge that we don't know what the risks of nanotechnology are, and we don't know what the benefits are, and we won't for some time." (Roger Kaspersen; quoted in Weiss 2004)

This article described how over the last year the public debate on nanotechnology in the Netherlands has been built up from the bottom. The first activities made clear that nanotechnology is still at an early stage of development, but loaded with expectations and shrouded in uncertainty. This conclusion came out of the public meeting, and was illustrated by the preparatory activities (see 5):

- many unknowns about health effects of nanoparticles;
- uncertainties about consumer demands and societal effects in the field of nanoelectronics;
- uncertainty about social acceptance of food products made by nanotechnology;
- unclear relationship between early diagnosis and disease.

Risk communication expert Kaspersen (see quote above) argues for the acknowledgement of these many unknowns and uncertainties about the risks and benefits of nanotechnology and take them as a starting point for further debate and measures. Policymakers, however, have a doubtful track record of acknowledging societal risks related to technology in advance. In cases like asbestos, nuclear power and GM foods, outside public pressure was needed to get such issues on the political agenda. This is fatal to public trust, since the actors involved are perceived to have failed to act in the public interest, by only looking at the benefits and not at the risks.

The challenge for the future, therefore, is to prevent the same mistakes, and address the benefits, risks and uncertainties involved in due time. One of the ways the Rathenau Institute will take up that challenge is to select five concrete applications that will likely come on the market within the coming ten years, and start a stakeholder dialogue on the societal issues at stake, and what appropriate measures should be taken. In this way the discussion on nanotechnology may become more concrete, which may increase the involvement of NGOs and citizens in this debate. This in its turn may help politicians obtain a clear picture of the pros and cons of nanotechnology.

Notes

[1] Besides Permanent and Temporary Commissions, the Dutch Lower House currently has two so-called Theme Commissions: one on the Ageing Society, the other on Technology Policy. These Theme Commissions seek to take a more reflexive, long-term, and pro-active stance towards a certain topic or theme.

[2] This paragraph is based on an internal paper written by Frank Biesboer, which summarises the main results of the preparatory workshops.

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