Work Programme 2009–2010

Rathenau Instituut

The **Rathenau Institute** shows the influence of science and technology on our daily lives and reveals the dynamics of this process through independent research and debate.

Work Programme
Rathenau Instituut
2009 – 2010

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Rathenau Instituut Work Programme 2009 – 2010

Summary and Reader's Guide

The Rathenau Instituut Work Programme 2009-2010 describes the research themes on which the Technology Assessment (TA) and Science System Assessment (SciSA) departments will be working in the period 2009 – 2010.

General

The Rathenau Instituut stimulates public debate and political opinion-forming on the social, ethical and political effects of science and technology. The institute also examines how the science system is organized and how it responds to scientific, social and economic changes.

In the first instance, the institute focuses on parliament, the government and policy-makers in the ministries and scientific bodies. In addition, we look at the European Parliament and society in the broader sense (the general public, business community and civic organizations) as important, relevant parties.

The Rathenau Instituut has two departments which support and complement one another although each has its own task and objectives. These are the Technology Assessment and Science System Assessment departments.

The Technology Assessment (TA) department explores, identifies and advises on the influence of science and technology. It organizes discussions to promote the formation of political and social opinions.

The Science System Assessment (SciSA) department studies the science system. It collects, integrates and analyses data, using it to provide knowledge for policy and scientifically-substantiated policy-making.

The Rathenau Instituut works closely with European and international institutions and organizations. It is, for example, one of the driving forces behind the alliance of European parliamentary technology institutes, European Parliamentary Technology Assessment (EPTA). It also collaborates on an international basis in the field of SciSA, such as in the European Union-financed European Network of Excellence, Prime. The Rathenau Instituut regularly publishes policy and research reports and uses diverse participative and interactive work forms such as focus groups, expert meetings, public debates, talk shows and forum discussions to spread information. Because the social and political debate on themes with which the Rathenau Instituut is occupied is largely held in the media, it is important that we create a high profile for ourselves.

We also make use of representational forms and experiential communication, including films, exhibitions and art projects in which the public can participate.

Technology Assessment *(pg. 25)*
In the work programme period, 2009 – 2010, the TA department is concentrating on four areas of research: The Usable Body, the Hunger for Raw Materials, the Prevention Society and Digital Hyperconnectivity.

The Usable Body *(pg. 30)*
Our bodies are not only becoming more 'makeable', but also more 'usable'.
We are examining into three trends within this theme:
- The personalization of medical technology and the development of the self-care market. New care technology gives the individual control over his or her own health. The Rathenau Instituut homes in on this trend in order to trigger interaction between the various interested parties.
- Human enhancement. The technological possibilities for perfecting the human body extend over many domains and throughout one's entire life. The Rathenau Instituut raises fundamental, ethical and legal questions relating to this development and tries to get concrete issues onto the political agenda.
- The market for body materials. Ova, blood, kidneys, stem cells from umbilical cord blood, you name it - our body materials are becoming valuable commodities. The Rathenau Instituut wants to inform and involve interested parties and contribute to the development of new forms of future-proof regulation.

The Hunger for Raw Materials *(pg. 34)*
The term 'Hunger for Raw Materials' refers to the complex social dynamics of the issue in which hunger in the sense of a shortage of food fights for priority with our hunger for energy.
- Sustainable energy. The Rathenau Instituut aims to add the citizen's perspective to the debate on our energy supplies on the basis of the standpoint that social support is a crucial factor in the large-scale deployment of some energy sources.
- Bio-nanobased economy. The current raw material question provides opportunities for new technologies such as bio and nanotechnology. Can these developments actually contribute to a more sustainable (cleaner, more economical) use of raw materials? The Rathenau Instituut explores the social possibilities and risks of the transition to a bio-nanobased economy.

The Prevention Society *(pg. 37)*
In the theme 'Prevention Society', the Rathenau Instituut examines the relationship between the need for security and health and the deployment of technology.
- Technologicalization of border surveillance. Biometry is the collection of technologies that measure and record the unique physical characteristics of individuals. The Rathenau Instituut examines the desirable and undesirable consequences of the use of biometry in monitoring borders.
- Profiling and architecture of databases in detection and security. The police, law and investigative services are making increasing use of digital files that can contain enormous amounts of data. The Rathenau Instituut explores the underlying political choices made in the architecture of such databases.

– Screening and prevention programmes. The Dutch Youth Healthcare's Electronic Child Database (EKD JGZ) and the national Electronic Patient Record (EPD) are large-scale medical prevention projects that lead to social questions and resistance. The Rathenau Instituut aims to get the debate going about the accompanying shift in boundaries in the relationships between government, healthcare sector and citizens.

Digital Hyperconnectivity *(pg. 40)*
In this theme, the Rathenau Instituut reflects on contemporary and future phenomena on the interface between information technology and the cognitive sciences.

– Public space 2.0. With the emergence of technologies such as Radio Frequency Identification (RFID), Near Field Communication (NFC) and Google Earth, and navigation systems like Global Positioning System (GPS), public space is becoming more and more virtualized. The Rathenau Instituut reveals the consequences of this fact. We also want to get the debate on, and regulation of, virtual worlds on both the political and public agendas. To this end, amongst other things, we are staging a play in which virtual and physical personages blend.
– IT and the cognitive sciences. Under this title, the Rathenau Instituut explores the area where information technology and the cognitive sciences meet - both now and in the future. We map the related technological possibilities and social visions and see to it that the future social scenarios and issues are placed on the agenda.

Science System Assessment *(pg. 47)*
The SciSA research programme has four main objectives:

1 To give a total picture of how the research system functions.
2 To provide a periodic overview of promising developments in science and technology.
3 To provide understanding of social opinion and judgements on the science system and how they are formed.
4 To provide interested parties with sound, accessible information on new scientific and technological developments and on the functioning of complex knowledge systems.

The five questions that were central to the SciSA research programme in the period 2006 – 2008 will again form the leitmotiv in 2009 – 2010:

– The value of science: what value does science have for us and how can we measure this?
– The dynamics of research fields: what are the various dimensions of the development of research fields? Can a typology of research fields be made on this basis?
– How the institutions work: what influence does institutional structure have on knowledge production and knowledge use?
– The organization of the science system: how do organizational forms influence knowledge production and knowledge use?
– The dynamics of research groups: what factors affect the functioning of research groups and how?

The Value of Science *(pg. 55)*
There is global agreement on the various dimensions of research output. These dimensions include excellent scientific knowledge, knowledge that has social impact, highly-qualified, creative knowledge carriers, networks between knowledge producers and users, and knowledge as a contribution to the culture of modern society. However, it is not a simple matter to convert these dimensions into usable indicators.

The Rathenau Instituut uses a number of methods. For example, we look at what relevant insights the long tradition of TA research has yielded. With the aid of historic case studies, we also study interventions that improve the conditions for (and the chance of) top quality and impact. Amongst other things, we are carrying out a study into the occurrence, the functioning and (if relevant) the 'disappearance' of excellent research groups. What have we learned about the conditions required for excellence?

One important condition for the social impact of research is that the results reach actors who can use them. Amongst other things, this leads to questions about the accessibility of knowledge. The Rathenau Instituut is examining the issue of whether 'open access' to data and results leads to better utilization of knowledge.

The Dynamics of Research Fields *(pg. 58)*
Researchers in any particular discipline refer to and build on work carried out by one another. The changing citation relationships in specialist journals and articles are useful for mapping the dynamics of areas of research. They can be used to sketch a picture of the central and peripheral research themes and of the institutes and countries that are actively working on these themes. We can then look at the position of Dutch researchers in promising fields and whether there are networks of research institutions and organizations and companies that may be able to use the knowledge in question.

The Rathenau Instituut has already analysed a number of fields in this way. These areas include water safety, genomics, nanotechnology, self-healing materials, media and communication. It is particularly concerned with fields that have raised great social and scientific expectations. Subjects for new (descriptive) field studies are: river and coastal research, genomics, transdisciplinary education science and regenerative medicine.

How the Institutions Work *(pg. 60)*
The research into how institutions in the science system work focuses on the themes of agenda-setting and funding. The Rathenau Instituut looks at various aspects, including the influence of the increasing internationalization on agenda-setting and at the national level. How is the agenda set at European and international level, how does this affect the actual practice of research and the research themes and directions?

Furthermore, the Rathenau Instituut carries out research into how various financing instruments work. What objectives are pursued? Are these objectives achieved and why, or why not? What unintended or undesirable side effects arise?

The Organization of the Science System *(pg. 62)*
Amongst other things, the research into the organization of the science system concentrates on the question of what the atlas of the Dutch research system looks like (who does what for research in the Netherlands and to what degree?). We are also examining the current and possible role of universities of professional education in research, as well as looking at the situation in several other countries and at the opportunities and risks of increasing Europeanization.

Researchers and Research Groups *(pg. 64)*
The Rathenau Instituut examines the way in which research careers are regulated in the Netherlands. A preliminary study has looked at the promotion of talented young researchers and measures taken by universities to promote advancement. Various other aspects of research careers will be examined in follow-up studies. We also compare research careers on an international basis.

Research groups form the smallest building blocks in the science system.
The Rathenau Instituut carries out research into, and works on, modelling of the nature and functioning of research groups. A review of the available knowledge on how research groups function forms the basis of the research on this theme. Moreover, we examine the relationship between the management of research groups and their performance, asking research managers about their management style and how they allocate their time to management, research and education. Data on scientific achievements and the social impact of research groups are also included.

Contents


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Foreword

Technology and science are developing faster than ever. Innovative technologies such as nanotechnology, molecular biology, the cognitive sciences and information technology can change the world fundamentally. But they are not the only things that are changing at a tremendous speed. Social changes, such as the ageing of the western world, the growth of megacities in developing countries and a world economy in which economic power and concentration are shifting, are manifesting themselves at a feverish tempo. Moreover, we face crises that are causing existing establishments to shake to their foundations: simultaneous credit, climate and food crises.

In order to properly link science and technology with ecological and social challenges, systematic attention will have to be paid to the relationships between science and technology and society. We will have to focus our attention on questions such as: How does the science system function? How can we properly link this science to social challenges, or better than is currently the case? And what effects do technological solutions have on society as a whole?

But attention of this kind is not automatically paid to such questions – in society or in politics. The problems are enormous, political institutions cannot keep up with them and, because of their nature, they cannot be delineated or easily tamed. They require a helicopter view and a cross-policy and terrain analysis. The Rathenau Instituut analyses and discusses these questions, so enabling political and social discussion. This is realized by the multidisciplinary team of scientific researchers, trend catchers and communication experts that work at the Rathenau Instituut. In this team, physicists, biologists, statisticians, computer scientists and technical engineers cooperate with social and political scientists, philosophers and economists. Their joint objective is to develop a clear picture of the political and social discussion and to feed and stimulate it as much as possible.

It is not possible to do this in all fields at the same time. This work programme therefore contains the technological and scientific developments the institute deems crucial in conquering the problems currently confronting our society.

1 The Rathenau Instituut Werk Programme 2009–2010

Mission
The Rathenau Instituut stimulates public debate and political opinion forming on the social, ethical and political effects of science and technology. The institute also examines how the science system is organized and how it responds to scientific, social and economic changes.

The Institute

The Rathenau Instituut is an independent organization that advises parliament on the influence of technology and science on society and the nature and structure of the science system. The institute deems the Upper House, the government, the European Parliament and society (citizens, companies, civic organizations and scientific institutions) to be relevant parties.

The objective is to describe the science system and bring developments in science and technology into focus in good time. The institute wants to involve society and initiate social debate, and knowledge and science-based interaction are indispensable for this purpose.

The institute not only collects and provides reliable information to this end, but clarifies it too; it demonstrates social, ethical, cultural and legal frameworks and sketches long-term visions.

The Rathenau Instituut reveals the various standpoints of interested parties and organizes interaction between citizens, stakeholders and scientists, and between politicians and society in general. The institute gets parties that do not communicate with each other, or no longer do so, around the table and talking.

History

The discovery of recombinant DNA, nuclear energy and micro-electronics were technological developments that led to massive demonstrations and political and social debate in the nineteen seventies.

The coalition agreement of the Lubbers Cabinet (1982) therefore laid down that the Minister of Education and Science had to promote research in order to make clear the 'social and ethical consequences of technological innovations and their introduction'. In 1986 the Netherlands Organization for Technology Assessment

(NOTA) was set up. Its objective was to carry out research into 'the social aspects of science and technology', in other words: Technology Assessment (TA).

Initially TA was seen as a special form of policy analysis. But the organization at tached a great deal of value to interactive methods right from the beginning. If the opportunities provided by technology are to be seized and possible problems avoided, it is important that society is involved in developments at an early stage. This was realized through expert meetings, workshops, public inquiries and conferences, and these methods are still used.

In 1994 the NOTA was renamed the Rathenau Instituut, a tribute to Prof. G.W. Rathenau, then director of the Philips Physics Laboratory (Natlab). Prof. Rathenau was one of the first advocates of research into the social consequences of technology. When the name of the institute was changed, the focus changed, concentrating more on public debate and political opinion forming. Since the nineteen nineties, the institute has been experimenting with methods for actively involving citizens in science and technology. For example, it organizes focus groups, citizens' panels, questionnaires and opinion polls. Technology festivals, media performances, public debates and the use of new and traditional media are also included. The institute aims to make links with film, photography and theatre.

In 2004 the institute was commissioned by the Minister of Education, Culture and Science to develop a second core task: Science System Assessment (SciSA). The objective was to increase understanding of how the science system works and to make data about this accessible for policy.

Tasks

The official description of the Rathenau Instituut's tasks is as follows:

- The institute's task is to contribute to social debate and political opinion-forming on issues relating to or resulting from scientific and technological developments. This includes ethical, social, cultural and legal aspects. The institute contributes in particular to the formation of political opinions in both the Upper and Lower Houses of the States General, the European Parliament and the relevant parties in the scientific world.
- The institute also has the job of increasing understanding in how the science system works. Furthermore, it collects data that is lacking, integrates the available data and makes this accessible.

To this end, the institute has two departments which support and complement one another although each has its own task and objectives. These are the Technology Assessment and Science System Assessment departments.

The Technology Assessment (TA) department explores, identifies and advises on the influence of science and technology. It organizes discussions, the purpose of which is to promote political and social opinion-forming.

The Science System Assessment (SciSA) department studies the science system. It collects, integrates and analyses data, using it to provide knowledge for policy and scientifically-substantiated policy-making.

The research areas of the TA and SciSA departments are close so that, for example, knowledge of the science system contributes to describing and understanding the influence of science and technology on society. And new developments and applications are often already visible in the science system for a considerable length of time before they impact on society. Synergy is created between the two departments in that data, analyses, research methods and networking are shared and results from one department are used as input for the work of the other. The SciSA field study into regenerative medicine, for example, will play a role in the projects falling under the theme 'The Usable Body'.

International Cooperation

Because developments in technology and science are not restricted by a country's borders and because the science system is internationally interwoven, the Rathenau Instituut works closely with European and international institutions and organizations.

The institute is one of the driving forces behind EPTA, the alliance of European parliamentary technology institutes. A number of joint TA projects are carried out, on a European level, within this framework.

The Rathenau Instituut also assesses technology for the European Parliament. This is coordinated within the parliament by Science and Technology Options Assessment (STOA). To this end, the Rathenau Instituut cooperates in the European Technology Assessment Group (ETAG), which has consisted of seven European parliamentary TA organizations since 2009. These are the Danish Board of Technology, the German ITAS, the Flemish viWTA, the Austrian ITA, the Catalonian CACIT, the Czechoslovakian TCASCR and the Dutch Rathenau Instituut.

The Rathenau Instituut cooperates internationally on SciSA, too, the European Union-financed European Network of Excellence, Prime, being a significant participant. Prime includes all the important groups that carry out research into the dynamics of science, the organization and functioning of the science system and scientific policy. It also has partnerships with related research groups outside Europe.

Identity and Image

Independence and expertise are important core values of the Rathenau Instituut. If we are to realize our objectives and ambitions, it is vital that we are in the middle of society and have a contemporary image. The Rathenau Instituut's core values are expressed in all of our activities and communications. The new house style we introduced in 2007 and our corporate means of communication play a supporting and reinforcing role here.

Communication

The Rathenau Instituut regularly publishes policy and research reports to provide politicians and policymakers with information that is relevant to policy and to alert them to trends and developments. We gather experts' visions around a topical theme in collections of essays, so providing a quick overview for those involved and those with interests in the theme in question. In our Reports to the Dutch Parliament, we provide members of parliament with tailor-made analyses and recommendations.

SciSA fact sheets entitled 'Facts and Figures' collect relevant information about the Dutch science system and make it accessible for those who are interested. We provide succinct, accessible insight into scientific or technological trends and developments in our 'Specials'. The Rathenau News, full of up-to-date information on our studies, projects, publications and other activities, appears every quarter.

On the occasion of the international EPTA conference 'Inspiring Future Politics' in 2008, we published the technology magazine 'Flux'. In 2009 we intend to publish new editions of Flux and further elaborate and flesh out the formula of this magazine.

Meetings

The Rathenau Instituut uses a range of participative and interactive methods such as focus groups, expert meetings, public debates, talk shows and forum discussions to promote interaction with citizens, policymakers, politicians and other involved and interested parties. What we are trying to achieve here is the exchange of thoughts or to initiate a debate to get the images, visions and standpoints of participants out into the open. The outcomes and results of these meetings form the input for ongoing studies and projects or follow-up research and projects.

In the first half of 2009 we used focus groups for a study into the general ideas and opinions of citizens regarding technology. The Rathenau Instituut also participated in the Netherlands Organization for Scientific Research (NWO) Spinoza debates. A new series of these debates will start in the Paard van Troje, a venue in The Hague, in 2009. The SciSA department is also organizing a series of lectures for policy-making officials on the science system in different countries.

Publicity

The social and political debate on themes with which the Rathenau Instituut is concerned is largely conducted in the media. Opinion pieces by Rathenau Instituut researchers appear very regularly in national newspapers. We are also frequently asked to respond to current developments by journalists.

The media are crucial in getting themes onto the agenda. They are also often the appropriate channel for intervening in debates that threaten to get mired down in old differences of opinion. Our approach in such cases is often to inject aspects or insights into the discussion that have so far had insufficient exposure. We try to augment debates, contribute to the removal of black and white contrasts and to give discussions new impetus or another turn. Visibility in the media and a good relationship with the press again have high priority in this coming work programme.

Digital communication
The Rathenau Instituut's website will be fully revamped in this programme period. Points of departure for the new site are that it be informative, accessible, interactive and attractive. It will be up-to-date and reliable and provide comprehensive, relevant information on science and technology. Coverage will also take up current political and social discussions, providing a platform for discussion and debate. Discussion forums and opinion polls on specific themes, interactive forms such as (serious) games, the initiation/facilitation of theme-related activities in communities and the setting up of a wiki are all conceivable.

Representational forms / experiential communication
We use representational forms and experiential communication to involve the public, press and politicians in science and technology in a playful and narrative fashion. During this programme period we want to get the market for body materials onto the agenda by means of a documentary or television programme. Many people still feel that this theme does not concern them and television or film will have to be used to bring the situation home to them. Furthermore, we want to set up an exhibition to make the theme of social robots tangible.

We are going to explore the common ground and overlaps between virtual worlds and the real world by means of an art project in which the public will participate. In addition we are working with a museum in The Hague on an exhibition with 'science maps' that show the dynamics of knowledge. This exhibition will be held at the end of 2009.

Events
The Rathenau Instituut holds large events every year. These events do not all focus on generating attention from politicians, press and public for important scientific and technological trends and themes. They are also intended to raise the institute's profile and positioning amongst important target groups, interested parties and partners.

Projects 2009
State of affairs in August 2009

Technology Assessment	
The usable body	
Medical Devices	A great many developments, including the growing availability of self-tests on the Internet, are giving people more and more control over their own health. We are examining the consequences of this development on the healthcare system and the responsibilities of care providers and care consumers. What information is needed for the social and political discussion, and soon? This project is being carried out on the instructions of the Ministry of Health, Welfare and Sport, and will result in a collection of essays. Expert meetings will be held to this end. The conclusions and recommendations will be well publicized when the essays appear. Parliament, in particular, will be informed of the findings of the project.
Human Enhancement	There are increasing technological possibilities for perfecting the body. The current political discussion on human enhancement is primarily being carried out on the basis of theoretical positions and, to a much lesser extent, on the actual state of affairs and opinions of citizens. The Rathenau Instituut is therefore carrying out a public survey and analysing the dilemmas in order to inform parliament and the general public accordingly. This project will result in a report and an interactive website.
Body economics	New technology is making it possible to change bodies, or parts of them. New markets are presenting themselves and they require new forms of regulation. The nature and dimensions of these new practices are being explored in a number of empirical case studies in the Netherlands and abroad. With this project, the Rathenau Instituut hopes to spot developments, and distinguish fact from fiction, in their early stages. A collection of essays, and possibly also a Notice to Parliament (Bericht aan het Parlement), will be offered to experts, parliament, ministers and secretaries of state. A documentary and related interactive website will also be produced for TV transmission.
The hunger for raw materials	
Energy in 2030	How far can the Netherlands go, and how far does it want to go, with energy conservation, the use of sustainable energy (such as sun, wind and biomass) and how many finite energy resources (fossil fuels and uranium) will we then still need? The Rathenau Instituut is developing an accessible and cohesive overview of the Netherlands' energy options in the form of a book of images. This book will pay explicit attention to the social context of the various energy options and bring them up for discussion amongst the general public. We will also be examining how the Dutch policy for making energy supplies more sustainable is turning out on a regional level.
WWViews on Global Warming	Op 26 September 2009 about five thousand citizens all over the world will take a good look at climate change during the WorldWideViews on Global Warming (WWViews) forum. With WWViews, citizens worldwide will be given a voice in the UN climate negotiations. The Rathenau Instituut is organizing the Dutch panel. To prepare for these activities, we are organizing a debate with science journalist, Mark Lynas, on 1 September 2009. Lynas is the author of the book Six Degrees, in which he explains, graphically, the possible ecological and socio-economic consequences for each degree the earth warms up. The debate will, amongst other things, raise the question of whether this representation is correct and examine the role of science and journalism in translating these images to the social debate.
The prevention society	
Databases in the picture	On the basis of a number of cases, this project will go into the growing use of digital data files and information systems in society, for private, corporate or public purposes. Besides opportunities, there are also risks attached to the use of digital databases: file pollution, faulty links and the misinterpretation or misuse of data. Case studies in the project are the Dutch Electronic Patient Record (EPR), Electronic Child Database (EKD), the public transport chip card and the Schengen Information System. Key points for attention here are design, processing, access and efficiency.
The technological borders of Europe	In February 2009 we presented the book De Migratiemachine (The Migration Machine) to the Secretary of State for Justice in response to his call to map technologies in international migration policy and particularly at the European level. We have also started preparations for the publication of the book: 'Europe's New Technological Borders' in the English language in 2010. Furthermore, we are carefully following current discussions concerning several important files on migration technologies so that we can jump into the discussion and intervene, if expedient, on the basis of existing research.
Digital hyperconnectivity	
Digitalization of public space	This project focuses on actions that are increasingly mediated by digital technology: tracking, paying, identifying, authorizing and profiling. A book that describes the new phase of the information society will be appearing in mid 2010. Two of the five case studies are the networked car and the 'real-time web'. The networked car will be reflected digitally in the Internet application, 'The BMW of Lickny2001' to supplement the book. This car can be followed online and, in this way, brings the virtual network of telematic connectivity into focus. The scenario of the 'real-time web' is brought into the picture with the interactive design Geocam. The objective of both Geocam and 'The BMW of Lickny2001' is to stoke debate on the opportunities and challenges of the digitalization of public space.
The rules of play of the hard virtual reality	In virtual worlds such as 'Second Life' and 'Habbo Hotel', the line between game and reality is difficult to draw. On the basis of a study carried out by an internship student at the Dutch embassy in South Korea, we are publishing a report that describes the far-reaching regulation mechanisms of virtual worlds used by the South Korean government. Moreover, in 2009 a play will be written that explores the boundary between 'virtual' and 'real'. The idea is to stage this play in 2010.

Social Robots	A study of various areas of application of robotics: in the household, healthcare system, the armed forces, transport systems and police tasks, will be appearing at the end of 2009. In order to stimulate social discussion and initiate political opinion-forming, the Rathenau Instituut is participating in the Big Robot Show for a robot exhibition to be held by the Nemo science museum in Amsterdam on 4 September 2009. We are also co-organizing an expert meeting in The Hague on 6 November 2009 (Robotica in Nederland: op weg naar een politieke agenda (Robotics in the Netherlands: the way to a political agenda) together with the Ministry of Economic Affairs, the Ministry of Education, Culture and Science and the STT (the Dutch foundation that examines the future of technology and society).
Trans-thematic projects	
Nanotechnology	The cabinet has appointed a committee to initiate social dialogue on nanotechnology during the next two years. The challenge for the Rathenau Instituut will be to propagate its message, in consultation with the committee, in this dialogue. The message in question will, amongst other things, be based on the publication Tien lessen voor een nanodialoog (Ten lessons for a nano dialogue) and new supplementary research. With a 'web special' the institute will position the message and activities relating to the social debate online. Our aim in the coming period is to broaden the political discussion on nanotechnology to include precautions.
Making Perfect Life	Nano, bio, neural and information technology. Developments on the interfaces of these fields increase our technological possibilities for intervening in biological and cognitive processes. Making Perfect Life is a new project that the Rathenau Instituut is implementing together with European Partners (European Technology Assessment Group, ETAG) for the European Parliament (Scientific Technology Options Assessment (STOA)). The Rathenau Instituut is taking the lead in a three-year study (2009-2011) in which Euro MPs are actively being informed about new technological trends on the interface between the biosciences and cognition.
Synthetic biology	The Rathenau Instituut is continuing to actively explore new developments in synthetic biology in cooperation with the Genetic Modification Committee (COGEM). In this exploratory study we are also working together with international partners, including within the framework of a European project that is exploring the future significance and implications of synthetic biology for the healthcare system. In addition, we are participating in a project in the USA with the Hastings Center, the J.Craig Venter Institute and the Woodrow Wilson International Center for Scholars, etc..
Spinoza debates	The Netherlands Organization for Scientific Research (NWO) Spinoza premium is a form of personal support for internationally-recognized, top-quality scientists. Winners of the Spinoza premium explore the boundaries of what we know with the audience of the Spinoza debates. These evenings take place on a monthly basis and are moderated by the Rathenau Instituut. The debates are organized by NWO in cooperation with the Dutch daily, NRC Handelsblad, Teleac and Paard van Troje (a cafe-restaurant).

Science System Assessment	
The value of science	
Research assessment	Now that research is being assessed more frequently, the discussion about it is also increasing. The question is no longer whether science should be assessed, but how. In 2008 we made an overview of approaches in research assessment in various countries and of the methods and techniques used to do so. The findings from this study will be collected in a report that will be appearing in the autumn of 2009.
Assessment of research in context (ERiC)	There is increasing agreement on the fact that scientific quality cannot be measured in the same way everywhere, and that the social quality of science is also important. The Education Resources Information Center (ERiC) project, which is being carried out with the Royal Netherlands Academy of Arts and Sciences (KNAW), the Association of Universities in the Netherlands (VSNU), NWO and the Higher Professional Education Council (HBO-raad), consists of various pilot projects, at universities, that will develop a method for measuring research quality in the broadest sense. The final outcome will be a report on the method that will be published at the end of 2010.
Siampi: research into productive interactions	Valorization is not only, or even mainly, dependent on the knowledge that is produced but also on the productive interactions between knowledge producers and potential knowledge users. In this international project, we are examining what productive interactions are and under what conditions they arise. To this end, we are carrying out a number of case studies at various research institutions that are engaged in ICT, medical and nano research. The first product of this study will be an overview of existing knowledge on the social impact of research. We will be publishing this in the autumn of 2009.
Science parks for knowledge circulation	Science parks enable a form of knowledge circulation that primarily involves young companies. In this international comparative study (the Netherlands, France, Japan, Finland, Israel) we are examining what networks successful starting entrepreneurs have and how these networks change as the company goes through different phases. Attention is also being paid to the conditions under which new knowledge-intensive activities develop and how science parks contribute to this. The Dutch case study started recently. A report on the first phase of the study will be appearing at the end of 2009.
Synergy in research investments	In addition to effects on the practice of science, investment in research infrastructure also has all sorts of social and economic effects. As a result of a project carried out for the Van Velzen Committee, we are systematizing the knowledge available on the synergetic effects of investments in science in a report that will be appearing at the end of 2009.
The dynamics of research fields	
Regenerative medicine	This is a bibliometric study into the development of regenerative medicine. The study has been carried out at the request of the exploratory committee for Regenerative Medicine and forms a contribution to the committee's final report which will be appearing after the summer. We will also be publishing our more comprehensive report in parallel with this.

Transdisciplinary education research	Are brain/neural sciences becoming more important for education research? This claim is made on a regular basis. but our bibliometric study, which will be published in the summer of 2009, shows that this is hardly the case, if at all. The relevance of brain/neural sciences for education relates primarily to the programme.
Chemistry	We are making a map of chemical research at the request of the Chemistry management group. Where are the dynamics? What is the Netherlands's position in chemical research? A first preliminary report will be appearing in October 2009, and the final report in 2010.
Imaging and neural and cognition science	How do new research instruments change research areas? A recent example is the influence of imaging technologies on brain, neural and cognition research. How does the new infrastructure help research and theory further – and what disappears from the agenda? Does this lead to new opportunities and understanding? How fast does that go, in the light of the high expectations?
The development of water research	Water-related research is an important research field in the Netherlands. This project leads to an overview of and comparison between the developments in coastal, river and drinking water research. In what way do similarities and differences in the local development and utilization of knowledge depend on the international knowledge dynamics in the three areas and on the specific environments and policy environments in which these research fields are financed and organized? We are organizing an expert meeting on Research & Development with the drinking water sector in September 2009.
Taxonomy	This project is being carried out in cooperation with the European Distributed Institute of Taxonomy (EDIT), an international network of taxonomy researchers. Taxonomic research has been pushed into the background by the molecular turn biology has made recently, but it appears to have been given a boost by the biodiversity problems. In a bibliometric overview of the development in taxonomic and biodiversity research we show how these research areas have developed recently and by whom taxonomic knowledge is used inside and outside science. A report is expected at the end of 2009.
E-science	E-science, amongst other things, appears to offer a solution for research into complex systems in the social sciences. Advanced computer simulations such as agent-based models, make it possible to relate the macro-outcomes at system level to behaviour at the individual level. A bibliometric analysis is being made of the development of the use of computational models in the social sciences (e-social science). This analysis will be appearing at the end of 2009.
The functioning of the institutes	
Recent Dutch developments	In 2007 we published a detailed study into the development of public research funding between 1975 and 2005. Since a lot has happened in the world of research funding in recent years, partly because of the many large programmes, we are implementing a supplementary study to bring the 2007 report up to date. Publication, in the form of an issue of Facts and Figures, will follow at the end of 2009.
Big programmes	Some of the most important instruments for research funding are the large programmes applied for and carried out by large consortia, such as the Investments in Knowledge Infrastructure (Subsidies) Decree (Bsik), Economic Structure Enhancing Fund (FES) and framework programme. How do they work, do they yield what is expected of them in terms of science and for society, what are the revenues and what conditions promote these revenues? A project plan has been drawn up for the Kennis voor Klimaatprogramma (Knowledge for Climate programme). Implementation will start in the autumn.
International funding	International funding is becoming more and more important. In this project we are mapping the dimensions of the international funding flows and the instruments used for this purpose. The report will be appearing in the summer of 2010.
Eurecia	Until recently, European funding focused on large programmes and consortia. Programmes for individual applicants are now also available through the European Research Council (ERC). In the past these were the domain of the national research councils such as NWO in the Netherlands. Two of the questions in this international project, which is financed by the European Commission, is how these new European instruments work and how they affect the position of national research councils. A report will be sent to the ERC and scientific publications will be published.
Project selection and past performance 2	A study carried out with the NWO Social Sciences Research Council (MaGW) in 2007 showed that past performance is a poor predictor for successful subsidy applications. Do these results only apply to the area of Dutch social sciences? Replications with international data from another domain arrived at identical findings. A publication on the results of this replication will be appearing in the autumn of 2009.
Project selection as decision making	What are the dynamics of decision-making regarding research proposals? This recently-started project studies the nature of the processes and the consequences of the competitive allocation of funds for the system.
Project selection in networks	Together with NWO MaGW, we are examining the influence of social networks on the chance of success of project proposals. In a multi-level, multi-theoretical approach, we are testing whether, and if so what network relationships have a positive influence and how strong the effect is. The first report will be appearing at the beginning of 2010.
Organization of the science system	
Biosecurity regulering en onderzoekspraktijk	Research is also influenced by regulation in other domains such as security (in relation to health), war and peace, and terrorism. In this project, we are investigating the emergence of regulation relating to 'biosecurity' and the effects it has on research and research institutions. We will be publishing a report on this topic at the end of 2009 and an expert workshop will be held at the beginning of 2010.
Governance en organisatie in zes landen	At the request of the Ministry of Education, Culture and Science, a comparison has been made for parliament of the ways in which science research is organized and studied in Denmark, Germany, France, Italy, the Netherlands and Great Britain. An English-language report and a Dutch-language summary with the most important conclusions will be published in the form of an issue of 'Facts and Figures' in mid September.

Researchers and research groups	
Eurecia	In this European Research Council (ERC)-financed project, we are investigating the effects of the new European ERC 'career subsidies' on the careers of talented, young researchers. The first result, an issue of 'Facts and Figures' on the differences between research careers in various European countries will be appearing at the end of 2009.
Successful careers	Successful careers require scientific talent, but not every talented researcher has a successful career. This project compares the successful and less successful careers of talented researchers. A report of the study will be published in the autumn of 2009.
Management and performances of research groups	On the basis of two surveys made in 2002 and 2007 amongst biomedical research managers, we have examined a number of aspects of management and organization in more detail: – what changes in management and organization have taken place; – the effects of management and organization on the performance of research groups; – the difference between the management of top groups and 'ordinary' groups; – the relationship between the scientific and social performance of research groups. The final report will be appearing in August 2009. There will be a follow-up on this work with a third measurement and a detailed study of leadership and the functioning of research groups at the end of 2009.
Life cycles of research groups	This project comprises the development of indicators for describing the lifecycle of research groups. The lifecycle will be connected to changes in the disciplinary environment of the research groups and to the related changes in the research group's strategy. The report will be appearing at the end of 2009.
Institute-forming in research institutions	Universities and other research institutions are increasingly trying to strengthen interdisciplinary cooperation by (amongst other things) setting up internal research institutes and other forms of interdisciplinary research cooperation. We are investigating the emergence and effects of this trend together with two research institutes.
Other projects: Methods and data	
Semantic web technology & next generation scientometry	In September 2009, we will be starting a methodological project on using advanced computer science techniques (in particular, semantic web technology) for scientometric research, together with VU University Amsterdam. The project will involve the conversion of heterogeneous data (such as web data) into data formats that enable scientometric research.
Models of knowledge dynamics	The Models of knowledge dynamics project is an international theoretical project on models of, and indicators for, knowledge development. Network theories are applied to scientific communication networks at various levels. This project will yield the theoretical framework and adequate indicators for field studies and for the interpretation of the findings of these field studies. The first publications are planned for late 2009.
Modelling the science system	The science system is a complex ecosystem. In order to understand the dynamics of the system, we have to model the various processes that work within the system in their interactions. We will explore the approaches that are feasible here in a project that will be contracted out. We will be organizing the first international workshop on this theme with the Virtual Knowledge Studio (VKS) in October.
Bibliometric software tools	In the project 'Bibliometric software tools', we will be developing a software toolbox for scientometric and bibliometric analysis. The first version was presented in the spring of 2009 and is freely available to researchers.
Other projects: Accessible information	
Facts and Figures	In order to make existing and new knowledge and information accessible for the political body and policy, a new series was started in 2008. The series is entitled 'Science System Assessment Facts and Figures'. The first publication, on universities, appeared in 2008 and a second, on public research institutes, in 2009. At the beginning of September we will be releasing a publication on the organization and governance of science in six countries. A 'Facts and Figures' on research careers and research financing will be appearing later this year.
Science portal	We are developing a website with information on the Dutch science system, with links to important international websites, together with the Royal Netherlands Academy of Arts and Sciences (KNAW). The site will be launched in 2009.
The formation of social opinions on science	Research is regularly carried out into the formation of opinions on science and scientific areas amongst the general public. In this study we take stock of what is known - empirically and theoretically. A number of focus groups and opinion polls will be taking place at the same time. These activities will be contracted out. The first report will be appearing in the autumn of 2009.
Summer school scientific indicators	In cooperation with the Network of Excellence, PRIME, and the European Network of Indicator Developers (ENID), we are organizing the second summer school on scientific and technological indicators. This summer school will take place in Amsterdam in September. Participants are young researchers from various countries and the lecturers come from the Netherlands, Switzerland, France and Norway.
Winter school research assessment	We are jointly organizing an international winter school on research assessment together with the University of Twente. This winter school is intended for policy assistants and administrators who are involved in scientific policy and assessment and will take place in December 2009.


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2 Technology Assessment

The Objectives of the Programme

The Rathenau Instituut's task is to contribute to social debate and the political opinion-forming on science and technology. It does so in three ways:

- by showing the social effects of science and technology;
- by involving society in this;
- by initiating public debate.

Making science and technology clear

Science and technology usually develop outside the view of the general public: in the laboratory at universities, on the Internet or at companies. Often citizens do not realize that a development will affect them, or how. And sometimes social groups are unprepared for the arrival of a new technology. Moreover, citizens, as individuals or groups, have different views on science and technology.

By clarifying science and technology, and by showing the various standpoints, the institute aims to deepen and broaden opinions amongst politicians and the general public.

Involvement of society

The TA department uses participatory methods to get society involved and is experimenting with new approaches. For example, it organizes focus groups, citizens' panels, questionnaires and opinion polls. Technology festivals, workshops, media performances, public debates and the use of new and traditional media are also included. The institute aims to make links with film, photography and theatre.

Initiating social debate

Experience has shown that a public debate does not arise simply by appealing to the nation to hold one or because a debate is organized from above. Discussion arises when something is at stake. The challenge for the institute is not to pull any punches when formulating matters – so that objections will be raised – without losing sight of scientific reliability and impartiality.

The Significance of Science and Technology

The objective of TA is to think through, clarify and initiate debate about the social effects of science and technology. There are different sorts of effects. Science and technology can, for example, solve problems, combat diseases that seem unconquerable or bridge large distances by exchanging information with the use of the computer. In these cases, science has a social significance because of the positive consequences.

But the consequences of such developments often reach further. They may have effects that we did not foresee or that we do not want. Nanotechnology – the processing of materials at the molecular and atomic level – is a case in point. It may provide revolutionary new materials but, at the same time, some synthetic nanoparticles may entail risks for our health and the environment. Negative and undesirable consequences give science a social significance, and a harmful one at that.

Besides desirable and undesirable consequences, science and technology also have another, often more indirect, impact on society. The use of medical technologies for human enhancement, for instance, not only has consequences for the future of healthcare but also for people's self image; the pursuit of perfection or improvement of healthy people raises questions about the relationship people have with their own vulnerable bodies.

New technologies have significance for the relationships between citizens and that between citizens and companies as well. They can contribute to new balances of power and inequalities, through knowledge monopolies, intellectual property or the setting of standards.

The relationship between citizen and government may change under the influence of science and technology too. Not only do technological information processing, screening and profiling have possible effects on privacy, but they may also lead to questions about power, institutional reliability and protective security systems. The significance of science in these cases, is that it can fundamentally change the relationships between people and institutes.

Technology Assessment in Practice
TA spots and explores new technology. It shows how technology will influence existing practices. Finally, it wishes to contribute to the thinking about the transition and innovation of technological systems that founder.

The spotting and exploration of new technology and science
Cognitive scientists are discovering more and more about how our memories and emotions work, and about how we decide between good and bad. This knowledge is even popping up in the courtroom. Should judges take this into account? May police and the judiciary use this knowledge, as they do DNA material?

The Rathenau Instituut organized a meeting on the judiciary and cognition together with NWO and the foundation that is occupied with the future shape of technology, STT. Cognitive scientists, criminal law experts and representatives of police and the judiciary exchanged knowledge and experiences on cognitive measurements, lie detection, how our memories work and questioning techniques which should lead to more objective tests and psychiatric reports.

The influence of science and technology on existing practices
Technological aids play a crucial role in the execution of the migration policy. Body scans, bone and DNA analyses and large European databases with personal details and biometric characteristics are all used in this context.

In the Migration Technology Project, the Rathenau Instituut produced a comprehensive overview of the significance of these technological aids for the nature and structure of the migration policy.

Transition and innovation of technological systems
The energy crisis is forcing us to reduce CO_2 emissions and to develop sustainable energy production. This is leading to discussions on the requisite innovations and transitions of our energy system.

In order for this switch to succeed, it is important that the solutions are clear, as well as what citizens know and think of them. The Rathenau Instituut organized focus groups of citizens on the underground storage of CO_2. The institute had proponents and opponents, including scientists, politicians and citizens, speak about CO_2 storage in order to promote social discussion on it.

Method and Network

The contribution the Rathenau Instituut makes to social debate and political opinion-forming goes beyond simply supplying information. In an assessment, we do not only look at technical or scientific developments and their direct and indirect effects. The TA department also concentrates on the often complex and ambivalent relationships between science, technology, politics and society on an international level. The institute tries to find links with cultural and social developments; it therefore also studies human relationships, self images and views on what a good society is.

Furthermore, the institute uses assessments to focus on the various visions of interested parties. We want to bring these visions to the fore and promote interaction between them. In doing so, we not only look at possible interests, but theoretical, philosophical, political, ethical, cultural and normative visions are explored and named.

As a rule, project team workers at the Rathenau Instituut are supported by a monitoring committee in order to safeguard the substantive quality of projects and to ensure that they are topical - and remain so. These project members work closely with experts and interested parties, such as scientists, NGOs, the business community, advisory bodies, policy-making officials, international organizations and citizens. The building up and maintenance of these networks is a critical factor for the success of assessments. Projects have only succeeded when discussions around science, technology and society have been picked up and elaborated within the right networks.

Selection of the Four Research Fields

The themes for work programme 2009-2010 were selected because they combined continuing to build on experience already acquired and searching for new scientific and technological developments. The institute also made use of official and unofficial consultations. The selection was based on four criteria:

- **The relationship with technology and science**
  Subjects have to have a clear link with a technological and/or scientific development.

- **Political, social and moral relevance**
  Subjects have to be politically, socially and morally relevant, for example because many citizens will be directly or indirectly affected by the consequences or because a development has possible consequences for a crucial interest for several citizens.

– **Social or political debate**
  Subjects have to be worthy of a social or political debate. New technologies can touch on a taboo or the possible unintended consequences of a technology can be given too little political attention. Ethical dilemmas can remain too implicit and underexposed. And important decisions can be insufficiently transparent for citizens. In these cases, it may be desirable to promote social or political debate.

– **Early spotting**
  We like to track down pioneering technological developments in good time: technologies that are going to change the rules of the game. Early spotting of a technology that is still described in general terms is often the first phase of a development that takes many years. Subsequently the technology in question pops up in all sorts of technical practices and there is again reason to ask for attention for the developments in question.

For the 2009 –2010 programme, the Rathenau Instituut arrived at the following four main fields on the basis of these criteria: 'The Usable Body', 'The Hunger for Raw Materials', 'The Prevention Society' and 'Digital Hyperconnectivity'. These four fields are further elaborated below.

TA research fields for the work programme 2009 – 2010

The Usable Body
– Personalization of medical technology in the self-care market
– Human enhancement
– The market for body materials

The Hunger for Raw Materials
– Sustainable energy
– Bio-nanobased economy

The Prevention Society
– Technologicalization of border surveillance
– Profiling and the architecture of databases
– Screening and prevention programmes

Digital Hyperconnectivity
– Public space 2.0
– IT and the cognitive sciences

2.1 The usable body

The human body counts as honourable, worthy and inviolable. But new technology is coming up with steadily more possibilities for encroaching on it. The body is, as a result, not only becoming more 'makeable' but also increasingly 'usable'.

The Rathenau Instituut traditionally pays a lot of attention to scientific and technological developments in the biomedical domain, and so does the work programme 2009 – 2010. Now that the emphasis is on the greater usability of the body, the institute will carry out three biomedical development studies in the period 2009 – 2010: personalization of healthcare and the coming about of the self-care market, the political and cultural images of human enhancement and the marketing of body materials.

Introduction
Pep pills, brain doping, deep brain stimulation or cosmetic surgery: diseases or shortcomings have not been the only reason for interfering with bodies for a long time. The prevention of disease or ageing and the improvement of functions now make up part of the medical repertoire too.

The body is becoming more usable: not only for the owner of the body in question but for others too. As the possibilities for transplanting, storing or modifying body materials (blood, stem cells, tissue, ova or organs) grow, our physical self is changing into something to which legal or economic value can be attached. Body materials are becoming a commodity, or merchandise. The relinquishing of ova or organs for payment, which takes place in some countries, and the Dutch discussion on whether we should pay for blood or organ donations are examples of what we are referring to.

The increased usability of the body is not only being driven by new technology and science. The desire to repair or optimize one's own body is driven by a culturally-carried hope for improvement. This wish for human enhancement is of all time. And it has a tremendous appeal. Occupation with one's body and the possibilities for modifying or enhancing it by means of technology is an increasingly important part of people's lifestyles. It is part of a cultural tendency in which people want to be boss of their own bodies and to have control of their own physical fate.

Currently almost seven percent of American students regularly take cognitive enhancers like Ritalin or Modafinil. Some scientists are even calling for the legalization of these substances, so that healthy people can use them without fear of legal action.

Medical technology is providing new opportunities: new growth markets and developments for therapy and timely interventions. These include diseases that can be detected using genetic tests or the storage of children's stem cells so that they can perhaps be used later for medical treatments.

Nevertheless, biomedical developments have consequences for the way people look at their own bodies. Medicalization as a lifestyle may also become a form of self monitoring, the emphasis being on prevention. And the increased possibilities for transplanting, storing or modifying body materials, are leading to issues about the ownership of – and the authority over – that body.

There are also consequences for traditional healthcare. Commercial high-tech markets are appearing at high speed in the healthcare sector, an example being the 'annual physical MOT check-ups'. These are rapid-growth markets in which the roles of new suppliers and manufacturers are often played by unexpected parties. The games industry, for instance, has set itself up as maker of real-life simulations for patients and design bureaus are taking nursing homes in hand.

The power of temptation of new medical technology will be irresistible for the majority of the population. The delineation of what counts as medical technology, a medical intervention or medical treatment, will become more difficult. Some scientists are of the opinion that our current medical thinking model – which is based on disease – is no longer adequate for an age in which many people will undergo medical treatments in order to enhance themselves. Furthermore, the growing, assertive autonomy of citizens, patients and healthcare clients, leads not only to new opportunities but also to new questions: on solidarity in healthcare, on the affordability and the distribution of scarce resources, on the role of doctors or the future of healthcare. And, finally, what it means, in the more existential sense, to be sick or healthy.

Personalization of medical technology and the creation of the self-care market
The training programme on your mobile telephone, the cholesterol test in the supermarket or the blood pressure meter for home use: new healthcare technology is making it easier and easier for us to look after our own health. We can even order personal DNA tests on the Internet. It is new healthcare technology that gives the individual control over his or her own health, and that can reduce the amount of care needed per bed.

In an ageing society the need for technology to relieve some of the pressure on the healthcare services is great. Most politicians, policy assistants and care institutions seem to agree on this one: patients will have to play an increasing role in their own care process particularly because of the increasing employment problems in the healthcare sector. Moreover, many people want to invest in their own health, even if they are not sick. Medicalization is becoming a lifestyle: the wellness industry is thriving; saunas, genotype diets and total body scans are very popular.

But this 'personalization of healthcare' has drawbacks too: precisely because technology is becoming more personal, it is also increasingly able to tempt people or to discipline them into showing certain behaviour. In this way, medicalization as a lifestyle may become a form of self control in which the emphasis is on prevention. And whereby the preservation of one's health is key to keeping the costs of the healthcare system manageable. Is modern health technology freeing users?
Or can it perhaps turn against us as well?

The Rathenau Instituut will shed light on the personalization of technology and the coming into being of the self-care market and focus on engaging the attentions of those involved. The idea is to initiate interaction between the various stakeholders: government, trade and industry, start-ups, consumers, but also banks, insurers and, for example, the housing associations. The institute aims to get them involved in a political and administrative discussion of the future of care.

Human enhancement
From care of the handicapped to top sport and from military applications to home use: the technological possibilities for perfecting one's body extends over many domains and throughout the entire human life. What begins with embryo selection and prenatal diagnostics may possibly end with anti-ageing technology and the dream of becoming immortal.

The boundary is shifting from making people better (with therapy, prevention and healing) to improving human performance or, to use the jargon, 'Human Enhancement'. Those who champion human enhancement strive for stronger, more intelligent, more beautiful people who stay healthier and live longer.

Developments in genetics, the neurosciences, pharmacy and plastic surgery seem to be bringing the realization of this old dream within reach. We are not just talking about pills, but also, for instance, brain implants, fertility treatment and gene therapy. Innumerable improvement technologies await our bodies: anti-ageing technology, muscle enhancers, embryo selection, genetic doping and stamina, memory and mood enhancers. The common factor between them is that they try to improve performance by changing human biology and not by changing the social circumstances.

The taboo that you can heal people but not improve them by means of technical interventions in their bodies has always existed. This taboo forms an important mainstay of the healthcare system; we stand by sick people, but not by perfectionists. Human enhancement is, however, finding its way into our society and healthcare with surprising speed. The practice of plastic surgery, which less than ten years ago was deemed a risky, morally dubious, expensive hobby is now embraced by an eager public. In vitro fertilization (IVF) was accepted in a jiffy. IVF is also an example of human enhancement, because infertility is not a disease. And a market worth billions has its eye on enhancing medicines such as Ritalin.

But social and political opinion on human enhancement is threatening to get mired down in arguments between proponents and opponents and, in particular, on the boundary between healing and enhancing. The proponents' arguments are strong and seductive: the wish to be better is not new. And taking Ritalin to improve brain function is not fundamentally different from human enhancement technologies such as the discovery of script, drinking a cup of coffee or following education.

Sceptics, on the other hand, point to the individual risks for users of brain peppers and the dangers for society in the longer term. Who is responsible if things go wrong? Will healthcare remain affordable? Should we invest public money in it? Will these means increase the socio-economic differences between people?

Will the freedom of choice of citizens still be safeguarded if, in the competitive rat race, social pressure to use these means arises? Will sympathy with the weak and handicapped come under pressure if health and intelligence become our own choice?

There are no ready-made answers to questions of this kind. But to prevent the social and political opinion-forming regarding human enhancement getting bogged down in a 'for-or-against argument', the Rathenau Instituut will be striving to create conceptual space in the debate in the next two years. The fundamental, ethical and legal questions must be opened up to discussion – and remain that way – and concrete issues must go onto the political agenda.

In the case of this trend, the institute intends to focus on the perceptions and the political, cultural and ideological dimensions that play a guiding role in human enhancement. The projects and activities employed for this theme will focus on providing citizens and politicians (both in the Netherlands and the European Parliament) with images and conceptual frameworks with which new standpoints concerning human enhancement can be developed.

The market for body materials

Will we continue to donate our blood voluntarily or do we want to be paid for it? Will we store stem cells from our child's umbilical cord in a public or commercial biobank? And what are the advantages and disadvantages of doing so? Will we, in the future, sell our ova or a kidney to pay for our child's university education? Our body materials have a monetary value and this raises questions. What are the pros and cons?

The emergence of new technology for changing and modifying bodies, or parts of them, is also leading to the creation of new markets and new considerations. Besides traditional markets for blood and organs, public and private markets for tissue, stem cells, ova and biobanks are being formed. Look, for example, at the Dutch stem cell bank (Stamcelbank Nederland), or American biobanks that collect their patients' DNA data and also claim the rights to that material.

Not only are new relinquished body materials and new applications unlocking these markets, but the increasing possibilities for materials that have already been stored are also opening up new vistas. Body waste or residual materials are, in this way, changing into merchandise, a commodity, something to which a value can be attached. This calls up questions about the ownership of, and control over, our bodies.

In the case of this trend, the Rathenau Instituut will concentrate on revealing all the things that can be done with body materials and what happens to them in practice. By doing so, it hopes to spur on the debate on the re-use and marketing of body materials and create scope for new forms of regulation.

The objectives are: to inform and involve interested parties (government, biobanks, citizens and international institutes) and to try to break open the social debate to create more scope for new forms of future-resistant regulation.

2.2 The Hunger for Raw Materials

The complex dynamics surrounding raw materials
The emergence of new economies such as China and India has greatly increased the demand for energy. This has resulted in new forms of scarcity and new forms of dependence (for example, gas from Russia).

International agreements, social requirements and the need to reduce CO_2 emissions are limiting the possibilities for stilling this hunger. Coal, for instance, is not scarce, but its use is limited by new requirements laid down by society.

These requirements often lead to new opportunities for technological innovation, such as CO_2 capture and storage or alternative energy sources. At the same time there is also pressure to exploit other raw materials (the sun, wind, biomass) on a greater scale. For a long time, the use of biofuels was promoted by the political body as a means of tackling the greenhouse effect. But criticism grew at the same time: biofuels led to the felling of ancient rainforests and food price hikes. The food crisis, in turn, has placed the debate on 'the use of genetically-modified crops as food supplies of the future' on the political agenda again.

In the period, 2009–2010, the Rathenau Instituut wants to pay attention to the theme 'the Hunger for Raw Materials'. We prefer to speak of 'hunger' rather than 'scarcity' or 'exhaustion', because the latter terms call up a picture of a natural given that must be overcome. 'Hunger' refers to complex social dynamics and has a double meaning: hunger, in the sense of a shortage of food, which has to compete with the hunger for energy.

Within this theme, the institute hopes to get stuck into the current energy discussion and explore the role nano and biotechnology could play in solving the raw materials issue.

Introduction
The global demand for natural resources – from oil, coal, copper and iron ore to wood, grain, maize, soya beans and water – has risen explosively in recent years. This international hunt for raw materials has an enormous effect on the economic and geopolitical power balances and, moreover, the effect of this hunger for raw materials is not seldom disastrous for man, animal and environment.

The burning of coal and wood in Asia, for instance, leads to the formation of brown atmospheric clouds; a three-kilometre thick layer of soot that stretches from the Arabian peninsula to the western shores of the Pacific Ocean. In this same ocean there is a floating island of plastic waste the size of France, Spain and Portugal together. Climate change, pollution and deforestation are taking their toll too:

a quarter of the mammals on earth are now under threat of extinction. It is, therefore, not surprising that sustainability is termed the new social project of the twenty-first century.

In the dynamics surrounding the hunt for raw materials, new forms of scarcity are created and more and more new social requirements are set on the use of raw materials. Lifestyle is a driving power here: chocolate must be produced without resorting to slave labour, biofuels may not lead to deforestation and cotton must come from ecological plantations, because people and the planet must be served as well as profit. Technological options come under social pressure in this way. Opportunities for new technologies that may meet social demands better (see box) are arising simultaneously. The interaction between science, technology and society forms the line of approach on which the Rathenau Instituut wants to focus with regard to the theme 'the Hunger for Raw Materials' in the coming two years. Moreover, the institute intends to tackle the topical energy discussion and explore the roles that nano and biotechnology can play in solving the raw materials issue.

Sustainable energy

A fundamental question now occupies centre stage in the Dutch energy debate: how quickly can the Netherlands make the transition to sustainable energy supplies? This question immediately leads to the next one: how ambitious are we in the field of energy conservation? How fast can we develop sustainable sources of power in the Netherlands? And: what role will be left for fossil fuels in the next twenty years?

The Rathenau Instituut wishes to contribute critically and constructively to this discussion with its 'Sustainable Energy' project. We will also follow the logics of the 'energy ladder', on which we want to organize our activities (study, consultation with interested parties and public activities). Saving energy takes top priority on the highest rung of the ladder, followed by the use of sustainable resources. Subsequently we will examine the possibilities for using fossil fuels as efficiently as possible and, lastly, the use of power stations where CO_2 is caught and stored.

Energy conservation

Firstly we will study the possibilities for stilling our hunger for energy. To this end, we will actively be looking for voices that advocate and work on lifestyles that consume less energy. We will also be paying attention to technologies that contribute to a more efficient use and re-use of energy. To what extent are these principles actually put into practice and with what result? What technological developments are of particular interest in this context? How do citizens look at changes in lifestyle?

Sustainable energy technology

According to some parties, solar energy could, in theory, provide the whole world with energy. But are innovations in sustainable technology going fast enough and is enough being invested in them? What opportunities do, for example, wind energy out at sea, energy-producing greenhouses and houses or the global growth in the sales of solar cells offer our economy?

The point of departure in these developments is that technology provides new, and more sustainable, possibilities for stilling the growing hunger for raw materials. This is helping to solve problems, but it also entails another danger. New technologies raise new demands for raw materials and new technologies entail new risks. These items will have to be addressed when evaluating new developments.

The role of fossil fuels
In the third phase, the roles of fossil fuels (such as coal-fired power stations with CO2 capture and storage) and nuclear energy are discussed. On the basis of research and discussions with parties in the field in the previous phases, possible transition scenarios that may be attractive for the Netherlands from both the economic and social point of view can be discussed.

The institute aims to introduce the citizens' standpoints into the debate about our energy supplies. What contribution can these citizens make to solving the energy issue and do they want to? This question is important because social support is crucial for the large-scale deployment of some energy sources.

The citizen also plays a significant part on the consumer's side and, on this basis, the Rathenau Instituut is organizing the Dutch contribution to 'World Wide Views on Climate Change', a project initiated by our Danish sister organization. In this project, citizens are asked for their visions on the climate problem.

The bio-nanobased economy
The current raw materials problem provides opportunities for new technologies such as bio and nanotechnology. An important question here is whether these developments can actually contribute to a more sustainable (cleaner and more economical) use of raw materials and, if so, how. In the next few years, the Rathenau Instituut wants to explore the social questions concerning biotechnology, food and raw materials that converge in the future image of a bio-nanobased economy.

Nanotechnology
In recent years, the Rathenau Instituut has brought the discussion on the opportunities and risks relating to nanomaterials to everyone's attention. Nanotechnology, the processing of materials at molecular and atomic level, provides possibilities for making materials more sustainable. At the same time, however, nanotechnology is breathing new life into the discussion on the safety of chemical substances for employee and consumer. In view of the social dialogue on nanotechnology that will be held by the government in 2009 and 2010, amongst other things, the Rathenau Instituut will continue to follow developments in nanotechnology.

Biotechnology in agriculture
Biotechnology is regularly put forward as the solution for the efficient deployment of limited agricultural land for food production. But the use of biotechnology in food production is not undisputed and has a long history of social debate. At the end of 2008, the Rathenau Instituut and the Upper House organized an expert meeting on biotechnology in agriculture. The most important outcome of the meeting was that a shift is taking place in the social debate on biotechnology:

the opportunities provided by the new technology are coming into focus and the questions are no longer directed primarily at gentech-inherent risks. The social debate is broadening to include more general technological questions on patents and power concentration and the question of whether different options can exist side by side with freedom of choice for consumers and co-existence in production (the convergence of genetically-modified (GM) and GM-free agriculture).

Green chemistry
The chemicals sector is also facing the challenge of becoming more sustainable and less dependent on oil, as is the energy sector. Oil is the basic raw material of many chemical products such as plastics. But because of the exhaustion of oil stocks, the call for alternatives is becoming louder and louder. As a result, a new vision on the future of the chemical complex has arisen in recent years: a transition from petrochemistry based on oil, to a bio-nanobased chemistry (also known as 'green chemistry'), in which biological substances originating from agriculture and forestry become the new basic raw material.

Moreover, developments in biotechnology are expected to create numerous possibilities for the use of biological raw materials for sustainable products. The growing use of biofuels has, however, now also become the subject of political discussion. In fact, biofuels not only affect the food price, but also have consequences for land use (deforestation). Furthermore, the question of whether this option actually leads to CO_2 reduction has arisen.

The Rathenau Instituut wants to explore the social opportunities and risks inherent in the transition to a bio-nanobased economy. We will also be paying attention to the use of genetically-modified crops and the tension between the use of bio raw materials for food, energy and chemical products. In addition, we want to examine the developments taking place within the industrial biotechnology sector and the questions these raise, for example in the field of patents.

2.3 The Prevention Society

'Prevention is better than cure' and 'trust is good, checking is better' are two expressions that characterize present-day dealings with risks. The idea is that by tracking risks down as early as possible, a lot of suffering can be avoided. This applies not only to criminal or terrorist activities, but also to the derailing of families, young people who are vulnerable to risk, medical blunders or even the risk of disease. New technologies and the extension of links between databases make this prevention increasingly feasible.

With projects such as 'Screening Society', 'Radio Frequency Identification (RFID)' and 'Migration Technology' the Rathenau Instituut has acquired a position in the debate on the use of technology in the fight against crime and terror and in border surveillance. In its Work Programme 2009 – 2010, the Rathenau Instituut wants to look at three components of 'the Prevention Society': 'the technologicalization of border surveillance', 'profiling and the architecture of databases' and 'screening and prevention programmes'.

Introduction
Large scale medical screening programmes, such as the Dutch Youth Healthcare's Electronic Child Database (EKD JKZ) and Electronic Patient Record (EPD) mentioned earlier, monitor the health of the citizen. The use of risk profiles and extensive and interconnected databases for investigation and international security policy is expanding enormously. Our national and European borders are changing into a technological selection mechanism, whereby biometric technology separates the foreign nationals that are desirable from those who are not.

In all these fields, that is healthcare, the judicial system, police and border surveillance, the government collects details from citizens, and this is increasing all the time. This information is not only used in retrospect but also in advance, to identify risks and draw up risk profiles. To this end, digital data are stored, compared, exchanged, analysed and used as points of departure for further investigation.

The rise of risk vocabulary in society and, as a natural corollary, the government and political body's endeavours to avoid risk by preventive intervention, have led to high hopes. The question is whether this will ever actually be realized. The risks of new terror attacks, derailing families and illegal migration will never be completely eradicated.

In the theme 'the Prevention Society' the Rathenau Instituut is examining the relationship between the need for security and health and the use of science and technology.

Important questions here are the effectiveness of the methods and technologies used and their unintended side effects. Attention will be paid to dealing with digital data files. How can file pollution, identity theft and sloppy management be prevented? How is access to data files regulated and what right to inspection and correction can or should citizens (and foreign nationals) actually have?

Technologicalization of border surveillance
DNA tests, X-rays, body and iris scans, speech technology and databases with personal details are all forms of technology that are used for border surveillance and monitoring tourist traffic in the Netherlands and Europe.

In the last work programme, the Rathenau Instituut explored the use of technology in migration policy in the project 'Migration Technology'. For Work Programme 2009 – 2010 the institute wishes to go more deeply into this subject. In the project 'Selection at the border', we will be examining three developments: the use of biometry (see below), the influence of Europe on technological border surveillance and the role that public private cooperation (ppc) plays in the implementation of migration policy and the application of technology.

Biometry is the collection of technologies that measure and record the unique physical characteristics of individuals. The most commonly used technologies are fingerprints, the iris or retinal scan, voice recognition and the facial scan on our passports. These biometric data often comprise highly personal characteristics:

data on race and health. By combining different files containing biometric data, an extremely detailed picture of a person can be obtained.

The Rathenau Instituut wants to show how biometry is changing the role of border surveillance. We would also like to investigate the desirable, as well as the undesirable, consequences of biometry in cooperation with, for example, the Ministry of Justice. Furthermore, we want to show the growing European influence on technological border surveillance, because more and more of the decision-making on the use and supervision of technology in this field is taking place outside our country's borders.

The institute also wishes to explore the role that companies – often in cooperation with the authorities (ppc) – plays in implementing migration policy and the application of technology (see box).

Privium Iris scan at www.schiphol.nl
You can now be checked at the border by means of an iris scan instead of having to show your passport. This method is safer and faster than the manual passport check. Iris recognition makes use of specific characteristics of your iris. It is rapid, reliable form of biometric identification.

If you are a member of Privium at Schiphol Airport, an image is created of both of your eyes. This entails no risk for your eyes or health. The iris scan works even if you wear spectacles or contact lenses (coloured as well as transparent). It does not, however, work when you wear sunglasses. After the scan, your iris details are only stored on the chip of your Privium Card. When you cross the border, the data from the scan in the chip are compared with those of your eye. The data are then immediately removed from the equipment.

The iris scan was designed by Amsterdam Airport Schiphol, in accordance with its own specifications. The requisite software was developed in close cooperation with the Immigration and Naturalization Service (IND) and the Royal Netherlands Military Constabulary at Schiphol.

Profiling and the architecture of databases in investigation and security
The European Visa Information System (VIS) contains the personal details and perhaps, in the future, the biometric data of seventy million people. Moreover, the compulsory storage of telephone, e-mail and Internet details of four hundred and fifty million EU residents is supposed to identify criminal or terrorist networks. The police, judicial system and investigation services are making increasing use of risk analyses and screening-based technological systems. There is a growing use of digital files (profiling) that can contain enormous, if not infinite, amounts of data.

The preventive use of these data is particularly striking, the objective being to identify risk groups as early as possible. In this way, a combination of travelling

behaviour, telephone traffic and surfing behaviour on the Internet may raise suspicion of possible involvement in preparations for terrorist activities.

With the project 'Profiling and the architecture of databases in investigation and security' the Rathenau Instituut intends to penetrate to the political choices that are made in the architecture of such databases. Amongst other things, it will involve the companies that design these systems in the debate for this purpose. The objective is to bring these designs to the public's attention with the idea of opening up possibilities for different design options.

Screening and prevention programmes
Under the motto of: 'no child out of the picture' every child born in the Netherlands from the end of 2009 will have a Youth Healthcare's 'Electronic Child Database' (EKD JGZ). The file will contain information about the child, family situation and environment. The objective: 'never again a Meuse girl'. (This is a reference to a young girl who was being followed by several social workers and yet was mistreated, killed, cut up and thrown into the Meuse in 2006.) GP out-of-hours surgeries, GP's practices, dispensing chemists and hospitals will be connected to the national electronic patient record at the same time. The system will enable care providers to exchange medical details so that the risk of medical mistakes is reduced. The idea is that, in the future, it will be possible to link the EKD to the electronic patient record (EPD).

The EKD and EPD are examples of large-scale medical prevention projects, which, despite their noble objectives, lead to social questions and resistance. The EPD sets heavy requirements on the management of the information and the protection of the privacy of citizens. What is more, the citizen is sucked deep into the healthcare organization. The details collected for the EKD are not undisputed either. The boundary at which the government and healthcare system stops and the private sphere of citizens begins seems to be shifting.

The Rathenau Instituut will identify the technology images underlying these programmes. These pictures are both positive and negative. The aim is to initiate debate about the shifting boundary in the relationships between government, healthcare and citizens and to get those involved around the table.

2.4 Digital Hyperconnectivity

Everything is possible with the Internet and the Internet itself is omnipresent; an old IT dream is becoming reality. A little longer and we will reach the 'Internet of things' and the 'Internet of people', possibly by a merging of technological systems, technology and the cognitive sciences, and of technology and people.

During Work Programme 2009 – 2010, the Rathenau Instituut will also reflect on contemporary phenomena in the field of information technology, such as the social web (Web 2.0), virtual worlds and the digitalization of physical space. These activi-

ties were started during the previous work programme and will be continued in this one. We will, moreover, try to look further into the future. Because of the mutual influence of information technology and the cognitive sciences, new future prospects for the information society keep popping up. In these future visions, we become physically connected with the web and the computer increasingly takes on the character of a being that can take action.

For the theme 'Digital Hyperconnectivity', the Rathenau Instituut wants to reflect on contemporary and future phenomena on the interface of information technology and the cognitive sciences during Work Programme 2009 – 2010.
The related projects are: 'Public space 2.0' and 'IT and the cognitive sciences'.

Introduction
Life without the Internet is already almost inconceivable. This was the medium that enabled the gigantic increase in accessibility and transparency of information. Yet it was only half way through the nineteen nineties that the Internet became accessible for the general public, along with the appearance of providers and graphic browsers. And then it broke through: from that point on, everyone could e-mail and follow information services and the Internet became the World Wide Web.

After the turn of the century, the net developed from an information medium into a communication medium: also known as the participation web or Web 2.0. Users deliver content (photographs, film clips, text) on online platforms in bigger and bigger social networks. Young people who have grown up with the Internet, in particular, appear on it and share everything with others on these platforms. But the web is developing all the time. It can now be accessed by mobile telephones and the difference between PC, laptop, palmtop, mobile telephone and even TV is disappearing at an amazing speed. The IT dream of pervasive technology or ubiquitous computing has, therefore, almost been realized. Everything is possible via the Internet and the Internet is omnipresent, both in terms of time and place.

So we have arrived at the last step of 'netting': the emergence of the 'Internet of things' and the 'Internet of people', enabled thanks to a convergence of technological systems such as the navigation system, Global Positioning System (GPS), Radio Frequency Identification (RFID) and Near Field Communication (NFC) (see box).

With this 'netting' physical and virtual space merge: the physical world becomes computerized. The www has therefore not only connected the computers of the world with each other, but is also catching the 'real' world in its 'web' too. We call this 'hyperconnectivity'.

Core concepts

Radio Frequency Identification (RFID)
Chips that can be read from a distance and that are used for payment, access and identification.

Near Field Communication (NFC)
More and more Dutch people are paying for their shopping, drinks and meals out with their mobile telephones. The technology that makes all this possible is called Near Field Communication or NFC for short. It is a wireless connection technology for short distances – no more than twenty centimetres – that enables communication between different devices. More than 45 million Japanese people use their mobile telephones as debit card, credit card, membership card, savings card, train card, air ticket and house key. And all this is made possible by a similar technology. NFC is also seen as an intelligent form of RFID. Whereas in the case of RFID information is primarily stored and sent in one direction, NFC communicates in two directions and is able to process the signals it receives too.

Hyperconnectivity
In the case of hyperconnectivity, people are always reachable by means of innumerable devices and many applications. There are, for example, researchers who speak of the creation of the 'hyperconnected werker'; someone who has at least seven devices at hand so that he or she can be reached at work and privately. This employee makes simultaneous use of many simultaneously applications: instant messaging (IM), texting, web conferencing and social networking.

Public space 2.0
How would it be if we could zoom in live on our neighbour's garden with Google Earth? Or on a flat in America? A flood in China? Or if all cars could be followed real time with GPS? Public space is becoming virtualized. Developments in the field of information technology often remain outside the picture for a long time and are subsequently suddenly incorporated into society at an incredible speed. Internet and the mobile telephone are cases in point.

We will be giving an overview of the technologies that virtualize physical space and the consequences at the end of 2009 for the project 'Digitalization of public space'. Examples of these technologies are RFID, NFC and Google Earth and navigation systems such as GPS. These technologies are all about the linking of the identity of the user to the place and time of the action, so privacy plays an important role in this discussion. But the debate goes further than privacy or the giving away of information on identity and behaviour. In fact, this type of broadly accessible information system also gives the user the chance to make choices. How do they influence the behaviour of people individually and collectively and how dependent on them will we become?

In the last work programme, the project 'The hard virtual reality' identified the incidents which occurred in virtual worlds such as World of Warcraft and Second Life: theft, child pornography, racism and hacking. It also examined how virtual worlds in South Korea are regulated: with the so-called 'Real Name System', where Internet users and gamers log in with certificates based on their citizen service number.

On the basis of these overviews we want to get the debate on, and the regulation of, the virtual world onto both the political and public agenda. We are doing so by staging a play: an artistic form positioned between the virtual and the physical and in which virtual and physical personages will intermingle. When is something still a game and when does it become real? How does virtual reality relate to the physical one? This play is aimed at the general public, members of parliament and the policymakers who are responsible for the regulation of virtual worlds.

IT and the cognitive sciences

With the project 'IT and the cognitive sciences' the Rathenau Instituut wishes to explore the area in which information technology and the cognitive sciences meet now and will do so in the future. What are the technological possibilities and society's visions of them? And what are the related social future images and issues?

The terrain encompassed by IT and the cognitive sciences is wide and it is developing rapidly. In the Ambient Intelligence vision, insights from the behavioural sciences merge with state-of-the-art IT gadgets. Look, for example, at ambient environments, an application that can be very useful to patients and consumers. They are realized by computer chips built into walls, appliances, clothing or even in our bodies. And these chips know which patient is where and how he or she is.

Persuasive technology goes that much further. In this field of technology, IT is used to influence human behaviour, by persuading people to act in a specific way. It is a mix of ICT and convincing communication methods from the field of psychology, such as computer programmes that coach people who want to stop smoking or online dietary advice when one is doing one's shopping.

IT can also be applied in the interaction between people, as illustrated in the example in the box below. Another area that is booming is that of the social robots. These are intelligent machines that fulfil a specific social function within the healthcare, monitoring or transport sectors. Machines that carry out a function of this kind are also expected to demonstrate social behaviour, which is provided by the cognitive sciences. The technology that brings about the convergence between IT and the body falls under the term 'man–machine interaction'. It may vary from intelligent and more intuitive interfaces between people and computers to the direct stimulation of the brain with an electrode (deep brain stimulation).

Micro-emotion meters: an example of man-machine interaction
The human being has only a limited number of emotional facial expressions, including happiness, anger, fear and disgust. These expressions are universal and the computer is able to read them on your face within a millisecond. This technology is being developed to give avatars (the manifestation of people in the virtual world) emotions. We can do this at the push of a button. The expression on one's face can also be scanned in real time to give the avatar the same emotion. However, this man-machine interface can also be deployed to analyse the emotions of another person.

Humans usually like to show their emotions to the outside world, but sometimes they prefer to keep them to themselves. Emotions can be suppressed, but not completely. Psychologists call this the 'non-verbal leak', and it may only last for a fraction of a second. The computer is, however, able to capture these micro-emotions and to reveal, as it were, what is going on at your very core. Psychologists have been using the technology for years, but IT computerizes the knowledge and makes it accessible for other users and applications. Head hunters, for instance, form one group of users.

At the American Democratic Convention where Barack Obama was chosen as presidential candidate, the facial expressions of ex-president Bill Clinton were analysed during his speech. In the entire speech only one moment of disgust was detected: the moment that Clinton spoke the name Obama. It is to be expected that this sort of psychotechnology will be commercially available within a few years, possibly as a standard feature on everyone's mobile telephone.

With the project 'IT and the cognitive sciences' the Rathenau Instituut wants to explore the area in which information technology and the cognitive sciences now meet and will do so in the future. We want to map the technological possibilities and social visions on this field, and get the related future social pictures and issues on the agenda.


STERDAM

3 Science System Assessment

Mission

The task of the *Science System Assessment* department *(SciSA)* is to increase, integrate and make accessible knowledge about the science system. The SciSA research programme focuses on the following four objectives:[1]

1 Giving a total picture of the functioning of the research system. This will consist of a description and a model of the science system. It will lay the foundation for research into all kinds of aspects of the system, such as its ability to respond to developments.
2 Providing a periodic overview of promising developments in science and technology. The core will consist of reports on the developments of existing and emerging research fields in order to arrive at a map of the science system.
3 Providing understanding of the forming of social opinion on, and assessments of, the science system.
4 Giving sound, easily accessible information on new scientific and technological developments and the functioning of complex knowledge systems. This information is intended for parliament and policymakers in the government, research institutions and other organizations within the science system.

In order to fulfil its mission, the Rathenau Instituut's SciSA department carries out fundamental, strategic and applied research into the dynamics of science and the functioning of the science system. On the basis of this same mission, the department also focuses on keeping the political body and policymakers up to date with relevant, accessible information.

Relevant considerations here are as follows:

– Knowledge on the dynamics and functioning of the science system forms input for policy discussions and the underlying policy theories of the actors involved. It clarifies the expected yields and costs of interventions and changes in the system. The empirical research implemented leads to relevant, accessible information on the system and the changes taking place in it, so that there is more information on which to base policy discussions.

1 Ministry of Education, Culture and Science (OCW) Science Budget 2004; Rathenau Institute, SciSA Research Programme 2005– 2008

- A 'map' of the science system and reports on specific research fields can contribute to the formulation of research priority areas in the science and innovation policies of the science explorations of the Royal Netherlands Academy of Arts and Sciences (KNAW) and other foresight and TA activities. The maps form input for the political and social debate on new developments in science and technology and the social opportunities and risks they entail.
- Social opinion on science is an important factor when it comes to political support for investments in scientific research. Furthermore, modern science and technology have ethical and political aspects that also often lead to social debate (TA) and political decision-making and regulation. Research into how social opinions arise may therefore form a constructive contribution to the social and political debate.

The intended output of the SciSA research programme has a number of forms:
- Scientific publications for colleagues;
- Summaries and specific reports to keep administrators, policymakers and politicians informed;
- Expert meetings and workshops for testing knowledge on its practical relevance and applying it in practice;
- Data on the science system for policy and research;
- Publications in public media for the public debate on science and the role of science in society.

Elsewhere in the world similar initiatives are being taken to the setting up of SciSA in the Netherlands. In Germany, for instance, the DFG set up the new Institut für Forschungsinformation und Qualitätssicherung at almost the same time. In the US the Science of Science and Innovation Policy programme was formed by the National Science Foundation (NSF). The Organization for Economic Cooperation and Development (OECD) evaluation of higher education and research in the Netherlands ends with the following remark:

"To develop a sound framework for national policy, policymakers must have a deep understanding of the institutions for which they are setting policy – whether police departments, hospitals, or universities. The most reliable way of developing this understanding is through working experience and immersion in the institution itself. […] We believe that OCW policymaking for higher education would be strengthened if its staff possessed a deepened understanding of and connectivity to higher education institutions. This can be accomplished through the recruitment of staff who have worked in tertiary institutions, devising plans of flexible secondment, even of a few months' duration, or by other means."[2]

In a knowledge society such as the Netherlands, one of those 'other means' is obvious: the formation of a research programme concentrating on the functioning of the science system. This is the function of the SciSA programme: to provide insight into the functioning of the science system and its various components, the objective being to contribute to adequate strategies and effective policy.

2 OECD thematic review of higher education in the Netherlands (2007).

This involves the transdisciplinary combination of independent research and direct experience with the practical situation.

Changes in the science system
Scientific research is becoming an increasingly important factor for social progress and economic development. The Dutch knowledge society therefore needs a science system that functions well and is internationally embedded and that produces the required output in terms of excellent research and social impact. With respect to the latter point, it is important that the science system is adequately linked to the economy and society. The position of science in society has changed drastically in recent decades. Whereas the science policy of thirty years ago was primarily aimed at improving quality, nowadays there are a great many policy matters. This is particularly apparent from the increased demand for research assessment. Partly as a result of the enormous growth in expenditure on research, calls to reveal its revenues and relevance have become much louder of late. The frequent use in policy of terms such as 'the innovation paradox' and 'the knowledge paradox' indicate that there is a least some doubt as to whether the social impact of scientific research is large enough.

Furthermore, there are still a number of other developments visible such as the emergence of new (interdisciplinary) research areas with great social and economic relevance, such as genomics, nanotechnology and the cognitive neurosciences, whereby the question arises as to whether they should be promoted, and if so, how. Changes in the focus of research, the globalization of the research system and the increasing European influence on scientific policy are also relevant.

The growing international competition for scientific talent is a new theme, and following on from this, the increasing demand for creative, highly-qualified professionals.

We also see that the public discussion on research has intensified, amongst other things due to its ethical implications, as in biomedical research. Moreover, the social consequences and, recently, the security-related implications of scientific research form a subject of public and political discussions that affect the practice of science. An example of this is the recent legislation on 'biosecurity'.

Finally, there is the persistent concern about the relationship between public research and the private economic interests that accompany scientific research. Look, for example, at the dependence of medical research on funding from the pharmaceutical industry.

These recent changes in the science system are thematized in the literature in terms of 'the changing contract between science and society', something that has led to a wealth of theoretical reflections and models in that same literature. Generally speaking, there are two objections: they are often based on anecdotal evidence and they often contrast an idealized model of the past with a new one from the future.

The added value of the SciSA programme should be that, because of its scale, it can place a lot of emphasis on empirical research into the functioning of the science system. This leads to a more adequate picture of a science system that is becoming more complex, varied and heterogeneous, both in types of knowledge production and in types of relationships between the production and the use of knowledge. Understanding of the heterogeneity of the system leads to a differentiated science policy and, in turn, to improvement in the functioning of the science system.

Research and system assessment
Because the importance of scientific excellence and the social impact of research has increased greatly, research assessment has gained a more explicit place on the agenda. Initially the focus was on the assessment of scientific productivity and quality, but gradually attention for the assessment of the social and economic impact has grown.

Assessment serves a number of objectives. The first is the legitimation of the (public) expenditure on research: do researchers and research groups deliver excellent, worthwhile work? Are research programmes and financing schemes effective?

The second objective is the delivery of substantiation for decisions on the allocation of funds. This is important since the demand for research funds is always much greater than their availability. Allocating research finances is a selection process that requires information on the effects of the research: 'evidence-based policy'.

Finally, assessment results can be used in communicating with the public and political body and which therefore contribute to more support for (larger) investments in R&D.

Assessment requires clarity regarding who and what precisely is being assessed. Are those that carry out the research, the financial backers or intermediate organizations in the research system being assessed? And what precisely is being assessed, at what level? Is it all about assessing projects, programmes, research portfolios, organizations or the whole science system? We use the general term 'research assessment' to refer to all of this.

The SciSA programme focuses on the assessment of the system as a whole as well as its major components. Assessments of individual institutions and programmes at this system level are important, particularly with regard to how assessment is carried out and what effect it has on the functioning of the system as a whole. On the point of view of the science system, assessment consists of the answers to two main questions:

1 What is the yield of the science system in terms of scientific excellence and social impact? How can this be measured and mapped? Does this vary for the various different fields of research?

2 How does the institutional structure and the organization of the system relate to the output? What features of the system contribute to enlarging the proceeds and what do not? And does this apply to all the research fields in the same manner: to what extent do the different research fields require different institutions, organizational forms and policy?

The research generates knowledge that contributes to answering these questions. Policy objectives regarding the scientific and social yields of scientific research form a starting point for system assessment.[3] SciSA research provides relevant information for policy on the degree to which objectives are realized. Moreover, this knowledge helps in estimating the consequences of possible interventions that are intended to increase effectiveness and efficiency in the system.

Comparative studies of science systems form an important tool for system assessment. What system configurations lead to the required outcomes? Comparison can take place on the national level (the European system versus the US system or the Dutch versus the Swedish, Belgian, Austrian, Swiss and Danish). Components of the systems can also be compared. Does certain research flourish in universities or in public research institutes? Which research institutions function better as knowledge intermediaries, private or public ones? And what is the best mix of types of research (independent fundamental, thematic fundamental, strategic, application-oriented, applied) and why? The big question is why one system works better than, and differently from, another. Is it because of the different 'incentives' embodied in institutions, such as the financing mechanisms (for example basic financing versus competitive financing) and career systems (which are different in universities than in research institutes), different policy (for example matching obligations or not), division of resources between research areas, ethical guidelines) or because of the different way in which research is managed (agenda-setting) and organized (institutes versus individual researchers)?

In order to be able to contribute to both short and long-term policy questions, an integrated research effort is needed.

Firstly there is need for better data on the science system; this would enable assessment at the system level. The available data often only yield partial answers to important questions. They may be incomplete or not available over periods sufficiently long to enable mapping. Finally, details from different countries are seldom easy to compare, thus complicating comparative studies. There are all kinds of significant developments both at the level of data and indicators and that of analysis and visualization of data to which the science system programme will gear itself.

Besides more data, a theory or set of theories on the functioning of the science system is needed. These theories will be about the differences in the cognitive and social organization of research areas, theories on knowledge networks and theories

3 Comparison of the working of various systems at the policy-making level is also informative: what policy objectives could be important for the future? Looked at this way, the objective of Science System Assessment is close to foresight.

that analyse the science system as a complex adaptive system or ecosystem. The long-term objective is to develop a model with which the dynamics of science systems and their components can be simulated as well as possible policy interventions in these systems. Cooperation will be sought with researchers in the field of science & science policy studies in the Netherlands and abroad for both the empirical and the theoretical work.

The Science System

The science system consists of researchers and research institutions. In addition, there are a number of organizations that are engaged in setting the agenda, financing, assessment, management and coordination, advice and policy. Lastly, there are the rules and procedures, the institutions that influence the actions of researchers and the others in the system in the long term. They are the rules by which resources are allocated, researchers are assessed and careers organized.

The core of the system is formed by the research group (or the individual researcher), the smallest building stone of the science system. This is the spot where research and knowledge production takes place and where new generations of researchers are trained. It is also the venue where cooperation with knowledge users takes place, new start-ups arise or patents are applied for. Incidentally we use the concept of research group somewhat loosely here. The term has a different meaning in each discipline. In some fields these groups are large units and in others, the 'group' consists of a single researcher. The manner in which research is organized also varies from country to country, and this affects the size and structure of the group too.

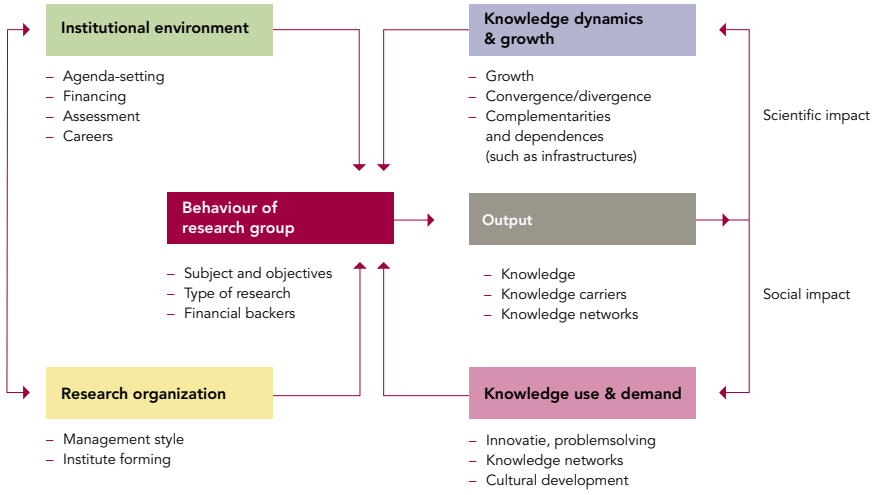
A number of factors have a significant effect on how the research group functions. These include its size, the style of management, the quality of the members and the networks in which the group functions. The research group's environment is also important: the environment comprises factors that influence how the group behaves and functions and therefore, indirectly, its output. The environment can be broken down into the following factors:

- the institutional context, including the financing context;
- the organizational context of the group: the research institute within which the group functions;
- the disciplinary contexts in which the research group is situated;
- any application context the group may have.

Figure 1 (pg. 53) summarizes these factors. The behaviour of researchers, and research groups, is influenced by the institutions present, the existing organizational forms and the characteristics of the specific discipline or disciplines in which they work.

Organizational forms, career systems, financing models and assessment protocols can promote innovative research or curb it; they can facilitate adjustment to new developments or slow it down; they can attract top talent or drive it away; they can promote the pursuit of social impact or inhibit it.

Figure 1 A model of the science system



It is useful to clarify the importance of differences between disciplines and fields of research. The latter vary in terms of dynamics. Some are stable, others show enormous growth and change. In some there is harmony regarding future directions (convergent search strategies, certainty of tasks) whereas in others there is a great deal of uncertainty on where it is all going (which leads to divergent search strategies).

Different fields have different relationships as regards dependence. In some fields researchers are highly dependent on one another because the research requires various types of expertise or expensive shared infrastructures. In other fields, researchers are independent of one another because of the small scale and individual nature of their work. The dependence on market parties and/or policy is also greater in some fields than others.

One of the objectives of the programme is therefore to arrive at a better theory on (multi) disciplinary development on the basis of which a typology of research fields can subsequently be developed. A typology of this kind should enable the formulation of a differentiated policy that does justice to the diversity of the science system.

Besides the above model, which is suitable for comparative studies, we also use a network model. In this model, the science system consists of a wealth of actors who try to achieve their objectives by means of transactions, concluding relationships, competition and cooperation.

The network comprises researchers who are active on a number of 'markets', and in particular the market for research funds (will your project be financed?), the market for scientific ideas (will your manuscripts be published in reputable journals?), the employment market (at which institute are you going to work and what possibilities will this yield?) and the knowledge market (are patents exploited and recommendations paid for?).

Other actors also operate on all of these markets: financial backers, editorial departments of journals and publishers, research institutions, companies and government institutions. The transactions and relationships realized will depend on the objectives of the actors in the networks and the preconditions within which they operate: institutional schemes, the characteristics of the research areas and organizational forms. Metaphorically speaking, it is essential for the science system that these different 'markets' work well. Organizational forms and institutions must therefore be geared accordingly. How these markets function and how environmental factors have to be adapted to suit them may vary according to research area and discipline. The research programme will build further on insight based on the network theory and theories on complex adaptive systems.

The model on page 53 leads to the five questions that were central to the last work programme [4], that is:

- What is the value of science and how can we measure it? (This question concerns the frame of reference for SciSA)
- What are the dimensions of the development of research fields? Can a typology of research fields be drawn up on the basis of these dimensions?
- What influence does the institutional structure have on the production and use of knowledge?
- What influence do organizational forms have on the production and use of knowledge?
- What factors influence the functioning of research groups and how?

The research questions

The subquestions of the SciSA research programme are elaborated below. As mentioned earlier, comparative research is an important instrument for system assessment. In the context of the SciSA programme, studies are therefore carried out in such a way as to maximize international comparability, preferably in cooperation with similar research programmes and research groups in other countries. The study into research financing implemented in 2007 is a good example of this approach.

4 ScisSA Research Programme 2005–2008 (pg. 29).

3.1 The Value of Science

In order to create a frame of reference for SciSA, we need an answer to the questions of what the value of scientific research is and how it can be measured. Without clarifying this area, we cannot answer the question of how the characteristics of the science system influence the output of the system.

There is global agreement on the various dimensions of research output. These dimensions include excellent scientific knowledge, knowledge that has social impact, highly-qualified, creative knowledge carriers, networks between knowledge producers and users and knowledge as a contribution to the culture of modern society. However, it is not a simple matter to convert these dimensions into usable indicators. This applies to scientific excellence, which is, in theory, only assessed by colleagues, but it is many times more complicated for the other aspects of social impact. There are several reasons for this, one of which is that the assessors of these other factors (who are not colleagues) look at matters with different frames of reference, interests and positions. In this context, what is known as the attribution problem is of crucial importance.

It is difficult (and perhaps even impossible) to attribute the social impact of scientific knowledge to specific research. Moreover, there is the problem of the time horizon: when can one decide whether research has given something to society or not? 'Seemingly useless' research can form a building block in a complex research line that yields something exceptionally useful much later on. In other words, scientific knowledge has a network structure and every individual element does not necessarily have to have a 'stand-alone value'. The whole can still have a very great social impact. Furthermore, there are always the skills that the researcher in question has acquired during the implementation of his or her research, skills that may later prove to be of use to society.

The fact that the demand for research funds is always greater that those available has already been brought up. This obliges us to make allocation decisions that are always implicitly or explicitly based on consideration of the scientific and/or social importance of the research in question. The demand for impact and quality consequently becomes even more compelling, because choices have to be made between qualitatively-different research fields, directions and programmes.

There is currently a great deal of discussion going on as to how to measure the value of science. The possibilities for and difficulties of assessing both the scientific quality and the social and economic yields of research are also subject to much debate. It is important that the state of affairs is assessed and that new ways are sought for moving further. Relevant question to this end are:

1 What do we know about the evaluation of scientific productivity and quality? What approaches and indicators are used in different countries? How are the outcomes used and how does this affect knowledge production? To what practical implications does this lead?

2 What methods are there for assessing the social quality of research and research programmes, of disciplines and of the social impact of the science system as a whole? Can these methods be used in the various types of research areas and what will that yield?

The attribution problem, the problem of the time horizon and all sorts of problems concerning the definition and measurement of the proceeds of scientific research require new ways of looking at assessment, quality and impact. A number of approaches are possible.

Firstly, the Rathenau Instituut, amongst others, has a long tradition of TA research, in which the effects of modern science and technology on society have been explicitly examined and mapped. This work could yield a valuable contribution to clarifying the social value of science and technology. An additional advantage is that TA studies often weigh up opportunities and risks, so that value can be qualified and subtle distinctions made. Secondly, it is worth focusing research on interventions that improve the conditions for (and chance of) top quality and impact instead of trying to measure the quality and impact of individual groups (although this is important as a form of self reflection and learning). The question then becomes: what conditions have to be met to maximize the chance of excellence, impact and serendipity. The answer can be found in historic case studies.

Research questions are:

3 What understanding does TA research yield for the determination of the societal value of science?
4 How have top research groups arisen in the recent past and, if relevant, how did they 'disappear' again? How and under what conditions did they function and in precisely what sense did they excel?
5 Do historic case studies into what, in retrospect, we call 'serendipity' yield insight in the conditions that enable research with a social impact?

One important condition for social impact is that research results reach actors that can use them. Potential knowledge users must, of course, be able to do something with it, which leads to questions regarding entrepreneurship, innovativeness, etc., that fall outside the scope of this research programme. But this also leads to questions on the quality of knowledge networks (see above) and on the accessibility of knowledge. Developments concerning 'open access' may play a role in the latter.

The area that needs investigation then becomes:

6 Does 'open access' to data and results lead to better utilization of knowledge? And if this is the case, in what situations, under what conditions and for what groups of potential knowledge users? What can we learn from this for the design of 'open access' to knowledge and data?

Projects on the Value of Science and Assessment

The SciSA Research Programme 2009 – 2010 includes a number of studies on the value of science and research assessment:

1 In the first instance, a review of the existing insights is made. This includes the various types of contributions of science to society: knowledge, knowledge carriers, knowledge networks and knowledge as contribution to culture.[5]
   - In assessments of research and research institutions with emphatic valorization objectives it is very often found that the most important output is the network, as a result of which companies or institutions are kept informed of the relevant knowledge environment.
   - Innovation literature emphasizes that the most important factors for an innovative knowledge economy are people who are educated in the sciences and who are able to play a role in innovation processes.
   - In this way, knowledge as product does not always seem to have a dominant role over capacity and knowledge networks.[6]
2 A survey of methods for assessing the social value of science at the group and programme level. How can social value be defined, how can we measure it? The 'quick scan' already published is being elaborated to form a complete review. In cooperation with universities and the Evaluation of Research in Context (ERiC) Project an assessment methodology will be developed that will be tested in a number of pilot projects. Other possible test environments are the large Economic Structure Enhancing Fund/Investments in Knowledge Infrastructure (Subsidies) Decree (FES/Bsik) programmes.
3 A report will be published on the methods of research assessment. How can scientific excellence be defined and measured? What are the criteria for scientific excellence in the various disciplines? How much consensus is there on the criteria and the outcomes if these criteria are applied? What is the state of affairs with regard to inter and multidisciplinary research?
4 An international project taking place within the framework of Prime Network of Excellence is attempting to measure the output of research institutions in a broader sense than simply the output examined in the Web of Science ISI. The idea is to make instruments that retrieve data from existing bibliographic and other databases. This method can then be used to create a multidimensional output measure.
5 A project will be implemented on what TA research contributes to making the value of scientific and technological knowledge explicit.
6 A project on open access and the use of knowledge that was started in 2008 will be completed.

5 SciSA Research Programme 2005 –2008 (pg. 29).

6 Compare also the coastal defences study: Femke Merkx, Anouschka Versleijen, Peter van den Besselaar: Kustverdediging: wetenschap, beleid en maatschappelijke vraag (Coastal defences: science, policy and social demand). The Hague, Rathenau Institute: 2007. (SciSA Report 0704)

3.2 The Dynamics of Research Fields

Researchers in any particular discipline refer to and build on work carried out by one another. At the research area level, this leads to a self-organizing process of cognitive development, whereby the research area develops in relation to other areas. The changing citation relationships in specialist journals and articles are useful for analysing the dynamics of areas of research. They can be used to sketch a picture of the central and peripheral research themes and of the institutes and countries that are actively working on these themes. We can then look at the position of Dutch researchers in promising fields and whether there are networks of research institutions, organizations and companies that may be able to use the knowledge in question.

In the SciSA programme a number of fields are being, and will be, examined in this way, including water safety research, genomics, nanotechnology, self-healing materials and media and communication. Generally speaking, these are fields that have raised great social and scientific expectations. In Work Programme 2009 – 2010 we will again be carrying out a number of field studies in cooperation with parties that are interested in these specific areas.

1 Subjects of these new (descriptive) field studies are as follows:
   - river and coastal research;
   - genomics;
   - chemistry, catalysis and biocatalysis;
   - regenerative medicine;
   - e-science;
   - transdisciplinary education science;
   - taxonomy and biodiversity;
   - research into climate change.

As indicated earlier, we have already begun to distinguish between research fields (and the phase of development they have reached) in terms of growth, degree of task certainty (convergence and divergence) and in terms of task dependence (complementarities). These dimensions of knowledge dynamics have been derived from theories on the dynamics of disciplinary development by authors such as Whitley and Bonaccorsi.[7]

The hypothesis is that research areas with different knowledge dynamics also require different institutional conditions. Bonaccorsi divides research areas into new innovative areas that are central for the knowledge economy and the older, stabilized ones. The hypothesis suggests that the knowledge paradox can be traced back to the outdated institutional structure that fitted in with the 'old' research areas, but does not fit in with the 'new'. Countries with the old institutional structure perform well in the old research areas (maths, physics, astronomy and some areas of chemistry) but less well in the new areas (nano, genomics and ICT).

7 Whitley, The social and cognitive organization of the sciences; Bonaccorsi.

Research questions relevant to this research are as follows:

2 Is it possible, on the basis of this typology, to create a method for field studies that relates the knowledge dynamics of a field to its context: what institutions and organizational forms are appropriate to what fields? Does this substantiate the relationship between institutions and performance in research fields as the theory suggests? And what do we learn from this about the position of the Netherlands in the various old and new research areas?
3 Are the typology and the dimensions distinguished in them suitable for analysing non-disciplinary research fields such as for multi or transdisciplinary research that is driven by social problems? And what is the situation with regard to interdisciplinary fields?
4 What other indicators, such as patent data, web data and data on cooperation in projects, can be used to map the development of research fields?

The strong developments in ICT are leading to a new generation of research instruments and infrastructures for cooperation and sharing data, knowledge and facilities. This makes it possible to ask new questions and to answer old questions in new ways.

5 What are the drivers behind new research infrastructures for the diverse disciplines? Who is involved, and who is not? How do choices for new infrastructures influence research agendas?

Knowledge has an increasing effect on man and society. This leads to all kinds of discussions on the desirability of certain research and attempts to regulate research and the spread of knowledge. There are abundant examples of 'embedded science'.[8] Look at the private financing of public research on medicines whereby the subsidy provider has an economic interest in the outcome, or the private appropriation of results. Not only are ethical discussions ongoing with regard to the use of knowledge, but also to the acceptability of research itself in the case of research with test animals or stem cells. Political regulation may also take place if there is any question of results interfering with security policy.

Related research questions are as follows:

6 How do the ethical, political and economic interests concerning research affect the formation of social opinion on science?
7 How big a share of all the research carried out does so-called 'embedded research' have? In which of the research areas does this play a role? What are the risks and how can the research sector be regulated in such a way that research is still possible?

8 'Embedded' in this context may be taken to mean the same as in 'embedded journalism'.

Projects on the Dynamics of Research Fields

1 A number of field studies have been included in Work Programme 2009 – 2010 as there is abundant demand for them at all sorts of institutes and institutions. Consultations are taking place on several field studies, and others are already ongoing: regenerative medicine, cognitive research, genomics, chemistry, taxonomy and biodiversity and e-science. If interesting TA questions arise, these generally have to do with science and field studies seem an obvious approach to upstream TA.
2 After the current project on the structure and effects of data infrastructures for biodiversity has been completed, there will be a follow-up study on research infrastructures in other areas, making use of the same design. The emphasis will be on the involvement of various groups of actors and on the effects of the infrastructures on knowledge production and research agendas.
3 International preparations are underway for a project on describing and modelling the dynamics of research fields using 'agent-based modelling' technology.
4 A central activity is the further development of bibliometric and other methods and indicators for describing the development of research areas in terms of the internal knowledge dynamics and the external institutional and organizational conditions. The objectives include identifying sub-areas within the various disciplines where new developments arise or there is a lot going on. This project is also being carried out with international cooperation.

3.3 How the Institutions work

The third set of questions concerns how the institutions of the science system work. We distinguish between agenda-setting and financing here. Research assessment has already been examined in detail above.

Preliminary (exploratory) studies and other forms of foresight are frequently used to arrive at an agenda. In the Netherlands, all sorts of organizations play a role in this. As argued earlier, research areas vary in their degree of growth, convergence and mutual dependence.

1 This leads to the question of whether agenda-forming processes take into account differences in knowledge dynamics and development phase. What actually happens in a preliminary study? What is the result and what are its effects on the various disciplines?
2 The international context is playing an increasing role in agenda-setting, including that at national level. This is evident in fields in which international coordination is inevitable, such as climate research, but coordination at the European level is playing more and more of a role in practically all fields because, for example, of the emergence of European Research Area networks (ERA nets). How is the agenda set at the EU and international level, what are the consequences on the practice of research and on the research themes and directions?

3 There is always a need for transparency and 'checks & balances' in all coordination mechanisms and decision-making arenas. Is the system open enough and are there alternative agendas and financing possibilities? Or is there an 'established order' as a result of which the system stays closed to newcomers and innovators? What do the social networks relating to agenda-setting (and finances and budget allocation) look like?

Projects on agenda-setting

1 Increasing management, coordination and harmonization indicate that agenda-setting is becoming more of a top-down process. SciSA research focuses on the questions of who are involved (and who are not) and what the explicit and underlying objectives in agenda-setting are. How do preliminary studies and surveys take place? Who is involved, what is the outcome and what happens with the results?
2 Agenda-setting is becoming more important due to growing Europeanization, as a result of which an extra (international) layer is forming. How does coordination take place on the national and international level, how is agenda-setting organized and what are the substantive effects of this?
3 In the follow-up to the SciSA study of coastal defences, a project is being set up on the role of inter and transdisciplinary research in solving 'untamed' social problems and the institutional conditions necessary for this. One of the aspects to be looked at here is how demand articulation and knowledge transfer and use are organized. This will be examined, amongst other things, in case studies of the functioning of Investments in Knowledge Infrastructure (Subsidies) Decree (Bsik) programmes.

Research funds are essential aspects of the science system. How do research funds flow? Who are the financial backers, what are the instruments and who receive the research funds? The speed with which financial flows can be rerouted if new opportunities arise codetermines the innovative power of the science system. The questions of whether the funding mechanisms work well, whether they are transparent and whether there are adequate 'checks & balances' in the system apply here too.

In an earlier publication [9] an overview was drawn up of the financial backers, their instruments and the size of the various forms and instruments used for the public part of research funding. How the situation has developed since 1975 was also examined. This has raised various questions that require following up:

1 How precisely do the instruments work: who decides, on the basis of what criteria and how are the different instruments coordinated? Are the targeted effects actually realized? What, if any, are the unintended, indirect effects such as shifts in decision-making power, the tying of resources that are allocated on other grounds, the long-term binding of researchers because funding is large-scale and long-term? What do these side effects mean for the practice of research?

9 Versleijen et al, Dertig jaar publieke onderzoeksfinanciering in Nederland (Thirty years of public research financing in the Netherlands).

2 How are funds distributed amongst the different research areas and the research institutions? This is very unclear, particular with respect to the parties carrying out the bulk of the research (the universities).

Projects on research funding

The research carried out earlier has led to a number of questions on the working of various financing instruments that require following up.

1 In 2007 – 2008, SciSA carried out a study on project selection in cooperation with the NWO Social Sciences Research Council (NWO-MAGW). The plan is to repeat this for other disciplines. Comparison between disciplines and with other project selection procedures (in other countries) is important if we are to build up a better understanding of how selection methods work and their effects.
2 We will make a network analysis of applicants, successful applicants, committee members and reviewers. This will yield useful information on how open the selection system is. For the time being we hope to do this with two research councils.
3 There is discussion on the quality of the results (and of the selection) of projects in the framework of large financing instruments such as the Economic Structure Enhancing Fund/Investments in Knowledge Infrastructure (Subsidies) Decree (FES/Bsik). The new research programme 'Knowledge for Climate' will serve as one of the cases. We will look at whether and how this financing instrument leads to excellent research and contributes to solving urgent social problems and policy questions.
4 Research will be carried out into the working and effects of coordination and management: what is it, precisely? What precisely happens there and what are the 'checks & balances'? How do research institutions respond and what does this mean in terms of how they work?
5 SciSA will also focus on the research question of what the prospects for, and consequences of, a shift in research funding to the European level are.

3.4 Organization of the Science System

The organization of the science system is an important theme for both descriptive and explanatory research. An atlas of the science system makes clear what expertise and research priority areas are present at what institutions and to what extent. Questions on variety, focus and mass can be answered in this way. Other relevant aspects of the organization are the way in which posts are divided between institutions, including more and more European institutions. Questions regarding the forms of governance of the system as a whole and of individual research institutions are also relevant.

Research questions on which SciSA concentrates are as follows:

1 Who does what for research in the Netherlands and to what extent (what does the atlas of the Dutch research system look like)?
2 What is the role of institutes of higher professional education (hogescholen) in research and what could it be? How does the increasing desire at institutes of higher professional education to carry out research relate to the wish heard from all sides to make higher education more varied? And, if focus, mass and concentration are required to achieve scientific excellence, why distribute the available resources amongst even more institutions? What niche could be allocated to research at universities of professional education?
3 What is the role of universities of professional education (and comparable institutions) in research in countries where this has already been taking place for some time (Germany, UK, USA)? What sort of research do people carry out and what is its added value?
4 What might the research policy in research institutions look like in relation to the tension between institute-forming and management on the one hand and the autonomy of the creative researcher on the other?
5 What are the opportunities and risks of the further Europeanization of the science system and, in particular, for the formation of organizations with the tasks of getting issues onto the agenda, and financing and evaluating them?
6 In the SciSA report on research financing mentioned earlier, we conclude that variety (competition) of financial backers is important for the functioning of the system. Is the Netherlands too small to design the requisite competition in the right way?

Projects on the Organization of the Science System

1 In 2006, H. Speelman (TNO) made an overview of the non-university public science system. The data on the university research were incomplete and attempts are being made to complete them. This will lead to an overview of who does what for research in the Netherlands and to what extent. Basic information on this will be published in a new series of 'Facts and Figures' on the science system.
2 On the European level, more and more organizations are arising that will be engaged in agenda-setting, financing, assessment and implementation of research. A number of related questions will be involved such as: does Europeanization lead to greater competition in the science system and, in doing so, to stronger cores and, simultaneously, a more unequal distribution of the research capacity throughout Europe?
3 Much has been said about the changing position of universities in an internationalizing and competitive research landscape. We will be giving an overview of these discussions in a new project.
4 The project 'The research function of universities of professional education' will be continued. We will examine the role of universities of professional education (and similar institutions) in research in countries where this has already been going on for some time (Germany, UK, USA). What sort of research is carried out there and what is its added value?

3.5 Researchers and Research Groups

An important research theme concerns the way in which researchers' careers are regulated. This is linked to the question of the employment market for researchers (including those at the top of the field) and those that want to become researchers (PhD students, post-docs). A preliminary, exploratory study was carried out to identify and list the problems that occur in researchers' careers, during recruitment and in finding (research) jobs outside the universities.[10] The emphasis of the study lay on the promotion of talented young researchers in the university context and on the various initiatives that universities have taken to promote the flow and career opportunities in general. The preliminary study will be followed up by studies into the various aspects of research careers, which will tie in with research implemented by others.[11] The research questions are as follows:

1 What are the determinants of a successful career in research? What ensures that someone rapidly succeeds in getting promoted in research and what factors hinder this?
2 The organization of research is different in the US than in the Netherlands. This is manifested in differences in the autonomy of researchers and in the dynamics of research careers.[12] These two factors seem to have a great deal of influence on the mobility of top Dutch talent to the US. What organizational forms and career routes have greater appeal for the better researchers? What does this imply for competition between institutions?

Projects on Research Careers

1 The promotion of talent is an important policy objective. In this project, we examine what factors in the early phase of a young researcher´s career determine whether he or she will be rapidly promoted. This will take place:
   – by comparing pairs of young researchers;
   – by comparing their CVs.
2 Because the international competition for top talent is becoming more intensive, the demand for methods for comparing research careers internationally is increasing. The appeal of a particular institution for young researchers is directly affected by the way in which careers are organized at it. Moreover, career systems influence the appeal indirectly because they partly determine the quality of the institution which, in turn, attracts more, or less, talent accordingly. This is relevant between countries (brain drain) but also within countries (competition between universities).
3 Preparations are underway for a project on modelling the mobility of researchers, the question being under what conditions concentrations of talent arise.

10 Van Balen & Van den Besselaar, *Universitaire onderzoekssloopbanen* (University research careers).

11 For example, the study of careers of people holding a doctor's degree carried out by the Netherlands Centre for Graduate and Research Schools (Centrum voor de Promotieopleiding).

12 Van Balen et al.; M. van der Aa, *Brain drain of brain gain? Een onderzoek naar de arbeidsmobiliteit van Nederlandse academici in de Verenigde Staten* (Brain drain or brain gain? A study of the employment mobility of Dutch academics in the USA). Eindhoven: TUE 2005.

Research groups form the smallest building blocks in the science system where knowledge is produced, knowledge carriers are trained and the exploitation of knowledge is initiated. Research into the effects of the institutional structure and of the organization of the system on the functioning of research groups is therefore a central part of the SciSA Research Programme, the nature of the research field being an important factor. The nature and functioning of research groups vary depending on whether a mono, multi, inter or transdisciplinary research field is involved. The following questions are asked in the programme:

1 Is there a relationship between characteristics of research groups, their performances and the institutional context within which they function? Are there differences between disciplines? And between countries?
2 What is the relationship between organizational forms, management and output?
3 Do top research groups have specific characteristics that do not occur in the 'average research groups' and if so, what are they? How can we explain the occurrence, functioning and 'disappearance' of top groups (historically)?
4 What reputation and selection mechanisms (career, HRM), incentives, resources, constraints and contextual factors play a role in this? Does this give an insight in factors that improve the functioning of research groups?
5 How can the functioning of research groups be modelled? Do 'agent-based' models generate outcomes that can be validated with results from empirical research? For example, on the mobility of researchers and the formation of clusters of top researchers? And on the distribution of top groups in institutions under different conditions?

Projects on research groups

Policy interventions have an effect if they facilitate and/or influence the actions of researchers and research groups. After all, this is the primary process in which the research is implemented. The Rathenau Instituut therefore focuses primarily on research into, and creating models of, the nature and functioning of research groups.

1 Research on the functioning of research groups is rather fragmented as it has been carried out on various aspects. A review of the available knowledge will be made as a preparatory step for the further work in this programme line.
2 We carry out research into the relationship between the management of research groups and their performance. The study is based on two successive surveys, in which research managers are asked about their management style and the time spent on management, research and education. Data on scientific performance and social impact were also collected. This yields insight into the changes in the bureaucratic load (how time is spent) between 2002 and 2007 and into the relationship between management and leadership styles, and the academic and social output. The study concerns the healthcare domain. The study is to be broadened to include other fields at a later date.

3.6 Other Projects

1 A new series of publications has been started with accessible 'Facts and Figures' on the science system. Specific themes will be studied in depth in different issues, such as Dutch universities, public research institutes, the developments in research financing and the differences between the organization and governance of science in European countries.
2 Science System Assessment Annual Report: an overview published every year that contains information on the system and articles on aspects of the functioning of the science system in the Netherlands and elsewhere. The first number is under preparation.
3 The project on improvements in data infrastructure will be continued. The first product in 2009 is to be a website with information on the science system. This project is being carried out in cooperation with the Research information department of the Royal Netherlands Academy of Arts and Sciences (KNAW).

Priorities have to be set within these clusters of research questions. Moreover, it is all about finding a good balance between providing the maximum possible useful, accessible information and generating knowledge on the functioning of the system. It is crucial to find the most important knowledge questions at this moment in time and to determine which ones are critical in enabling us to contribute to a long-term, knowledge-based, evidence-based policy.

Prioritization is arrived at on the basis of consultation with the board of the Rathenau Instituut, the Board´s Advisory Committee, institutions with which the institute cooperates and fellow researchers. The SciSA Research Programme is adjusted throughout its duration in accordance with current developments in policy and science.

Who was Rathenau?

The Rathenau Instituut takes its name from Professor G.W. Rathenau (1911–1989), who was successively Professor of Experimental Physics at the University of Amsterdam, director of the Philips Physics Laboratory in Eindhoven, and a member of the Scientific Advisory Council on Government Policy. He achieved national fame as chairman of the commission formed in 1978 to investigate the societal implications of micro-electronics. One of the commission's recommendations was that there should be ongoing and systematic monitoring of the societal impact of all technological advances. Rathenau's activities led to the foundation of the Netherlands Organization for Technology Assessment (NOTA) in 1986. On 2 June 1994, this organization was renamed 'the Rathenau Instituut'.