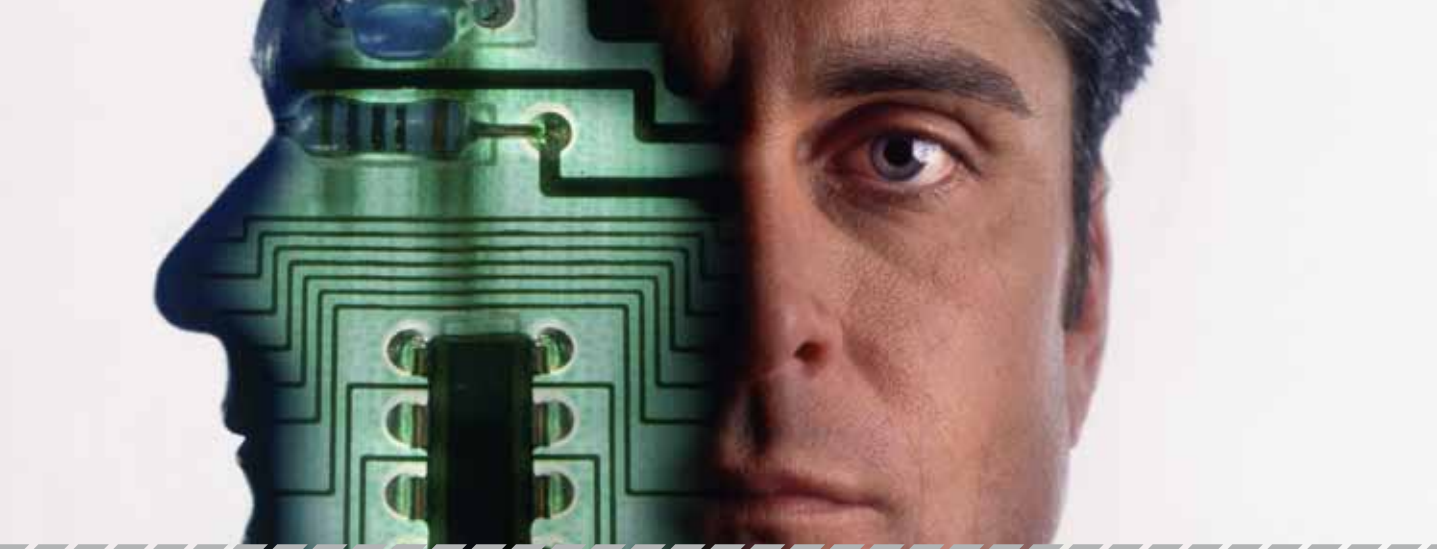

Work Programme 2013 – 2014

Rathenau Instituut

The **Rathenau Instituut** promotes the formation of political and public opinion on science and technology. To this end, the Institute studies the organization and development of science systems, publishes about social impact of new technologies, and organizes debates on issues and dilemmas in science and technology.

Rathenau Instituut

Work Programme 2013 – 2014

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Foreword

Much is happening in the field of science, technology, and innovation. Of course, developments within science, technology, and innovation have already been playing a role in daily life for a long time. But recently, we are confronted with discussions on the limits of things that science and technology can offer us. Consider, for example, debate on the Electronic Health Record (EHR) and DNA databases, or discussions on the tenability of our science system. One thing is certain: we cannot do without science and technological innovation. After all, both are extensively utilised, especially due to their potential for our future prosperity and economy.

The Rathenau Instituut has the task of manoeuvring at the intersection of science, technology, and innovation, especially in disputable situations, in a multidisciplinary manner. The institute acts when myths or conflicts of interests stand in the way of solutions, or when large controversies are expected. Especially in these cases the Rathenau Instituut wants to make a contribution by creating space and clarity concerning necessary boundaries, and by working on solutions. We aim to do this by informing and advising members of parliament, departments and (international) organisations involved with innovation, the top sectors, and the Dutch science system. Moreover, we put emphasis on strengthening our debate function within new target audiences. Simply because developments in both science and technology impact the lives of everyone.

The new work programme 2013 – 2014 is based on four trends that have radically changed society, of which we may safely expect they will continue to do so. Partially, the elaboration of the themes that resulted is a continuation of and addition to our previous work programme, as is the case in our research on medical care and the increasing thirst for raw materials. However, all our themes noticeably have a more international component. The working field that we study is pre-eminently international and transcends our national borders. By studying comparable problems that take place elsewhere, we may also learn and understand much about the Netherlands.

The new work programme 2013-2014 offers a good basis for continuing research on the societal impact of changes in science and technology, together with other parties, from various perspectives, and to create space for solutions.

I hope you will enjoy learning about our new work programme.

Prof. Corien Prins, LL.M.,
(Acting) chairman of the Rathenau Instituut management

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Summary and **reading guide**

On the Rathenau Instituut

The Rathenau Instituut plays a unique role at the intersection where science, technology, and innovation meet society, policy, and politics. The Rathenau Instituut wants to create space at this intersection for directions for viable solutions. This takes place based on a broad variety of methods and means.

The Rathenau Instituut is independent and multidisciplinary. The institute also actively participates in various European and global relations, which are becoming increasingly important. Based on the self-assessment in the period spanning 2011-2012, the Rathenau Instituut formulated the most important challenges, and its ambition to strengthen its unique position and to continue to play its role in the rapidly developing field as carefully and as well as possible. The work programme 2013-2014 is an elaboration on this.

Trends

The Rathenau Instituut observes four political, scientific and societal trends: individualisation, knowledge economy, globalisation, and digitisation. These trends are described in connection with science and technology development, and form the backdrop to the chosen themes and projects.

Individualisation
Authorities have lost power since the process of individualisation. Fixed patterns, which are determined by social status, sex, race, or religious beliefs, are disappearing into the background. The rise of the Internet and consequent networking technologies have strengthened this development. The authority of science is frequently disputed because citizens and businesses make use

of scientific knowledge that is readily available online. Political choices, too, are more frequently influenced by social networks and the media. Conversely, politicians and businesses also make use of these networks, and this accelerated knowledge creation and circulation offers perspectives for innovation and an evolving dialogue.

Knowledge economy

The Netherlands is a knowledge economy and has a strong focus on innovation. Knowledge and technology are increasingly determining factors for economic growth. To maintain the current levels of knowledge production and innovation in an economically and societally complex reality, the government invests in top sector policy where the collaboration between science and business must be strengthened. This calls for close collaboration between traditional knowledge providers and knowledge consumers, and for the co-creation of knowledge. With regard to technology development, the question remains which role key technologies, as the driving force of innovation, can fulfil.

Globalisation

The spread of products, production processes, and human capital is no longer limited to national borders; it has become global. This process of globalisation is accelerated by the rise of the Internet, which led to a greater interdependency between countries. These consequences also become apparent from the structuring and the content of science. With regard the structure, the national structure of the knowledge process no longer suffices: Dutch research and innovation takes place in a European context, in coherence with the European 'Grand Challenges'. Moreover, scientific careers get an international character, research programmes are often internationally determined, and value chains cross national boundaries. For many issues, for example the scarcity of certain resources or climate change, new solutions and techniques are only available on a global level.

Digitisation

Digitisation defines today's society. It stems from science, and subsequently it is found in science. We can map an increasing amount of information on our physical functioning. Digitisation provides data information and complex databases that can only be deciphered using smart algorithms. New fields of science have emerged and others have undergone radical changes. Digitisation speeds up technological development, such as long-distance care, new tracing methods, or the monitoring of our own behaviour

and that of others. This offers new possibilities, but it also raises questions concerning the boundaries of our human rights, such as privacy.

Themes and projects

Theme 1 – Resilient Knowledge Infrastructure

Dutch research and science policy has been very successful over the past twenty years. However, the knowledge infrastructure's functioning is being questioned. This theme is elaborated on in five projects

- **The Future University Order**
  Universities must increasingly deal with stakeholders and their expectations of and influence on university policy. This appears to hinder a thorough long-term vision of the role and position of universities. Together with parties from the sector, the Rathenau Instituut explores the future university order. The central question in this exploration is: what should the university order look like in the future if it wishes to keep its knowledge function involving fundamental research, scientific education, and knowledge transfer?
- **Non-academic Public Research Institutes**
  The legitimacy of non-academic institutions is under pressure. These institutions have little visibility in research policy, and their multiple roles more often lead to criticism than praise. However, these knowledge institutes do appear to play an important role in value chains and they play the lead in sectoral knowledge systems. The Rathenau Instituut aims to better map these research institutes by analysing their legitimisation. To this end, the central questions are: what are the institutions' aims, how do they achieve them, and what parties do they serve?
- **Exploration of Practice-based Research**
  The introduction of lectureships at polytechnics has led to the development of their research function. The Rathenau Instituut leads an exploratory study to determine what the position of this research is within the knowledge infrastructure of the Netherlands. The most important points are: valorisation – what is the societal meaning of this research – and innovation – how is the public-private collaboration between businesses, the government, and polytechnics being strengthened.
- **The Careers of Scientists**
  There is little knowledge on the course and the development

of scientific careers. In consultation with stakeholders VSNU, NFU, Promovendi Netwerk Nederland, SofoKles and NWO, the Rathenau Instituut is analysing the careers of scientists and the developments in the job market that influence these careers.

– **The Funding of Research**
  The Rathenau Instituut publishes an annual TOF (Total Research Funding) overview in which government research spending is made transparent. Due to the growing need for a better overview, the Rathenau Instituut will elaborate on this information. First, the innovation expenses will be integrated in the TOF figures. Moreover, the Rathenau Instituut strives to gain more insight in three other areas: in the development of the European funds for research and innovation, in the financing of large infrastructures, as determined in the so-called Roadmap (March 2012), and in the flow of funds within universities.

Theme 2 – Societal Permit for Science

Citizens, businesses and policymakers look to science as a source of valuable information. Expectations of science are great. At the same time, trust in science is under pressure due to societal controversies on new technologies and incidents of fraud. This theme is elaborated on in four projects.

– **Valorisation**
  The legitimisation of the practice of science depends on, among other things, what it can offer society. The project 'Valorisation' focuses on the question of how, within social sciences and humanities, valorisation can be interpreted, knowledge transfer for the benefit of society, the third core task of universities. The project also focuses on the emphasis on valorisation and its effects on research on fundamental processes, of which the direct benefits are not absolutely clear.
– **Attitudes towards Science**
  Against the backdrop of trust in science and breaches of trust through a lack of unambiguous answers or scientific fraud, the Rathenau Instituut and the WRR started a long-term project. The aim of this project is to create an empirically founded and systematic overview of the attitudes of citizens, policymakers and scientists towards science, and the role of science in policymaking in particular.
– **Democratisation of Knowledge**
  The role of citizens within evidence-based policy is of utmost importance, but it is not always recognised by the government. This project focuses on the roles and possibilities of citizens in relation to the new media: in what way and with what means

can new media, used by citizens, shape public debate? Furthermore, the relation between the new, digital participative processes and the representative democracy is studied.

– **Science Communication**
  The (alleged) declining authority of science raises the question of to what extent science communication can and should play a role in restoring trust in and a basis for science in society. Together with partners, the Rathenau Instituut wants to do an exploratory field study on recent developments in science communication and science journalism.

Thema 3 – Innovation 2020

Knowledge plays a crucial role in making innovation possible and strengthening the economy. The theme 'Innovation 2020' concerns the way in which innovations come into existence and the backgrounds that influence the materialisation of the market power of these innovations. This theme is elaborated on in four projects.

– **The Future of Innovation in the Netherlands: Globalisation and Key Technologies**
  Contrary to the innovation story of the government, innovation does not limit itself to national borders. R&D departments of businesses frequently move to a different part of the world. This project is a critical reflection on the existing innovation story, featuring questions such as: how do businesses organise R&D and in what way do businesses apply their R&D strategy to national and international innovation dynamics? Do key technologies play an important part in this?
– **Science as "Partner in Development"**
  With the development of the 'top sector policy', science and innovation policy have grown closer together. Therefore, a central question in this project is: how can the relation between scientific activities and innovation best be organised? The focus is on the Top Consortia for Knowledge and Innovation (TKIs) and the water knowledge infrastructure. The shift within the knowledge system to the priorities of the European Union raises the question of how the structure of the national science and innovation policy fits within international innovation dynamics. And this raises another question, namely, what is the added benefit of coordinating TKI-like organisations at the European level?
– **Innovation and Regulation**
  Regulation is often seen as limiting and preventing innovation. However, rules often clearly serve a facilitative purpose. The dilemma surrounding rulemaking surfaces where the key tech-

nologies are concerned, because innovations in this field have insufficiently taken shape for new rules, while old rules no longer suffice. Therefore, this project searches for ways of 'regulatory learning'. Within the European project GEST, together with partners from Europe, India and China, this subject is discussed and research is done on how debate can take place on international levels.

– **Co-creation of Knowledge and Innovation**
  Citizens are becoming increasingly important players in the domain of innovation, helped by easy access to knowledge, means of production and distribution options, mostly due to the Internet. Consequently, citizens have become an integral part of the development of innovative products and services. At this moment, all sorts of ways to collaborate are being discovered, between businesses, governments, knowledge institutions and citizens, often at a very local level. This project researches what can be learned from these initiatives.

Thema 4 – A Broad Perspective on the Thirst for Raw Materials

Raw materials have become scarce, but the need for them has only grown. Today's global struggle for raw materials is consciously viewed from a broad, societal perspective. The debate surrounding raw materials is often focused on the physical, economical and geopolitical aspects, but focus on ecological, technological and sociocultural dimensions is just as important. This theme is elaborated on in five projects.

– **Search for a Societal Basis**
  Many sources of energy lead to societal resistance. Because the current form of gas extraction will, in 2030, yield only a quarter of what it did in 2009, shale gas production is considered an alternative. This alternative, however, meets great societal resistance, and this resistance is worldwide. This project studies the societal resistance against shale gas production and the roles of various parties involved on local, national, and international levels.

– **Opportunities for Recycling**
  The rising struggle in the field of raw materials offers opportunities for innovation. There is renewed interest in the recycling of materials, and the Netherlands takes the lead in this field. This project studies opportunities in the Netherlands in the field of circular economics. How can the Netherlands strengthen and develop its position? Are there any drawbacks to recycling and can the Netherlands present itself upon new, economic models that stimulate market parties to recycle?

- **Climate Engineering**
  The subject geoengineering or climate engineering has appeared on the international scientific and political agenda over the past years. This concerns great, technological interventions that aim to keep climate change and its consequences under control. Climate engineering has not entered the stage without some debate in scientific circles. This project therefore aims to map societal issues concerning geoengineering and research what guidelines must apply for these kinds of substantial technologies, especially internationally.
- **Consumer Behaviour**
  Consumer freedom is the driving force behind the economy. This is at conflict with the compelling character of the policy measures that are needed to meet the European 'Grand Challenges' – climate change, energy sources, water management, and sustainable food production. There is a need to set preconditions in the market, but these do affect the choices of individuals. By means of a citizen panel – that takes place within the framework of the European PACITA project – the Rathenau Instituut aims to explore this tension between private interest and the common good.
- **Food Security in the Long Term**
  Due to global population growth and increased prosperity in many countries, it is expected that food security cannot be guaranteed. Reactions to this are varied: from the further intensification and scaling-up of highly technological food production to small-scale, animal-friendly and traditional food production. With this duality in mind, this project reflects on the conditions of a sustainable system for world food production.

Thema 5 – Shifts in the Care System

Due to new, scientific insights and increased free market activity, the organisation of medical care is subject to big changes. This causes tension between autonomous patients who organise their own care and take responsibility for their own health, and the solidarity principle on which the current health care system is based. This theme is elaborated on in three projects.

- **Patients Know Better**
  Influenced by the rise of market thinking, patients must be more autonomous. Patients are expected to form an opinion on the quality of (hospital) care and know how to choose the best offers. It is questionable how realistic this expectation is, and if patients are truly capable of making optimal choices.

This project centralises the patient perspective within hospital care. Based on research on the experiences of patients, light is shed on the concept of patient-centred care and research is done on what is needed to reach the ideal of independent, autonomous patients.

– **Measurable Man**
  Possibilities for measuring bodily functions have greatly increased. This measuring is not only limited to medical science. Health insurers, policymakers, and, increasingly, citizens themselves, actively measure and monitor their bodily functions. The promises of a 'measurable man' are great, but do raise fundamental, ethical and societal questions, such as: do healthy people still want to contribute to the health expenses of people with unhealthy lifestyles? What parties can gain access to (sensitive) data and how much say do patients have over this? These and other questions form the subject of the project 'Measurable Man'.
– **Medical Scientific Research**
  Medical research pays an important contribution to scientific and technological innovation within the medical sector. However, there is little insight into relation between funding and performance and the organisation of the knowledge infrastructure. The project 'Medical Scientific Research' aims to provide a quantitative and a qualitative view on the medical knowledge infrastructure. How many researchers, institutions, and research facilities exist? How is medical research being funded? What is the relationship between research funds and the financing of care, education, and valorisation of knowledge? And based on what are choices made concerning the granting of research funds?

Thema 6 – Big Datasets, Big Consequences

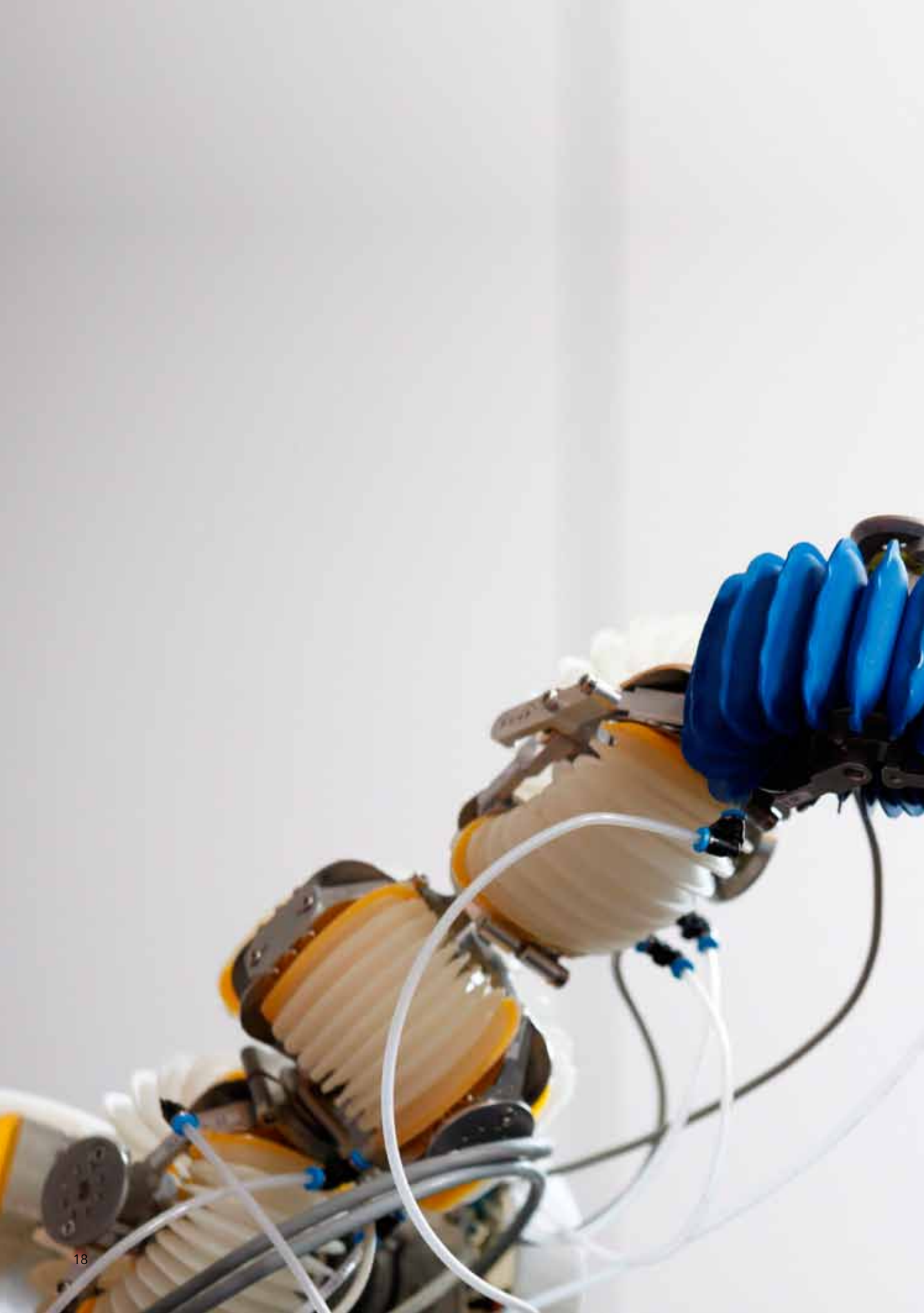
The process of digitisation leads to an explosion of data. A recent development is the interpretation of this data using algorithms. Using algorithms, data on our behaviour, our emotions, and our brains can be interpreted, and decisions can not only be suggested, but also made. This raises questions on the consequences of such datasets with regard to the safeguarding of privacy, but also with regard to freedom of choice. How does the user's autonomy relate to the morality of automated decision systems? This theme is elaborated on in four projects.

– **Algorithms: Smart, Dumb, or Stupid?**
  Smart applications of algorithms within large-scale datasets can yield countless advantages. However, the use of algorithms

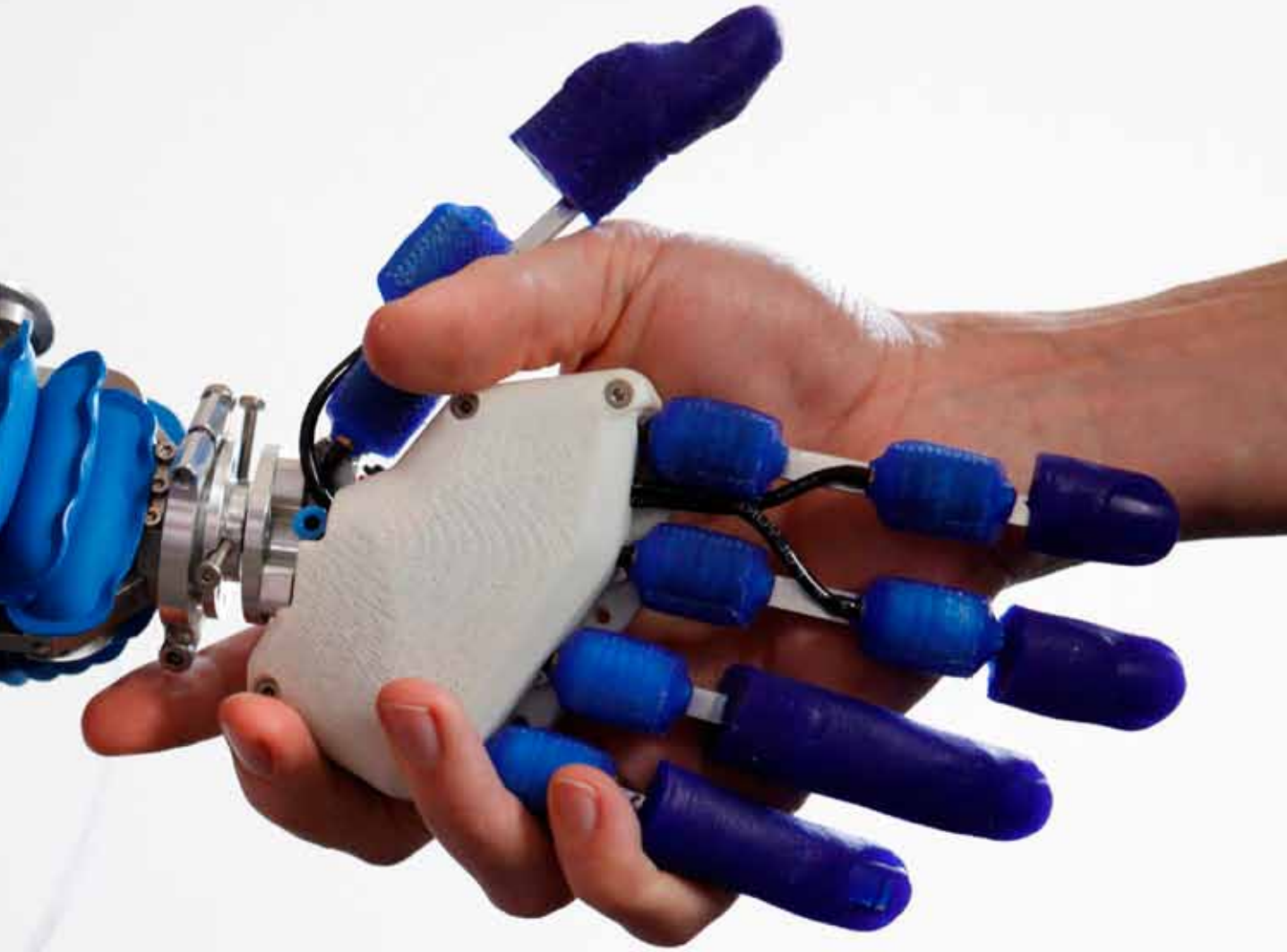
also raises questions, for example, algorithms in trade within the financial sector. This project explores in what ways relevant digital data are generated and in what ways this data can be interpreted using algorithms. There is also focus on the ways in which these interpretations (may) influence decision-making processes.

- **Electronic Lifestyle Coach**
  Based on a surplus of data, computers can be employed to advise us on our behaviour and our lifestyle. Using persuasive technology, research is done on how an individual user can best be influenced and enticed to 'desired' behaviour. However, with this step, not only our memory, but also our emotions and willpower are outsourced to technology. This project studies issues that correspond with the rise of these persuasive techniques, such as autonomy, moral sensibility, normalisation, privacy, and new relations between providers and consumers.
- **Digitisation of the Brain**
  The digitisation of the brain yields a new stream of data that computers can store, process and interpret. This development makes direct interaction between brain and computer possible. Measured brainwaves can drive a computer, and reversely, brain activity can be influenced using electromagnetic signals. Together with the ministry of Security and Justice, the Rathenau Instituut organises a Knowledge Chamber on brain-computer interfaces (BCIs) to inform the top of the ministry. Ethical and legal questions that receive attention are: what possibilities exist for utilising BCIs for a safe and just society? Can we guarantee everyone's cognitive freedom? And can someone be forced to contribute towards his own conviction through thought registration?
- **Digitisation of Risks and Disasters**
  Our vital infrastructures – transport, hospitals, water management and power plants – have become increasingly dependent on IT. Digitisation calls for a rethinking of the vulnerabilities of these infrastructures and the ways in which we deal with the corresponding risks. This project focuses on the possible risks and disasters that may come from digitisation. Do we pay attention to and are we aware of the origins of the dangers? Are we politically, managerially, and organisationally prepared for dealing with the risks and disasters in this digital era?

Work Programme
Rathenau Instituut
2013 – 2014



1 On the Rathenau Instituut



Chapter 1
On the Rathenau Instituut

Missie

The Rathenau Instituut stimulates the formation of public and political opinion on science and technology. To this end, the institute performs research on the organisation and development of the science system, publishes on societal effects of new technologies, and organises debates on issues and dilemmas in the field of science and technology.

A unique role at the intersection of science, technology and society

The Rathenau Instituut operates at the intersection where science, technology and innovation meet society, policy and politics. Much is happening at this intersection. We have experienced serious incidents and trust crises: Q fever, underground CO2 storage, shale gas extraction, and the HPV vaccine. We have seen how large socio-technological systems falter. Think of the health care system, mobility and agriculture. Science is important. Science is being used intensively for contributing to wealth and the economy, and to make this visible.

The Rathenau Instituut holds a unique position in this extensive and complex field. The institute is active where science and technology meet politics, policy and society, in situations of conflict. When deadlocks have unfolded, when myths or conflicts of interests stand in the way of solutions, and when big controversies and public distrust (threaten to) exist, it is our task, together with those involved, to create space for viable solutions.

The Rathenau Instituut has a strong focus on the future. We signal trends in science and technology and watch how these affect the actions of citizens and businesses. We are especially interested in what you can expect from new technologies and changes in science. We want to timely signal new trends and explore them. Hereby we place ourselves at the vanguard, trying to get to the meaning of developments. We keep a close eye on them, through conversations with all sorts of stakeholders: from ministries to businesses, and from patient organisations to concerned environmental pressure groups, from individual experts to organised interest groups.

The Rathenau Instituut is especially interested in the societal impact of changes in science and technology. It often concerns opportunities and threats, and thus we arrive at ethical issues, for example with subjects such as health care or data traffic. Medical science, for example, is increasingly capable of assessing health risks and defining them up front, but do want this? Should data from such research influence insurances and the rates that must be paid for this? Such issues often come up in debate and form input for the work of the Rathenau Instituut.

Methods and means

In order to fulfil our role, we utilise a broad range of methods and means. We supply facts and figures, conduct analyses, interpret developments, and give our stakeholders concrete (policy) suggestions. We try to provide conceptual clarity. We organise discussions and contribute to public debate. We bring together parties for a dialogue and we forge coalitions.

Independent, multidisciplinary, and international

The Rathenau Instituut has an independent position. This independence is an important first condition for fulfilling our role in a credible manner. We are accepted and valued by other parties as partner and connecting link, exactly because we have an unconstrained role. We have no other interests than to help avoid problems and to create space for solutions.

Another important condition that makes it possible for us to fulfil our role is the multidisciplinary character of the institute. The combination of Science System Assessment (the study of the science and innovation system) and Technology Assessment (the study of the societal impact of science and technology) within the institute enables us to view developments and issues where science, technology, and innovation meet policy, politics and society, from different perspectives.

The field of activity of the Rathenau Instituut is pre-eminently international. The kinds of issues and the trends that we study, the figures we collect, and the conclusions and recommendations that we formulate, increasingly cross our national borders. Rule making is often harmonised on the European level. Knowledge production and funding increasingly follow European trends. Important players in the development of new science and technology have an international strategy. Governance of science and technology takes place on a global stage. The Dutch science and innovation

policy is related to the 'Grand Challenges' that have been defined in Europe, and our work agenda and strategy are more and more being tuned towards these European goals and challenges. Europe's interest in the field of science and technology is reflected by the tasks and activities of the institute. The Rathenau Instituut collaborates with sister organisations in the network of European Parliamentary Technology Assessment and is commissioned by STOA, the bureau for Science and Technology Options Assessment of the European Parliament. The Rathenau Instituut also participated in a series of projects by the European Seventh Framework Programme.

Furthermore, the Rathenau Instituut is situated in an ambitious, growing international network of embassies (with officers for science and technology, including contacts in China and Japan) and among academic partners. This strengthens the knowledge basis of our projects, because we learn how other countries deal with similar problems, such as the introduction of IT applications, biobased economy, the role of universities, and stimulation of new research fields. The network also offers a platform for better understanding the international dimension of the dynamics of science and technology. Sometimes discussions and solutions abroad have taken more shape than we think. Sometimes, upon closer inspection, the rose-tinted stories of a better-organised abroad are more subtle. Almost always, much can be learnt from knowledge exchange and comparisons.

Self-assessment

In order to continue fulfilling our role well and presenting the institute as convincing, the previous work programme included a self-assessment (2011-2012). In advance, in the period spanning September 2011 to January 2012, Bureau Berenschot studied the image that stakeholders have of the Rathenau Instituut. This research shows that the Rathenau Instituut has a clear 'license to operate'. The stakeholders characterise the Rathenau Instituut with the following references: "relevant questions and approaches", "intellectual, scientific, and nuanced", and "independent, determined, and critical".

In our self-assessment, we came to the conclusion that the Rathenau Instituut has invested greatly in relations with the Dutch and the European parliaments over the past years, which resulted in greater visibility at both institutions. We also established that ministries more frequently make use of the Rathenau Instituut's

expertise. With regard to our debating strategy, we conclude that our investments in an active press strategy have led to greater visibility in media, in particular the quality press.

Another conclusion is that the Science System Assessment task has, over the past period, grown much and become embedded in the institute. The activities of SciSA have become more visible in public debate and in political decision-making.

Furthermore, the Rathenau Instituut has invested in the establishment of new, national collaborations and we have also presented ourselves more strongly internationally.

Ambition

Based on the self-assessment, we are able to indicate what we consider to be our most important strategic challenges and ambitions for the coming years:

1 **Strengthening our informative function**
The Rathenau Instituut is developing into the most authoritative source of objective information on the Dutch science system and on scientific and technological developments with a large societal impact.

2 **Strengthening our debate function**
Next to the audience of higher-educated people who are interested in science, technology, and politics, we also want to reach new target audiences, such as youths and less-educated people. These groups, too, are affected by the impact of science and technology and their consequences for everyday life and society as a whole.

3 **Strengthening our position within innovation and industrial R&D**
The Rathenau Instituut works at acquiring a distinct, unique position and role in the field of innovation and the innovation agenda.

4 **Strengthening our services to parliament and departments**
The Rathenau Instituut's efforts can be expanded so as to fit the description of an independent and trustworthy service provider (comparable to planning offices) to the departments and other institutions in the field of the STI (Science, Technology, and Innovation) policy.

5 Strengthening our European and international position

The decision-making on science and technology is increasingly gaining a European and international dimension. This means that the institute's projects must better reflect these European and international dimensions, and that the institute must become more visible in international networks and discussions. Internationally, collaborations with Asian organisations in the field of science and technology are being strengthened.

By organising consortia with sister institutions in member states, we want to create a stronger connection to the increasingly important European policy agenda in the field of science and technology.

The Rathenau Instituut is an independent institute that falls under the administrative responsibility of the Royal Netherlands Academy of Arts and Sciences (KNAW). In 1986, the then minister of Education and Sciences, Wim Deetman, founded the Netherlands Organisation for Technology Assessment (NOTA). In 1994, NOTA was renamed the Rathenau Instituut, named after Prof. G.W. Rathenau (1911-1989), professor of Experimental Physics at the University of Amsterdam, director of the Phillips Physics Laboratory in Eindhoven, and a member of the Scientific Advisory Council on Government Policy (WRR).

In 2004, the institute received a second task: Science System Assessment (SciSA), initiated by the minister of Education, Culture and Science (OCW).

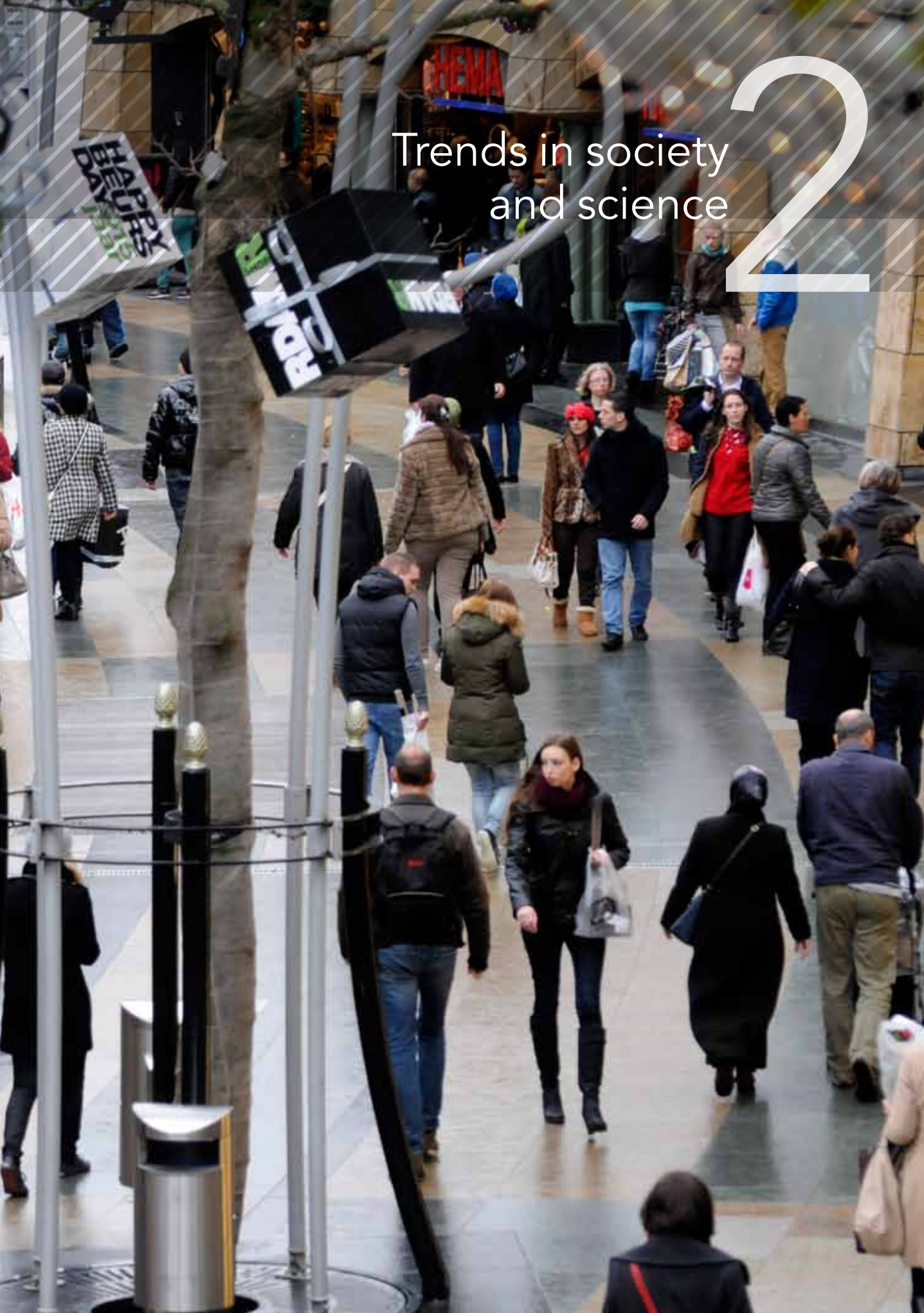
Today, 2012, the Rathenau Instituut has 56 employees filling 49.77 FTE (Full-time equivalent, reference date 01/12/2012). The OCW contribution is € 4,6 million.

The Rathenau Instituut has four departments. The department of Technology Assessment focuses on research and debate on science and new technologies. The Science System Assessment department researches and integrates knowledge on the way in which the science system functions, to broaden the knowledge base for science policy. The department of Communications, together with project staff, attends to project communication, and it is responsible corporate communication. The department of Management and Support is responsible for finances, staff, secretariat, automation, and quarters. The department also manages finances and staff for two other institutes of the KNAW. A director leads the institute. Together with the four departmental heads, he forms the Management Team. The director answers to the institute's board – which, in turn, answers to the minister of OCW – and the KNAW. He holds the function of secretary on the board.

Every two years the management of the institute decides on a new work programme. The minister sends this work programme, including his standpoint, to both chambers of the States-General of the Netherlands.


YVES ROCHER

2 Trends in society and science



Chapter 2
Trends in society and science

In drafting the work programme, the Rathenau Instituut is inspired by scientific as well as political and societal developments. Within this range of developments, we can discern four trends. These trends are years-long developments that have radically changed society, and are expected to continue to do so. Moreover, they will strongly influence our work in the coming years. Some trends are mostly of a sociocultural nature; others have a strong technological drive.

Below we discuss the four trends, and we indicate what kind of relationship we signal with science and technological development. The four trends are:

1 Individualisation
2 Knowledge economy
3 Globalisation
4 Digitalisation

Trend 1 – Individualisation

Individualisation is a well-known and well-discussed trend that manifested in the 1960s (Knowledge agenda OCW 2010). In short, the concept of individualisation entails that individual action is no longer determined by fixed patterns, which were, in turn, fixed by social status, sex, race, or religion. One of the consequences of this is that the notion of an authority is much less self-evident than it used to be, and authorities are increasingly confronted by well-informed citizens and businesses. The expansion of education supports the process of individualisation: a much larger portion of the population belongs to the group of more highly educated than before.

In the 1990s, this development of individualisation gained a new dimension because of the introduction of the Internet. Accordingly, people gained easier access to knowledge through an increasingly big network of broadband connections (also see the trend 'Digitalisation'). As a consequence, patients obtained information on illnesses and symptoms, and this knowledge made them more

articulate at a visit to the doctor. Consumers became better at judging the prices and quality characteristics of products and services.

In short, people are much better informed through the Internet. Based on what they learn online, they adjust their actions within businesses, in politics and management. Therefore, the Internet does not only provide information, it also directs behaviour. Another consequence of the Internet is that it limits privacy: much personal information becomes available consciously or unconsciously through our browsing behaviour.

Today, people do not only browse the web for knowledge; they also live their lives on the net. Internet is the place where individuals are more visible than ever before; people leave behind many traces in cyberspace. This way, the Internet has changed the world drastically, and this process will continue through developments in social media, and through the rise of *cloud computing*.

While the introduction of the Internet seems to strengthen individualisation, people do actually form new collectives using social networks. New relations come into existence when persons feel drawn towards certain groups. This can be based on a common interest, study, hobby, or fondness for a product. Certain consumer products even lead to almost extremist worship that unifies a large group of people.

On the other hand, individualisation and globalisation have caused a strong countermovement. One's own identity and belonging to a certain community have actually become more important again, and gained political significance with political movements that accentuate the uniqueness of the population. All these observations confirm a modern countermovement to the individualism of which the significance is not yet exactly clear.

Coherence with science and technology

An important development that originated at the increased individualism and the higher-educated population is that more people – in their professional fields but also in their lives as citizens and consumers – make use of scientific knowledge. Science influences much more than it did previously and a much larger part of the lives of the population. This intrusive relationship with science also causes increased attention for science and technology in the media and on the Internet.

However, more knowledge with citizens and businesses also ensures that more questions are raised on science itself and the role that science fulfils in society. The relations between citizens and businesses on the one hand and science on the other have become more complex. People are critical due to their increased knowledge, and the authority of science is less self-evident than before – think of the vaccine against cervical cancer or the IPCC climate panel.

Furthermore, citizens want to be able to influence choices within politics that are made thanks to new technologies, especially if those choices impact their lives directly, as was the case concerning the intended experiment for CO_2 storage in Barendrecht. Constantly modernising network technologies, such as *file sharing*, *wikis, open source, creative commons,* and *publishing platforms*, accelerate the creation and circulation of knowledge. This offers new perspectives for innovations and possibilities for introducing new products and services.

Social networks are a rich source of information for businesses that help to map consumer patterns and the (latent) needs of citizens (and businesses). Social networks accelerate and strongly intensify the harmony between the supply of products and services and the demand of citizens and businesses. The dialogue between citizens and scientific institutes is changing, through websites, the media, panels, and social networks.

Social networks exist alongside the traditional gatekeepers of knowledge. The formal democracy, which safeguards the influence of the political body on science, is increasingly influenced by social (and traditional) media. Patients go to the doctor armed with (unfiltered) information, form opinions on vaccines, and directly influence political decision making. *Trending topics* on Twitter have direct influence within the political arena.

Trend 2 – Knowledge Economy

The Netherlands is a knowledge economy. Knowledge is a distinguishing factor in the economic development. Whoever has the best and newest knowledge will also see the economy develop. Without knowledge and education, there is no progressive technology and high labour productivity. A good knowledge infrastructure is vital to the Dutch economy and competitive power,

and has great influence on the functioning of citizens and businesses.

Stimulating the knowledge economy has become a global point of interest for politicians. The Lisbon strategy (2000) and the EU2020 strategy provide frameworks for the economic development in which investments in research and development should rise to 3% GNP (Rutte cabinet intention: 2.5%; realised in 2010: 1.8%).

Dutch science policy has a long history, and knowledge production is at a high level, both qualitatively and quantitatively. The Netherlands has a great capacity for innovation, which also came to light in the *Global Competitiveness Report* by the World Economic Forum. In this report, the Netherlands was distinctly classified as an innovation-driven economy. At the same time, it is clear that the success of a knowledge economy lies not only in the production of knowledge, but especially in the utilisation of knowledge. Especially this utilisation by masons, mechanics, hairdressers, and salesmen is the key to success. It is crucial to a knowledge economy that knowledge and technology are not only being developed, but that the market knows how to utilise this knowledge and that it is ready for it socially and societally.

Societal and economical reality is becoming increasingly complex. The linear model of innovation from the times of the post-war reconstruction of the Netherlands loses its significance; the belief is getting old that the centrally-coordinated changes in the structure of our economy also led to desirable changes. The linear model therefore makes place for a model in which the government, businesses, citizens, and scientific institutions together determine changes. This is expressed by, among other things, an increased collaboration (both enforced by policy and unenforced) between science and businesses and between science and policy. Ideally, the government, businesses, and knowledge institutes work together. They should know each other, collaborate, and they should be cable of taking over each other's tasks; the government invests in a company, companies perform research like knowledge institutes, and universities start businesses. This ideal fulfils a guiding role in political debate. But critical questions still apply. Is this ideal picture really ideal? And to what extent is it realistic, or is it based on wishful thinking?

Coherence with science and technology

Knowledge and technology are becoming increasingly important

as determining factors for economic growth. This is not one-way traffic from knowledge to societal applications; it works through cyclic knowledge chains. There is a high degree of interdependency between science, businesses, and citizens. Scientific knowledge is a decisive factor for innovation in businesses. This can also be seen in top sector policy and the increasing need for *evidence-based policy*. This calls for a closer and more intensive collaboration between traditional knowledge providers (universities, research institutes, academic medical centres) and knowledge users (businesses, governments, parliaments), as well as for the co-creation of knowledge. At the same time it is important that both the knowledge provider and the knowledge user keep bearing their tasks in mind. Scientists shouldn't pretend to be politicians and politicians shouldn't postpone decisions on uncertain and controversial issues until 'science' has figured something out.

Increasingly, demands are being placed on science: what knowledge and insights are societally relevant and at what price? Science is viewed as hope for the future, as motor of the economy, and informer for policy decisions; but also as utility in which you can either invest or not invest. This raises new questions such as: with what will we earn our money in the future if the manufacturing industry disappears from the Netherlands? What is the role of key technologies? And: what do the processes of co-creation of knowledge entail?

Trend 3 – Globalisation

The world is becoming smaller and smaller. Distances become easier to bridge. Products and cultures spread across the planet. Upcoming economies in Asia and South America show that this process, called globalisation, is in full swing. Internet only speeds it up.

The struggle for scarce resources such as energy sources, but also human capital, is becoming global. At the same time, new technologies make other resources scarce. Think of materials such as lithium and indium gallium for mobile telephones and hybrid cars. Human capital, especially where it concerns much wanted or unique knowledge, is also spread internationally. Global mobility is the order of the day and people follow market opportunities.

Production processes are also spread more often over countries and continents. A design is made in one region, raw materials come from various continents and the actual assemblage takes pace in

another part of the world. The back offices of large service businesses frequently move to the southern hemisphere. The increasing complexity of production processes is not conducive to the transparency of the origin of products.

The rise of new economies in Asia and South America illustrates how all states and enterprises must adjust to these altered circumstances. The global effects are enormous. The interdependency between countries is becoming bigger, and economical problems in one region have direct consequences for other regions. The current financial crisis has an almost global character. The banking crisis began in the US, but it quickly spread to other parts of the world, all the more because European banks operate in the US and vice versa. However, political systems are still very nationally focused and can't keep up with global developments, let alone control them.

Coherence with science and technology

What applies to products, also applies to science. The relatively simple national structuring of knowledge processes no longer suffices. For example, the Netherlands operates within an increasingly important European context. Scientific knowledge production is global, and there is strong competition between countries. This means, among other things, that scientific careers are becoming increasingly international. Scarce talent brings much mobility and there is competition between knowledge institutes to rope in this talent. International competition is now widely characteristic to science itself, as becomes apparent from, for example, the international rankings of universities and the increase in the funding of Dutch research by, for example, Europe, or businesses from abroad. Scientific research programmes are more often international and determined by networks of researchers and institutes, together with globally operating businesses. Furthermore, value chains cross national borders.

While the Netherlands takes the lead in numerous scientific fields, successful science policy without taking international dimensions into consideration is unthinkable. Dutch science and innovation policy is geared to the Grand Challenges defined in Europe. The importance of a knowledge infrastructure on a European scale is increasingly emphasised. Knowledge institutes must team up with businesses in cross-border consortia to make innovation possible. Concentration on strong suits paired with success in the job market of scarce talent are, according to many, important conditions for knowledge institutes to keep up and excel.

The problems that directly relate to globalisation will also affect the issues that science must address. Climate change will call for new solutions and techniques. The economic crisis threatens the funding of innovation and research, but it also creates opportunities for large changes in other directions and the making of decisions.

Trend 4 – Digitisation

1948 saw the introduction of the first electronic calculator. The first pc was introduced in 1981 and the Internet came ten years later. Google was founded in 1998 and in 2005 *cloud computing* begins. Digitisation is a trend that has come to influence much of our daily lives. It can be found everywhere: communication, amusement, hospitals, retail – almost all facets of our lives are influenced by it and many occupations have changed accordingly, both their content and working method.

Digitisation puts the 24-hour economy in perfect shape. Businesses are changed because of it; it stimulates an enormous economical development and raises productivity. New services and products enter the market at a great pace. Digitisation ensures that the designers of products and services can very quickly gain clear information on the wishes of consumers, through digital panels, consumer forums, and the likes.

Social media become increasingly significant, topics on Twitter are presented as new facts, and incidents such as the 'Project X' party in the Dutch town of Haren are made possible through the quick spread of knowledge.
Digitisation strengthens all sorts of developments, in speed and diversity. It speeds up the circulation of knowledge, stockbroking, the actuality of news, and the way in which we communicate with each other using WhatsApp, Skype, e-mail, and so on.

As the trend 'Individualisation' already described, traditional relations between people (based on social status, race, religion, unions) have become less defined. Thanks to the possibilities that come with digitisation, new, virtual societies are formed based on common studies, occupation, hobbies, and interests, along with a virtual sense of belonging. Communication between people is thereby changing: people chat online in groups and communities without having to meet each other physically.

Citizen participation is becoming digital and sometimes more important, more intensive, and especially faster. Thereby, democracy is changing shape.

Coherence with science and technology

Digitisation stems from science, and subsequently it is found in science. Physical processes within living organisms such as the human body can be digitalised, and thereby understood, controlled, and manipulated. The workings of genes, proteins, all sorts of metabolic processes, and even the brain are being mapped quicker and better. This so-called *digital control paradigm* of life leads to an increased engineering perspective on life. We can digitalise, change, and better understand an increasing amount of information on the working of ourselves.

Digitisations caused an explosion of data and information. There is an increasing amount of data and more and more information is being stored in databases, by businesses, governments, but also by science. These enormous, complex data files are a treasure of information; increasingly complex algorithms must ensure that these treasures can be found. Mankind lost the overview and we often don't understand how we got from data to information. Totally new branches of science have evolved that previously did not exist (information technology, artificial intelligence). Other branches of science where digitisation created broader possibilities and new techniques have radically changed the field. Spectacular examples of this can be found in the medical sciences, chemistry, and particle physics, but also in the use of digital longitudinal panels in the social sciences.

Technological development is increasingly supercharged by digitisation, and the Internet contributes to this. Distance care, new developments in tracing methods, the analysis of syndromes, and also recognising consumer patterns; all are increasingly technology driven. The superior measurements of all sorts of physical parameters gives rise to all sorts of technologies with which we can monitor and steer our own behaviour or that of others. This offers new possibilities, but it also raises questions concerning certain basic rights, such as privacy. Do we really want to launch all these technological possibilities in care, transport, and security, and at what price?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3 Themes

Chapter 3
Themes

The mission of the Rathenau Instituut revolves around debate and policy on science and technology. Against the backdrop of the four abovementioned trends, this signifies that the coming two years we will concentrate on six themes. The themes, which will be elaborated on below, are:

1 Resilient Knowledge Infrastructure
2 Societal Permit for Science
3 Innovation 2020
4 A Broad Perspective on the Thirst for Raw Materials
5 Shifts in the Care System
6 Big Datasets, Big Consequences

The first theme, Resilient Knowledge Infrastructure, expands upon the previous work programme, in which we focused on issues surrounding the organisation of the scientific knowledge infrastructure, and with regard to this subject we have strengthened our informative function.

In view of the trends 'globalisation' and 'knowledge economy', we have observed that the expectations on the achievements of universities and research institutes diverge, that the insecurity concerning their role is increasing, and that their function is becoming more important. This is why we are researching the future of universities and the role of non-academic research institutes. We are also performing an explorative study on the position of practice-based research. We also examine two crucial processes within the dynamics of the knowledge infrastructure and the organisation of the research: academic careers and the funding of research. There are more and more signals that existing arrangements for these processes are no longer optimal.

The four trends that have been described above have a great effect on the ways in which we deal with knowledge and organise the development of knowledge for policy, society, and the economy. These effects are not yet understood completely. Two themes in this work programme are therefore about the role of knowledge in our society: Societal Permit for Science and the theme Innovation 2020.

In the theme Societal Permit for Science, we research societal pressure on and the expectations of science. In the coming period, the activities surrounding valorisation will be focused on the question of how valorisation in the social sciences and humanities can be organised. Furthermore, we will try to gain an understanding of the degree of trust that citizens, policymakers, and scientists have with regard to science. Clear facts are still lacking. In connection to anniversary activities surrounding evidence-based policy, the question was raised to what extent the science agenda should be determined by the users of knowledge, such as businesses and governments, and what role and possibilities can be reserved for the new media. Finally, focus is placed on science journalism. What is the role of science communication and journalism, and what should it be?

In the theme Innovation 2020, we examine the connection between the knowledge infrastructure and innovation issues that come up in the field of the Rathenau Instituut. We research how NBIC (nanotechnology, biotechnology, information technology and cognitive sciences) leads to new innovations and new industries. The combination of these four fields is interesting, because especially in these fields, harmony between science, industry, and societal integration is an important condition for innovative success. In a separate project, we look at a different dimension of innovation: the importance of regulation. Furthermore, we will continue with projects on the co-creation of knowledge and innovation, because this form of knowledge is of utmost importance for innovations in the field of societal challenges.

Therefore, in three themes we discuss how the tension between scientific and technological developments and societal dynamics affects sectors that are crucial for the quality of our economy and society, such as raw materials, health, and information.

The availability of raw materials is a crucial factor for industry, and thereby society. The availability of energy, however, is no longer guaranteed. Many highly technical products make use of raw materials that are becoming scarce. Food production and food markets are becoming increasingly dependent on global markets and climate change. Next to the problem of the physical availability of resources, we also find that the social dimension is becoming more important: new forms of energy harvesting, raw material harvesting, and food production are subject to fierce societal debates. In the fourth theme, A Broad Perspective on the Thirst

for Raw Materials, we aim to play a part in bringing to light the wicked problems, by naming the dilemmas and offer new perspectives for solutions.

Health care is a sector strongly driven by the development of new knowledge and new technologies. This development is intertwined with trends such as individualisation and digitisation. In previous work programmes, attention was paid to this sector. In the fifth theme of this work programme, Shifts in the Care System, we aim to centralise the experiences of patients, through projects such as 'Patients Know better' and 'Measurable Man'. We expect that this will help us offer new perspectives on the dilemmas in care. Furthermore, in this work programme we wish to gain better insight into the organisation and tendencies of medical research. In the past years, medical research has become much more extensive, and we expect that the debate on expenses in care will also have repercussions on research.

The Rathenau Instituut has a long history of signalling bottlenecks in the development of information technology and the use of stored data. In the sixth theme of this work programme, Big Datasets, Big Consequences, we continue this task and analyse the developments surrounding the use of datasets and algorithms, new forms of e-coaching, and the digitisation of our brains. Big datasets have big consequences, and the development of the information infrastructure can give rise to new risks and a new kind of disaster. The digital era accelerates the dynamics of such disasters – how do they originate and how should they be managed – and this calls for a thorough consideration on the vulnerabilities of our vital infrastructures and the ways in which we deal with them.

Theme 1
Resilient Knowledge Infrastructure

Dutch research and science policy has been very successful over the past twenty years. With relatively modest investments in R&D, Dutch research institutes are often ranked above others in European counties, and this position only appears to be getting stronger. Knowledge institutes also have a strong position in the European research field and research surrounding societal and economic themes such as health, water, food, and high-tech is very well organised.

Despite this success, the functioning of the knowledge infrastructure is debated. Non-academic institutions, which have always played a central part in research on policy and society, realise that their legitimacy is under pressure. Their multiple roles in the system – research, policy advice, quality control, enforcement – are seen by stakeholders as less of a merit, and more of a sign of bias, distortion of competition, or loss of quality. Universities must deal with more and more stakeholders and their (sometimes) contradictory interests. Researchers feel misunderstood and express their dissatisfaction concerning funds and career opportunities.

The theme Resilient Knowledge Infrastructure is focused on evidence-based strategic policy in the Dutch science and technology system. Decisions that impact the system on a fundamental level and influence the long-term achievements of science must be based on reliable and complete information. The Rathenau Instituut has a clear task in this. The institute's information is spread using the portal (www.denederlandsewetenschap.nl), for example the most recent TOF figures. The informative function of the Rathenau Instituut also involves divulging and aggregating the information developed by other organisations (amongst others the CBS – Statistics Netherlands). Here the quality of the data is also assessed.

Building on the theme 'the value of science' from the previous work programme, this work programme centralises the resilience of the knowledge infrastructure. This is elaborated on in various projects. The project 'The Future University Order' explores the role and the position of universities in the future. The project 'Non-academic

Public Research Institutes' raises the question of how universities and non-academic knowledge institutes must develop, given the abundance of expectations and budget-related pressure. Express focus is placed on developments within Europe. Research policy is one of the most successful fields of European policy, and Dutch researchers have a strong position within Europe. The project 'Exploration Practice-based Research' researches the position of practice-based polytechnic research within the knowledge infrastructure.

Furthermore, two crucial processes are examined that are related to the dynamics of the knowledge infrastructure and the organisation of the research and the research funding. These are elaborated on in the projects 'The Careers of Scientists' and 'The Funding of Research'.

The Future University Order

The societal relevance of universities causes an increasing number of stakeholders to translate their (sometimes contradictory) expectations into university policy. Sometimes by drawing on their direct links with universities, but also through media and politics. Thus the future of the university order has become a kind of free fight, where the ultimate outcome appears more dependent on coincidental coalitions, political twists, and the way economic winds blow, than on long-term visions of a robust Dutch university order.

Considering these developments, the Rathenau Instituut explores the role and position of universities in the future and focuses on their three core tasks: fundamental research, scientific education, and knowledge transfer.

With parties from the sector we would like to perform an exploratory study on the future order of universities. The goal is to construct scenarios that support the university sector in their strategic dialogue with stakeholders. The central question of the scenario study is what the university order should look like in future, should it wish to continue fulfilling its knowledge function. To support these scenarios, we will make use of external expertise and results from this current and previous work programmes.

Non-academic Public Research Institutes

Universities dominate the research landscape. Outside of academia, however, large numbers of public organisations also perform research and fulfil a crucial role; some have done so for over a

hundred years. For example, planning agencies support government policy. The KNMI and Deltares provide for public knowledge needs. The RIVM supports regulation and quality control in the field of environment. Many of these institutes represent the Netherlands in international consultations and provide knowledge at such events.

In research and innovation policy these institutions have little visibility and direct funding is decreasing. Furthermore, if debate on their position takes place for any reason, their multiple roles in the system – research, policy advice, quality control, enforcement – will less and less be seen as a merit. Instead, issues come up regarding bias, distortion of competition, or loss of quality. Yet, it seems it is these institutes that play an important part in value chains. Through organisations such as the Netherlands Forensic Institute, the application of scientific knowledge becomes available to everyone. Such institutes play the lead in sectoral knowledge systems, thanks to their focus on a specific subject (viruses, traffic safety, water management).

The Rathenau Instituut wants to better map this group of research institutes, not only with facts and figures, but also through analyses of their legitimisation. We focus on the following questions: what purposes do these institutions serve, how do they reach their goals, and what parties do they work for? The relations with government, market, and science are clearly secondary, because these various relations often cause contradictory impulses.

Exploration of Practice-based Research

Ten years ago, Dutch polytechnics made a huge leap within their research function through the introduction of lectureships. Their research function is clearly focused on the improvement of education and strengthening public-private collaborations between higher education and professions. Meanwhile, there are over 480 lectureships at Dutch polytechnics, and since 2007 there is a so-called Branch-protocol Quality Assurance Research (Brancheprotocol Kwaliteitszorg Onderzoek, BKO) – two years later followed by a Quality Assurance System – and the first branch report of the research was published in 2010. Every polytechnic has a few centres of excellence where this research is brought together. The total input in 2008 was estimated to be more than €100 million, with the involvement of 2,600 lecturers, researchers, and teachers (source: *Naar een duurzaam onderzoeksklimaat. Ambities en succesfactoren voor het onderzoek aan hogescholen,* 2010).

The increasing scope of practice-based research and the ambition of value-based research (in the application of knowledge and in education) justifies an explorative study by the Rathenau Instituut to establish what the position of this research is within the knowledge infrastructure in the Netherlands. The most important points of interest are the societal relevance of the research (among other things, valorisation) and the role that such research plays for innovation (within the triangle of polytechnics, government, and businesses).

Careers of Scientists

Excellence of science implies excellence of scientists, and this excellence is not up for grabs. For this, a career is needed; scientists must achieve a top position after their promotion, with or without experience outside the academy. In the past fifteen years, academic careers have become an important instrument within science policy. The knowledge and information on academic careers is limited, however. One of the notions about academic careers is that the higher ranks at university are almost always 'closed' and young scientists have relatively few opportunities for a career in science. This leads to questions concerning the relations between the structuring of careers through financing, the organisational goals of research institutes, individual careers, national policy, and the role of researchers in a knowledge society.

Through making use of the information and databases of VSNU and CBS (Statistics Netherlands), we aim to make an analysis of the careers of scientists and changes in the job market that determine these careers. This we do together (or in consultation) with our stakeholders on this subject: VSNU, NFU, Promovendi Netwerk Nederland, SofoKles and NWO.

The Funding of Research

The Rathenau Instituut publishes an annual overview of government spending on research; the so-called TOF figures. Conversations with researchers, policymakers, and managers have shown that there is a great need for insight into the funding of research and innovation. In the coming years we therefore wish to expand the information on the funding of research. We will choose a thematic approach. Firstly, because the need for insight often comes up as a result of specific questions. Secondly, because the complexity of the flow of funds makes it impossible to map it in detail.

An agreement has been made with the ministries of OCW and economic affairs (EL&I) to integrate innovation expenses into the TOF figures. This does justice to the relation between research and science policy and innovation policy. Together with the NFU we want to make a Facts and Figures overview of the university medical centres (UMCs), much like those of universities and research institutes. The funding of medical research will hereby also be brought to light, which closely correlates with the funding of other functions of the UMCs (see the project Medical Research).

Furthermore, we want to improve the understanding of research funding for three subjects. The first subject concerns the development of the European funding for research and innovation. For Dutch institutions, European funding is of great importance, as it is one of the few funding sources. Questions come up about the interaction between European funding and national funding and, for example, on the capacity of institutions to match this funding with own funds.

The second subject concerns funding of large infrastructures. In March 2012, the 'Roadmap' was actualised and the State Secretary decided to invest €80 million (2012-2016) in five large-scale projects, with three small advances for encouragement.

The investments thereby amount to about €20 per year. Many expenses for new facilities and for maintenance, upgrades, and actual use of existing facilities are hidden in institutional budgets. Means are fragmented and invisible. This gives rise to two dangers: first, incapacity to invest on a large scale and play an internationally meaningful role, and second, threatening too little investment in the quality of the research infrastructure of universities and other knowledge institutes. To gain a better insight into this, we will update our inventory of large-scale research facilities in 2008, where emphasis now lies on the way in which the facilities are financed.

With the third subject, we want to gain more insight into the cash flow within universities. The lump sum funding of universities is an important aspect of their autonomy. Uncertainty about the way in which research is funded within universities, however, leads to views on research funding that do universities and their policy little good. One of the questions within this subject is whether it should be possible to break down the funding of the various fields.

Theme 2
Societal Permit for Science

The government expects that public investments in science will yield a return. Businesses have great trust in the capacity of scientific research to stimulate innovation. Citizens expect that large societal problems can be tackled through science and that technology will help us in the future, too. And even with controversial subjects – underground CO_2 storage, shale gas extraction, the question whether UMTS submit harmful radiation, the introduction of the HPV vaccine, reports on the IPCC panel, and the EHEC bacteria outbreak – citizens, businesses and policymakers first look to science as a source of valuable information. In short, this encompasses the theme of the societal permit for science. The essence is found in the expectations of science and the shifts that take place within science.

In the past years, the Rathenau Instituut has worked on these subjects within the projects Valorisation and Evidence Based, amongst others. The sketched tensions, however, raise new questions. The coming period, therefore, the project Valorisation will focus on the question of how valorisation is and could be interpreted in practice, especially within the social sciences and humanities. The project also focuses on the emphasis on valorisation and its effect on research on fundamental processes of which the direct benefits are no longer evident.

Expectations and trust lie close together. Over the past years, the scientific world has had a few wakeup calls from incidents that were a breach of trust. Cases of fraud created a movement in scientific circles that led to measures to prevent them. There are suspicions that the authority of science is decreasing, but nobody knows if this is indeed the case. The project Attitudes towards Science aims to gain empirically funded and systematic insight into the attitudes of citizens, policymakers, and scientists with regard to science in general and the role of science in policymaking in particular.

The classical view on the role of science in policy, as provider of trustworthy and objective information, is debateable, as became clear earlier. This raises the question to what extent the agenda of science should be decided by the users of knowledge, such as businesses and governments. This is the central question of the

project Democratisation of Knowledge, where especially the role and the possibilities of new media are explored.

The (supposed) declining authority of science raises the question to what extent scientific communication can or should play a role in the recovery of trust in and a basis for science in society. The project Science Communication therefore aims to explore recent developments in science communication and science journalism.

Valorisatie

The legitimisation of the academic science pursuit is partially dependent on what it has to offer society: in terms of the status of knowledge-intensive country, the highly educated population, and the knowledge that is transferred to and used by society. In 2004, the latter (knowledge transfer for the benefit of society) was appointed as the third core task of Dutch universities, next to organising education and performing scientific research. In the Netherlands we call this valorisation. In other countries, too this *third mission* has been formalised.

Over the past years, the Rathenau Instituut has gained much expertise on valorisation (ERiC; SIAMPI; MIA; Waardevol). It has shown that it is difficult for scientists and policymakers at universities and for those seeking knowledge to integrate valorisation into existing work. The central questions that will be tackled in our upcoming studies on valorisation are: how is valorisation treated in practice and how should it be treated? What factors stimulate valorisation and what factors hinder it? We focus on the social sciences and humanities, which are very societally active. From our contacts we find out that the economic connotation of valorisation (it generates money) all too quickly brings to mind the fact that valorisation is completely new to these scientific fields, while at the same time we come across many examples of societally relevant research. In direct collaboration with researchers we wish to bring to light the valorisation of this research.

Furthermore, in this project we pay attention to the emphasis on valorisation and the effect on fundamental research, of which the direct use is not absolutely evident. The legitimisation of research appears to be under pressure in science, while in society and in public media much focus is on results and breakthroughs in fundamental research.

Attitudes towards Science

Science balances between the high expectations of society and society's obstinacy. For scientists it is difficult to provide unambiguous answers concerning issues such as underground CO_2 storage and the HPV vaccine – especially because normative arguments also play a role with these issues – while society does expect answers to be clear. Furthermore, incidents of scientists committing fraud or plagiarism cause a breach of trust.

In the project Attitudes towards Science, we want to bring these tensions to light and make them discussable. Remarkably, there is not a lot of empirical data on how citizens, policymakers, and scientist feel about the value of science in general and its role in policy in particular.

Together with the Scientific Advisory Council for Government Policy (WRR), the Rathenau Instituut is starting a long-term project with the goal of gaining empirically funded insight into the attitudes of citizens, policymakers, and scientist with regard to science in general and the (desired) role of science in policymaking in particular.

Democratisation of Knowledge

The position of science and its role in policymaking has had a lot of attention recently. Our research has shown that the role of citizens within evidence-based policy is of utmost importance, but it is not always recognised by the government. Citizens who experience that they are unjustly not being heard, who believe that founded science is not the only or correct base for policy, often become actively involved with the decision-making process. They do not only provide other scientific facts, but also economical, social, and emotional arguments. This raises the question what democratic decision-making should look like in evidence-based policymaking.

During the anniversary dinner of the Rathenau Instituut in 2012, Gerdi Verbeet – in her then position of chairman of the House of Representatives – put a question on the relation between new participative and interactive policymaking and its significance on the parliamentary agenda.

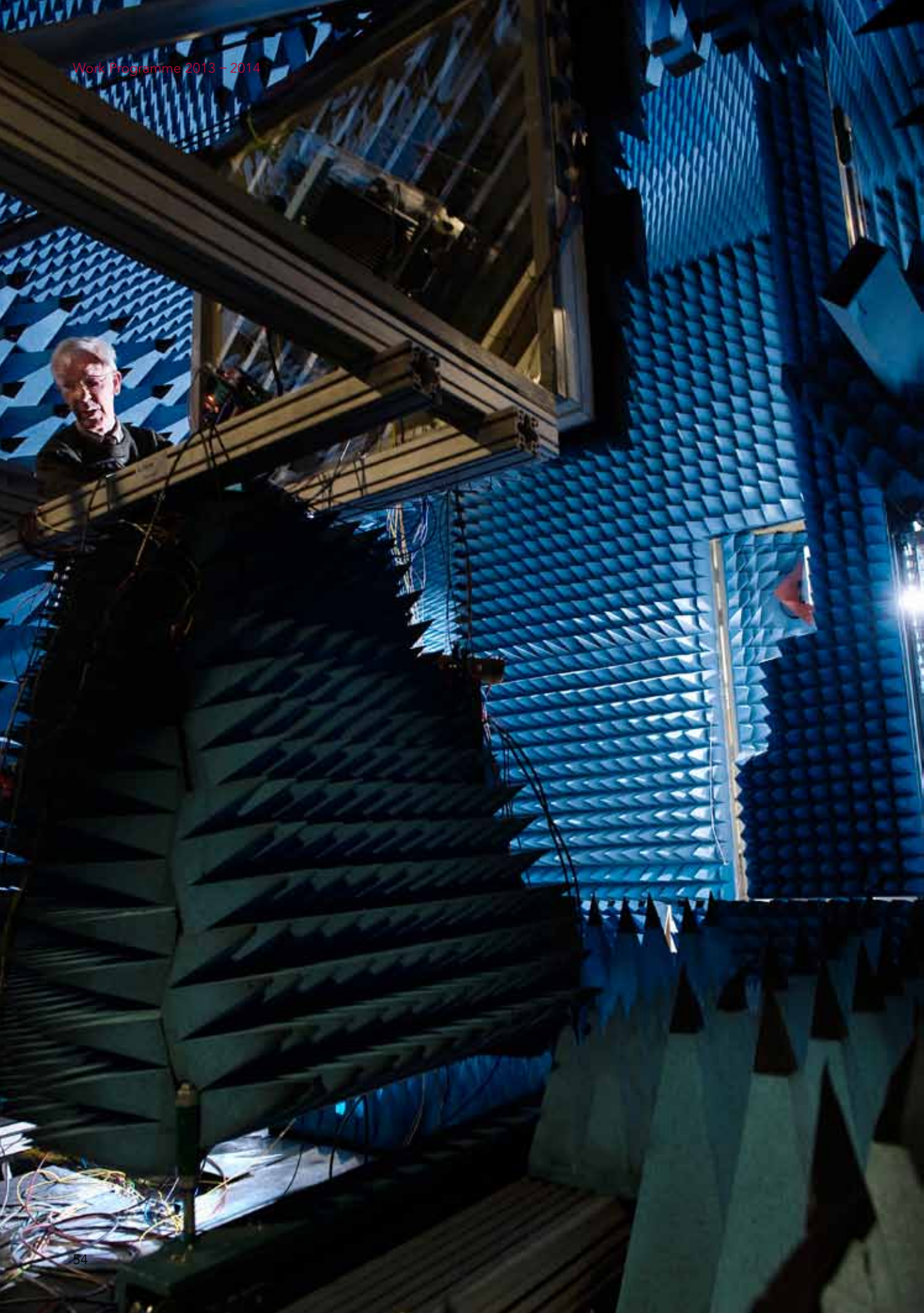
Within the project Democratisation of Knowledge, we shall mainly focus on the role and possibilities of new media: what do new developments surrounding the Internet offer innovation and instru-

ments to mould public debate? In this project we study how the digitisation of civil society and, in particular, the rise of new digital participative processes lead to new questions for a representative democracy.

Science communication

In discussions on the (supposed) waning authority of science, the question is often raised to what extent science communication and journalism can and even should contribute to recovering trust in and a base for science in society. Sometimes the (implicit) assumption appears to be that more and better communication on science can repair trust in and the base for science in society.

Following our activities and contributions surrounding the themes Valorisation and Reliable Science, the Rathenau Instituut wants to perform an explorative study on the recent developments in the field of science communication and science journalism, together with partners in those fields. How do science communication and science journalism contribute to the 'societal permit' of science? What are the reactions to the (supposed) waning authority of science? What (implicit) convictions play a part in this? Could one speak of changing roles? What can be expected from science communication and science journalism?



Thema 3
Innovatie 2020

The Netherlands currently holds fifth place in the ranks of top competing economies that has been listed by the World Economic Forum. In order to maintain such a position in future, innovation has been ascribed a leading part as a source of economic growth, competition between businesses, jobs, and prosperity. Innovation, however, no longer appears bound to a single country: new ideas and knowledge can be thought up in the Netherlands, while in another country they are transformed into products. Considering this, therefore, it is important to know more about how businesses organise their R&D and what part of this is located in the Netherlands. The pressing question is with what the Netherlands will earn money in a number of years.

The theme Innovation 2020 is about the role of knowledge in strengthening the economy. Innovation literally means renewal and derives its meaning (within science policy) especially from renewal of products, production processes, and services that are focused on the market. The Rathenau Instituut looks at the way in which this renewal comes about, as well as at the background of the way in which especially the market power of innovation comes about or is conditioned.

In order to thoroughly understand this theme, it is essential to understand how innovations come about within the mutual connectedness of businesses, government, and knowledge institutes; how do businesses organise R&D, in what way do businesses apply their R&D strategy to the national and international innovation dynamics, and what is the role of key technologies in this? In the project 'The Future of Innovation in the Netherlands: Globalisation and Key Technologies' we try to address these questions. In the project 'Science as "Partner in Development"', we pay close attention to the contribution of knowledge institutes to these innovation activities and to arrangements for the collaborations between knowledge institutes, businesses, and government, that are expressed in connection to the Grand Challenges in the partnership of these parties with the top sectors.

In order to thoroughly understand the market power of innovations, some aspects are important that help determine market success. Fort he acceptance of radically new products and services, it is cru-

cial to think about their embedment in a broader societal context. Regulation must be considered, but also the role of governments, end users, societal groups, and local communities. It is not self-evident that regulation should be an integral part of market power; rules are often seen as limiting and hindering innovation. But for innovations they also have a clearly facilitating role. They actually make innovation possible and create a *level playing field* for entrepreneurs, and this way they promote the free market. The dilemma surrounding regulation keeps returning for key technologies, because these are insufficiently thought out for new rules, while old rules no longer suffice. The project Innovation and Regulation therefore searches for ways of '*regulatory learning*'.

Today, citizens form an integral part of the development of innovative products and services. As such, they can form an unexpected source of creativity and make substantive contributions in the shape of practice-based knowledge, ideas, or defining the preconditions and rules. The initiatives in this field form the subject of the project 'Co-creation of Knowledge and Innovation'.

The Future of Innovation in the Netherlands: Globalisation and Key Technologies

Since the 1960s, the Netherlands has had less and less of an old (mass)production industry. Production has disappeared to low-income countries. At the same time, new businesses appeared in the production industry with new products (ASML, TomTom, Océ). A part of the production industry thereby seemed to return to Europe. The dynamics gave rise to the question of what kinds of products the Netherlands is still capable of producing. The standard answer to this is that the design of products as well as the final tailoring before market introduction will continue to take place in the Netherlands.

The promise of innovation entails that Europe and the Netherlands can stay ahead of 'less developed' countries through innovation and competition. Through innovation the Netherlands keeps a grip on high-grade knowledge (R&D, design, and marketing), which has added value. But R&D processes are also subject to globalisation. This can lead to R&D moving to places in the world where sufficient highly educated staff is available and where markets are growing, such as in China, India, Brazil, and Russia.

The globalisation of innovation provides us with ample challenges and fundamental questions. It asks for a critical reflection on

the existing innovation story. Do the story and the corresponding policy still make sense, or are they outmoded and should we search for a new vision that suits today's reality and offers hope for the future? We will research how large and small businesses apply their R&D strategy to national and international innovation dynamics.

The so-called key technologies, such as biotechnology, information technology, nanotechnology, and neurosciences, play a special part in this explorative study. Since the 1970s, innovation policy has been focused on the stimulation of these key technologies. To what extent will these key technologies play the lead in the way in which the Netherlands innovates?

Science as 'Partner in Development'

Within the framework of the global innovation race, it is important to know the role of the knowledge infrastructure. How do businesses profit from publicly financed research in the Netherlands? What are decisive factors in businesses' decisions concerning the establishment of (new) R&D facilities? Can top sector policy contribute to this? What is the position of public-private collaborations in the total portfolio of industrial R&D activities? Why and under what conditions do innovation clusters come into existence in some regions (Eindhoven) and not in others? What is the role of spinoff companies from universities in the utilisation of research results?

In the past two years, a new framework was created for scientific organisations such as NWO, TNO, KNAW, and universities, with the development of top sector policy. Consequently, science policy and innovation policy have come closer together. A central question is how the relation between scientific activities and innovation can and should best be organised. Based on recent research on coordination within science, the Rathenau Instituut will continue focusing on the collaboration between businesses and knowledge institutes, with particular attention for the Top Consortia for Knowledge and Innovation (TKIs) and the water knowledge infrastructure.

Furthermore, a shift is taking place within the science system to the research priorities of the European Union. These are largely organised based on big societal issues, the Grand Challenges. This raises the question of how the structure of a national science and innovation policy, which currently knows a sectoral arrange-

ment, fits within international innovation dynamics. Another question that is raised here is what the added benefit is of the coordination by TKI-like organisations at the European level.

Innovation and Regulation

Regulation is a way for a society to create the conditions and the opportunities for the usage of innovation. The societal embedment of innovations, such as the abovementioned key technologies, is paired with social and ethical questions. This indicates the tension surrounding regulation. Regulation is often seen as a hampering barrier for innovation, but it can also stimulate innovation and/or make it possible. It offers businesses something to hold on to and establishes the framework for competition and collaboration. In the Rathenau Instituut's studies on key technologies, a certain dilemma keeps returning: while it is clear that existing regulation is insufficient, the new technologies are not thought out well enough to establish new rules. Therefore, the Rathenau Instituut aims to find new forms of *regulatory learning*.

The co-creation of knowledge implies that various disciplines and parties are involved with research on and the development of solutions for societal issues. This leads to different dynamics for research and innovation processes. Within the Rathenau Instituut there is a project on knowledge co-creation within the framework of large research programmes. Interdisciplinary and transdisciplinary research is seen internationally as a strength of the Dutch science system, because it corresponds with societal reality and because it is a challenge for young researchers. The general expectation is that this way of research is also crucial for research on the Grand Challenges as defined by the European Union, which are defined in broad terms.

Citizens have become increasingly important players in the innovation domain, helped by low-threshold access to knowledge, production means, and the distribution possibilities of mainly the Internet. Thereby citizens not only become the party that decides if an innovation actually has market power, they also become an integral part of the development of innovative products and services. Businesses and governments can make use of these new possibilities by outsourcing tasks to large groups of users (crowdsourcing) or by developing (co-creating) products and services together with these groups. Such collaboration means that knowledge institutes, governments, and businesses must innovate from a different philosophy, namely in constant dialogue and collabora-

tion with end users, as well as by equipping them with means and possibilities to pay a contribution to the knowledge development and innovation. In some cases this calls for new income models. At this moment, all sorts of ways are being experimented with regarding new forms of collaboration between businesses, governments, knowledge institutes, and citizens, usually at the local level. The Rathenau Instituut wants to research what can be learned from these initiatives. How do these ways of innovation work and what are crucial factors for success? Are they mainly local and tailor-made or is there a possibility for scaling up? What is the role of the government when it comes to promoting these kinds of innovations and defining the preconditions (limits, guarantees, rules)?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Thema 4
A Broad Perspective on the Thirst for Raw Materials

The 1970s saw the end of the so-called *easy oil*. The era of readily available and cheap raw materials had also passed. Especially our dependency on materials such as lithium, indium, cobalt, and gallium, which are used in modern products, such as smartphones, hybrid cars, and solar panels, has grown. But there is not only a shortage when it comes to minerals, metals, and energy sources. Resources such as fish, wood, water, fertile land, clean air, biomass, biodiversity, and the stability of the climate are also under pressure, according to the European Commission. Furthermore, use of energy and materials intensify one another, it involves large-scale production of biomass fertilisers, farmland, fresh water, and pesticides, and bulk materials such as steel and copper are needed for the development of wind farms. Not to mention societal support: these days this is also a scarce good.

The past years political attention for the raw materials issue has grown rapidly. The realisation that various forms of scarcity and use of raw materials are often linked is growing too, although less fast. The current discussion on raw materials is mainly focused on the physical, economical, and geopolitical aspects of scarcity. For a fair discussion, however, it is important that there is attention for the ecological, technological, and sociocultural dimensions of the raw materials issue. The ecological dimension, for example, refers to the impact that the extraction of shale gas has on the natural environment. There is a clear tension between our thirst for raw materials and our goal to preserve the environment, whether it's about climate change or biodiversity. The sociocultural dimension refers, among other things, to the societal basis and consumer patterns. Less use of raw materials – consuming less – correspondingly lessens the urgency of the raw materials issue.

The Rathenau Instituut aims to focus on the global struggle surrounding raw materials that is currently taking place, and wishes to place today's thirst for raw materials in a broad societal perspective. On the one hand we are searching for the perverse effects of this struggle, such as mass deforestation and blood minerals as tantalum. On the other hand we are searching for the positive developments that stem from the perception of scarcity and the raised

prices, such as renewed interest for recycling.

The various projects that we conduct always focus on a number of specific elements in the complex raw materials issue. The project 'Search for a Societal Basis' researches the (lack of a) societal basis for shale gas extraction; the opportunities for recycling are explored in 'Opportunities for Recycling'; the use and necessity of climate engineering are researched in 'Climate Engineering'; 'Consumer Behaviour' explores the tension between private interest and the common good, and 'Food Security in the Long Term' aims for a broad reflection on the conditions for a sustainable system for world food production.

Search for a Societal Basis

Many energy sources – ranging from nuclear energy to wind and biofuels – one way or another lead to societal resistance. The coming period, the Rathenau Instituut wants to specifically focus on shale gas extraction. There is much focus on the tension between national economic profit and energy security versus local consequences for the environment and public resistance.

In 2030, the common processing methods for our natural gas will be a quarter of what it was in 2009. This signifies a huge drain of our treasure, which now counts billions. Shale gas extraction appears to be an option in the Netherlands, too, but it raises questions regarding environmental risks, for example on the possible pollution of the groundwater.

Within the space of a few years, a worldwide movement against shale gas has come into existence. We want to explore the background of the rise of this movement. We would also like to explore to what extent local support for or resistance to the extraction of shale gas exists, and what motivates this. Moreover, we want to find out what kinds of responsibilities for the broader energy issue local inhabitants and council members want to take up. On a national level we will search for the perceived urgency of the option of shale gas extraction and the way in which the government wants to deal with local outcries.

Opportunities for Recycling

The upcoming struggle in the field of raw materials also offers opportunities for innovation. There is renewed interest for recycling materials, and the Netherlands takes the international lead in this field. Dutch pigs, for example, eat mostly food waste, such as

juice pulp and waste from the potato industry. Thus, pig farming is hardly dependent on maize and soy, for which the costs are currently quite high. But there are also other possibilities, such as the recycling of laptops, mobile phones, cleaning cloths, and so on.

The project 'Opportunities for Recycling' researches the possibilities that exist in the Netherlands in the field of a circular economy. How can the Netherlands strengthen and expand its position? Are there any drawbacks to recycling (for example, high energy use and strains on the environment, or uncertainty on the origin of the reused material)? And can the Netherlands base its image on new economic models in order to stimulate recycling within market parties, apart from through the classical model of recycling? For example, think about renting out consumer products instead of selling them, so the responsibility for recycling is no longer with the consumer, but rather with the producer (*the lease society*).

Climate Engineering

Until recently, the discussion on climate change focused on reducing CO_2 emissions, through saving energy and anticipating negative effects, for example through building higher dykes. In the past years, more extreme forms of interventions have entered the international scientific political agenda: geoengineering or climate engineering. This concerns big technological interventions that are aimed at limiting climate change and its negative consequences. Examples of this are: the whitewashing of clouds or placing mirrors in space, causing less sunlight to reach the surface of the Earth. Another example is the fertilisation of oceans, so they will store larger amounts of CO_2.

Meanwhile, climate engineering has brought some debate in scientific circles. Therefore, the Rathenau Instituut wants to map the societal issues surrounding geoengineering, and research what guidelines must be in place for these influential technologies. This is a global debate. Can China or the US interfere with the constitution of oceans if it has consequences for other countries? Which techniques seem effective? Which techniques are affordable? What is the societal basis?

Consumer Behaviour

The demand for raw materials is ultimately determined by the production processes with which consumer products are made, as well as by their economic appreciation by consumers. Individual freedom to choose is the driving force in the economic system:

markets function because of human needs. Consumption leads to the use of raw materials to keep the production process going, and the use of materials in the products and services that are offered.

This consumer freedom is at odds with the compulsive character of policy measures that are needed to tackle the Grand Challenges, such as climate change, energy sources, dealing with water, and sustainable food production. It is essential to subject the market to preconditions, but that affects the range of choices of individuals.

Through a citizen panel, the Rathenau Instituut wishes to gain a thorough understanding of this tension between private interest and the common good. Results are compared to panels in other countries. The project 'Consumer Behaviour' takes place within the framework of the European PACITA project.

Food Security in the Long Term

Food production in the Netherlands and Europe is high, as well as food security. Even globally, sufficient food is being produced. The most important problems at this moment concern the field of food distribution and poverty. In the long term, we expect that the issue concerning food security will change radically. The growth of the world population and growing prosperity in many countries are the most significant causes for this. Population growth does not only lead to an increased need for food, but also to more competition over available land, partially as a result of an increasing occupation of land because of urban development. Increased prosperity also leads to an increased demand for luxury products such as meat and dairy, which are more resource-intensive.

A frequently heard reaction from the field of science and policy to the growing need for food is to apply a more thorough intensification and scaling-up of highly technological food production, with the use of biotechnology and other food technologies. This reaction is at conflict with the trend in many western countries for small-scale, animal-friendly, and traditional food production, which can be found in farmer's markets, organic agriculture, and DIY farming, but also in many food advertisements, haute cuisine, and d'origine quality marks. And is shown in the EU project 'Global Ethics in Science and Technology', which is being conducted together with partners from China and India, discussions on the acceptability of food technology are not restricted to 'the wealthy West'.

The issue on long-term food security calls for a broader reflection on the conditions of a sustainable system for world food production than the quick call for further intensification and scaling-up. Next to topics such as sustainability, animal welfare, and the experience of food, we would like to look at the impact of consumer patterns, food wastage, and hidden costs. We expand upon a previous study by the Rathenau Instituut, *Een strategische agenda voor het ethiekbeleid van LNV* (translation: *A Strategic Agenda for the Ethical Policy of the Ministry of Agriculture, Nature, and Food Quality*, 2010). We also wish to join the citizen panel on sustainable consumption, which is organised within the framework of the EU project PACITA. For more information see the project 'Consumer Behaviour'.


AMBULANCE

Theme 5
Shifts in the Care System

The organisation of medical care is subject to big changes. This is the result of both new scientific insights as well as an increased free market approach.

Scientific and technological innovations cause increased insight into individual health risks. New diagnostic methods and the use of large medical databases lead to an earlier discovery of diseases, and give insight into individual risk profiles. Patients have become more independent, but more is expected from them, too. There is an increased free market approach, where care providers become each other's competitors and patient-centred care is the norm. Patient-centred care and a growing focus on the importance of a healthy lifestyle puts the idea of health care as collective right under pressure. The development of patients as 'care consumers' goes hand in hand with an increased responsibility for individual health. This increased responsibility and an increased emphasis on personalised medical interventions must, in turn, contribute to driving back the cost of health care.

At the same time, these developments are questionable. What are the consequences of demand-driven care and the responsibility of the patient for his own (un)healthy lifestyle for the solidarity principle on which our current care system is based? The project 'Patients Know Better' revolves around the question of to what extent patients must be independent and responsible. Is a patient capable of choosing from the range of health care insurances on offer? The project 'Measurable Man' is concerned with other questions. How does the increasing emphasis on a healthy lifestyle relate to personal responsibility? What does this mean for the roles and responsibility of doctors, hospitals, health care insurances, and the government? Lastly, it is interesting to consider what guiding role assumes medical research and technical innovation for the abovementioned developments: which tendencies are supported by this, which ones aren't, and what form of reflection follows this? Research on this takes places in the project 'Medical Research'.

Patients Know Better

Under the influence of the advancing market thinking, patient-centred care has become a central topic. Patients have been assigned an active and controlling role over the past years. They are ex-

pected to form an opinion on the quality of (hospital) care based on the information available, and know how to choose the best offer. Increasing competition between care providers is supposed to lead to better price-quality ratios.

That's the promise. The question is how realistic such an expectation is, and if patients are indeed capable of coming to optimal choices. This especially counts for hospital patients, who are often in vulnerable and dependent positions. Hospitals are often complex sociotechnical systems, in which a patient may quickly get lost. The idea of well-informed, autonomous patients calls for a critical discussion and a more detailed interpretation.

'Patients Know Better' centralises the patient perspective on hospital care. How do hospital patients experience the care they receive? What goes well, what could be better? Attention is paid to contact with care providers and the opportunities that patients get to co-decide on the type of care offered. For this project, experiences of patients are collected. Based on these, lessons are learned for a more optimal organisation of hospital care, and the notion of patient-centred care is examined. Is this notion realistic considering today's hospital practices, and what is needed to get closer to the ideal of an independent, autonomous patient?

Measurable Man

'Measurable Man' is about the increasing possibilities for measuring bodily functions and about the consequences of this for medical practice and policy. Through technological advancement in conceptualisation, sensors, chips, high-throughput methods, and techniques such as mass spectrometry, an increasing amount of bodily functions can be quantified. The human body is therefore increasingly becoming a subject of statistics: the sum of predictable values and functions.

This measuring is no longer limited to medical science. Health care insurances, policymakers, and, increasingly, patients too, actively measure and monitor bodily functions. An example is the *Quantified Self* (QS) movement. The expectation is that with this, more insight can be had into individual health risks, including the relevant lifestyle factors, and tailor-made preventative care strategies.

The promises of a measurable man are big, but also raise fundamental questions. The quantification of individual health risks and

the corresponding lifestyle factors go hand in hand with a bigger emphasis on the personal responsibility of citizens or patients for their own health. This can have consequences for the distribution of the roles and responsibilities between patients, care providers, insurers, and policymakers, and for the question of how far solidarity between the healthy and the sick should reach. Do healthy people still want to pay for the health expenses of people with a 'bad' lifestyle? At the same time, the question is: what parties gain access to (sensitive) data, and what do patients get to say about this? Does the use of all this health data lead to a more independent patient, or does the continuous monitoring of a person's body lead to new forms of prevention-based paternalism? In conclusion, the question is whether or not a measurable man and the promise of tailor-made care contributes to lowering health care expenses, or if the opposite is true.

Medical Research

An important part of scientific and technological innovation within the medical sector originates in medical research. UMCs, universities, hospitals for top clinical care, regional hospitals, community health services, and other research institutes pay an important contribution to this. Medical research is a pillar within Dutch science with good reason.

However, there is little insight into the coherence of funding and achievements and the organisation of this medical knowledge infrastructure. It is difficult to determine what part of the total financing of UMCs is being used for scientific research. This problem is also prominent in the interdepartmental policy research that was drafted in May 2012. The lack of information on the flow of funds and the organisation of medical research in general is particularly relevant, because the changes in the organisation and the cost of health care (especially surrounding the improved declaration system for hospitals and highly specialised care) can also have consequences for the organisation and quality of clinical and preclinical medical research.

The project 'Medical Research' wishes to provide a quantitative and qualitative view on the medical knowledge infrastructure. How many researchers, institutes, and research facilities are there? How is medical research financed? How are research funds connected to the funding of care, education, and valorisation of knowledge? And based on what are choices made in the allotment of research funds?

Theme 6
Big Datasets, Big Consequences

The digitisation of many aspects of our world of experience – identity, activities, behaviour and preferences, environment and body – is in full swing. This has led to an explosion of data. Next to 'classical' statistical personal data, such as name and address, our actions on the Internet provide information on our social connections, new trends, and so on. And data is generated in many other ways, too. Think crowdsourcing, people who collect information on their lifestyles via their smartphones, but also cars, "smart" dykes, and energy networks. The past years saw a discussion on the exponential growth of data, which centralised the question on safeguarding privacy: who can use and collect what data for what purposes, and how will users stay in control of the use of personal data by others?

While this discussion has by no means died out, a next step is already taking place. Many new forms of data are created, such as the digitisation of behaviour, emotions, and the brain. And on top of this data there is a new layer: a layer of interpretations and decisions that are made with the help of algorithms based on the data collected.

Data form a 'digital goldmine'. Awareness has grown that opening up this data creates huge societal and economic value. Smart algorithms can create new, valuable connections: insights into the wishes of customers, health behaviour, mood, stock market dynamics, the development of pandemics, traffic patterns, and so on. These kinds of insights can be used, often real-time, to take certain decisions and undertake certain actions.

The development of information systems that automatically make decisions or give advice based on data and algorithms causes a fundamental broadening of the societal discussion on IT. 'Privacy', as well as the subject 'freedom of choice' is becoming increasingly central in this debate; next to user autonomy, there is focus on the morality of automatic decision-making systems.

The Rathenau Instituut addresses these questions in various projects. Through an exploration in the project 'Algorithms: Smart,

Dumb, or Stupid?' we aim to gain insight into the use of algorithms in a wide range of fields. The projects 'Personal Lifestyle Coach' and 'Digitisation of the Brain' focus on the rise of the e-lifestyle coach and the digitisation of the brain, respectively. Finally, in the project 'Digitisation of Risks and Disasters' we orientate on the question of what influence digitisation has on our perception of and the ways in which we deal with risks and disasters.

Algorithms: Smart, Dumb, or Stupid?

The Los Angeles police department uses data from past burglary reports to plan better patrol routes. Rijkswaterstaat, part of the Dutch Ministry of Infrastructure and the Environment, wants to apply sensors on a massive scale for monitoring the condition of the dykes. Twitter posts provide early signals of increased unemployment in a country. Search terms for Google can predict an upcoming flu epidemic more accurately than the traditional methods of health institutions. Tracking millions of SIM cards of citizens in Port-au-Prince after the earthquake helped map the location of 600,000 inhabitants and aided disaster relief organisations. TomTom uses GPRS data that our mobile phones send out to give drivers actual traffic information. Data from medical scanning equipment can be used to improve hospital logistics. Smart usage of data has countless advantages.

However, in another example, the use of data raises questions, particularly in the automated algorithmic trade in the financial sector. The global financial crisis has brought the existence of these systems to public attention, and since then, a discussion has been taking place on the question to what extent this crisis was caused or actually kept under control by algorithmic trade.

We aim to explore in what ways relevant digital data can be generated and in what ways this data can be interpreted using algorithms. We are particularly interested in the ways in which this influences decision-making processes. For example, algorithms are used to take investment decisions and make medical diagnoses within milliseconds. Often, the complexity of today's technical systems demand the use of autonomous and semiautonomous decision systems. The development raises countless questions. Based on what are such decisions made? What data models are used and how (and to what extent) is reality captured by these models? How can we keep the quality of data in check (so-called data hygiene), as well as the quality of the algorithms? Is there a need for an algorithm inspection service, which distinguishes

dumb algorithms from smart ones? Can we have effective control when decisions are made within microseconds? How can we make sure that (semi)automatic decisions are morally sound? How much room to act do users have with automatic decisions? What media wisdom do users need to make autonomous choices?

The Electronic Lifestyle Coach

Based on a huge amount of data, computers can be used to advise us on our behaviour and lifestyle. If a designer knows that people sooner click a green button than a red one, he can use this information to steer the user's behaviour. This principle forms the basis of persuasive technology: information technology designed with the intention of influencing behaviour.

In order to influence behaviour, information is gathered on the behaviour in question, and also on how a person can best be influenced. Think of an intelligent speed-assistant in a car that advises the driver and stimulates him to stick to the speed limit. Or think of the increase in mobile applications (apps) that stimulate users to eat well, sleep better, move more, and consume environmentally friendly. In future, these apps will increasingly make use of advanced sensors that register and analyse behaviour and emotions. Wit the help of persuasive technology, it is researched how an individual user can best be influenced and enticed to 'desired behaviour'. With this step, as well as memory, matters such as emotion and willpower will be outsourced to technology. This project researches issues that correspond with the introduction of these persuasive techniques, such as autonomy, moral sensibility, normalisation, privacy, and new relations between providers and consumers.

Digitisation of the Brain

The digitisation of the brain is in full swing. This provides a new stream of data that computers can store, process, and interpret, which also makes possible a direct interaction between the brain and computers. This concerns measuring brain signals that can direct a computer or vice versa, influencing brain activity by means of electromagnetic signals.

The Rathenau Instituut works together with the Ministry of Security and Justice in organising a Knowledge Chamber on brain-computer interfaces (BCIs) to inform the top of the ministry. Questions that are addressed are: what are the possibilities for applying BCIs for a safe and just society? Think in terms of thought-

reading, lie-detection, helping witnesses remember things, identify paedophiles based on brain scans, aggression treatment, and improving cognitive capacities of government staff. What are the ethical and legal issues that play a part in these kinds of applications? Can we guarantee everybody's cognitive freedom? Could it be possible to hack BCIs and how is the storage of neural data organised? Can someone be forced to contributed towards his own conviction through thought registration?

Digitisation of Risks and Disasters

Our vital infrastructure is being digitised. We already communicate and pay electronically, but our transport infrastructure, hospitals, water management, and power plants are also increasingly dependent on IT. Problems with the Dutch Railways in Utrecht as was the case on Friday 25 November 2011, or with banks which cost web shops millions of euros, painfully emphasise the weaknesses of and our growing dependency on the IT infrastructure. In the past years, attention for cyber warfare has much increased. People have come to the realisation that the army must not only be prepared for war on land, sea, and in the air, but also in cyberspace. This means that it is important to gain more insight into our own digital weaknesses.

Digitisation – and more generally, technologisation – compels us to rethink the weaknesses of our vital infrastructures and the way in which we deal with the corresponding risks. This project therefore focuses on the possible risks and disasters that may come from digitisation. Do we pay attention to and are we aware of the origins of the dangers, how big they are, and what measures must be taken to create a robust infrastructure? Are we politically, managerially, and organisationally prepared for dealing with the risks and the disasters in the digital era? Are the governmental and institutional responsibilities clear at this moment, or will the discussion on this subject only be held after a disaster has taken place?

These kinds of questions are all the more relevant because the influence of IT introduces intangibility and even alienation to a strong degree. To make a simple comparison: until quite recently, an amateur could easily repair his car, but with the increased digitisation of cars, this has become virtually impossible. The same goes for the digitisation of our infrastructure. If something goes wrong, those in charge will have increasingly less grip on the situation; they are at the mercy of specialists with all the subsequent

unrest and risks. A similar story applies to normal citizens. What does this mean for the public perception of the risks and the way managers and the government deal with those risks? Finally, it is important to recognise that some worries do not stem from the risks of technology itself, but rather from societal dissatisfaction on the direction that technology is being developed. Furthermore, digitisation also offers innumerable opportunities for signalling risks in an early stage. Think of the development of "smart dykes" with sensors that measure if a dyke is still stable, or at the verge of collapsing.

Annex

Annex 1 - List of current projects and recently completed projects (work programme 2011 – 2012)

Connection with work programme 2013 – 2014
Theme 1; Resilient Knowledge Infrastructure

Project title	Introduction	Duration
1 Careers and talent selection in science	The goal of the project is to gain insight into the dynamics of academic careers and the academic job market.	2011 – 2013
2 Informative function of Dutch Science	The Rathenau Instituut is the place where information on the system is brought together and made available through the website www.denederlandsewetenschap.nl, as well as through focused publications on research organisations, financing, and specific policy themes.	As of 2008
3 Non-academic Public Research Institutes	The Rathenau Instituut is the place where information on the system is brought together and made available through the website www.denederlandsewetenschap.nl, as well as through focused publications on research organisations, financing, and specific policy themes.	2012 – 2014
4 Knowledge and Innovation System Water Sector	Water management is a complex, problematic field of global proportions. It holds a central position in a number of Grand Challenges such as climate change, sustainability, population growth and urbanisation, and energy demand. The goal of the project is to gain better insight through empirical research into the functioning of knowledge networks surrounding complex problems.	2009 – 2013

Connection with work programme 2013 – 2014
Theme 2; Societal Permit for Science

Project title	Introduction	Duration
5 Valorisation	For a number of decades already, there has been great interest in the utilisation of scientific knowledge by societal parties. The goal of this project is to collect experiences and best practices with valorisation and to support researchers who strengthen the relevance of their research.	2011 – 2014
6 Betrouwbare wetenschap	The central question of this project is: "What criteria must scientific knowledge and policy based on this knowledge meet to earn public trust?"	2011 – 2013

Connection with work programme 2013 – 2014
Theme 3; Innovation 2020

Project title	Introduction	Duration
7 Coordination Dutch Science	The goal of this project is to better understand what coordinating intermediary organisations do in the science system, and what the added value is of this. Research has been conducted on the history of coordinating mechanisms and on the coordination of catalysis, genomics, and polymerism, and a comparable analysis of innovation contracts in top sectors.	2010 – 2013
8 In Search of a Technological Match	The main goal of this project is to collect evidence that will give direct insight into the connection between science and business. We use patents as *empirical* basis.	2012 – 2014
9 Synthetic Biology	The project SynBio focuses on issues concerning regulation and on the stimulation of the formation of public and political opinion on the societal and ethical themes that are proclaimed by SynBio to be strong innovative technologies.	2012 – 2014
10 Biosecurity	Attention for security policy has greatly increased and also influences Dutch science. In this project we research how research organisations (could) deal with the development of biosecurity as a new regulatory framework.	2011 – 2013
11 Knowledge for Climate	In this project we look at the programme Knowledge for Climate as a large multi-actor programme (MAP). Attention is paid to the dynamics and impact of knowledge co-creation and an international comparison is made of the Dutch programme with similar climate research programmes abroad.	2009 – 2014

Connection with work programme 2013 – 2014
Theme 4; A Broad Perspective on the Thirst for Raw Materials

Project title	Introduction	Duration
12 Climate Engineering	The goal of this project is to inform parliament on climate engineering. The second goal is to understand and possibly stimulate societal debate on climate engineering.	2012 – 2013
13 Raw Materials Politics	Scarce raw materials are a central topic in the societal and political debate. Our endeavour is to make the debate accessible to politics by describing the debate in expert circles and by explicating the various political standpoints.	2012 – 2013

Connection with work programme 2013 – 2014
Thema 5; Shifts in the Care System

Project title	Introduction	Duration
14 Upcoming Markets for Human Tissue	This project focuses on the meaning of scientific and technological developments concerning human tissue for the donation system and thoughts concerning non-commerciality and altruism. The researchers are working on an English-language 'slim-line' version of the book, the goal being to join and contribute to the European discussion of the subject.	2012 – 2013
15 Patients Know Better	The goal of the project is to collect patient experiences on hospital care, to gain insight into the meaning of patient-centred care, the way in which patients are supported by technology, and the consequences for the organisation of hospital care.	2012 – 2013
16 Better People	The project 'Better People' is a continuation of the earlier projects on human enhancement (HE). The goal of this project is to inform the public and parliament on HE (i.e. possible consequences for society and policy options).	2012 – 2013
17 Measurable Man	De meetbare mens gaat over het kwantificeren van lichaamsfuncties en hoe het doormeten en monitoren van het menselijk lichaam ons denken over ziekte en gezondheid verandert.	2012 – 2014

Connection with work programme 2013 – 2014
Thema 6; Big Datasets, Big Consequences

Project title	Introduction	Duration
18 Persuasive E-coaching	This project researches the societal issues that correspond to the development of persuasive e-coaching. Central issues are, for example, privacy, autonomy, normalisation, and new relations between providers and consumers.	2012 – 2013
19 Knowledge Chamber Brain-Computer Interfaces (BCIs)	The Rathenau Instituut has been invited a third time by the Ministry of Security and Justice (direction Strategy) to co-organise a knowledge chamber. This time the subject is brain-computer interfaces (BCIs).	2012 – 2013
20 Persuasive Technology in Automotive	Together with the Technological University Eindhoven, the Rathenau Instituut organises a policy workshop to map the social, ethical, and legal issues surrounding the application of persuasive technology in traffic. The project is part of the NWO programme 'societally responsible innovation'.	2012 – 2013

Connection with work programme 2013 – 2014
Science and Technology International

Project title	Introduction	Duration
21 Security of eGovernment Systems	eGovernment Security is a STOA project that the Rathenau Instituut conducts together wit the EPTA partners DBT and ITAS. The project concerns the possibilities and (safety) risks of interoperable IT systems at he European level. The Rathenau Instituut is responsible for the case study on biometric passports. The research needed for this has been outsourced.	2012 – 2013
22 GEST: Global Ethics in Science and Technology	eGovernment Security is a STOA project that the Rathenau Instituut conducts together wit the EPTA partners DBT and ITAS. The project concerns the possibilities and (safety) risks of interoperable IT systems at he European level. The Rathenau Instituut is responsible for the case study on biometric passports. The research needed for this has been outsourced.	2012 – 2013
23 PACITA Parliaments and Civil Society in Technology Assessment	In this broadly set up European project, established parliamentary Technology Assessment institutes work together with newcomers. In Bulgaria, Lithuania, Ireland, the Czech Republic, Portugal, and Hungary there is interest in institutionalising a form of parliamentary TA. The goal of this project is to map the possibilities for this.	2012 – 2013

Connection with work programme 2013 – 2014
Link with and closing of a project from the previous work programme

Project title	Introduction	Duration
24 Neuroscience and Education	One of the most important fields to apply the growing knowledge on the brain is in education. The Rathenau Instituut is working on two publications on how the introduction of neuro-scientific knowledge takes effect in educational practice.	2012 – 2013

Annex 2 - Discussion partners in stakeholder consultation

In preparation of this programme, the following stakeholders have been consulted:

Jacky Bax	Ministry of OCW, Management HO&S
Carolien Bouma	Nederlandse Federatie van Universitair medische centra (NFU)
Roger van Boxtel	Menzis, Senate D66
Mark Chavannes	*NRC Handelsblad*, Programme committee RI
Dorette Corbey	Advisory council for science and technology policy
Ot van Daalen	Bits of Freedom
Wim Deetman	Council of State, Programme committee RI
Richard Derksen	Ministry of OCW, Management OWB
Albertine van Diepen	RMO
Wim van den Donk	Queens Commissioner of North Brabant, Programme committee RI
Koen Frenken	TUE, professor of Economy of Innovation and Technological Change
Thomas Grosfeld	VNO-NCW (entrepreneurs climate and strategy)
Foppe de Haan	Ministry of Economic Affairs
Rene Hageman	VSNU
Ruby Hoogenboord	Ministry of Health, Welfare, and Sport, Management market and consumer
Tini Hooymans	TNO
Dick Jung	Ministry of Infrastructure and the Environment, Management security and risks
Cor Katerberg	Ministry of OCW, Management OWB
Jan Klaver	VNO-NCW (entrepreneurs climate and strategy)
Jan Karel Koppen	NWO, Director policy development
Klaas Kuitenbrouwer	Virtual Platform
Coby van der Linde	Clingendael
Peter van der Loo	Zorgbelang Nederland
Marcel Mennen	RIVM
Peter Paul Mertens	Ministry of Economic Affairs, Director-General of Business and Innovation
Jos de Mul	Erasmus University, Professor of Philosophy of Humankind and Culture
Jan Nieuwenhuis	Ministry of Economic Affairs, Director-General of Business and Innovation
Sijbolt Noorda	VSNU
Sip Oegema	Ministry of Economic Affairs, Director-General of Business and Innovation
Gerard van Oortmerssen	University of Tilburg, Professor of Evolution of the Internet
Nelly Oudshoorn	University of Twente
Kim Putters	iBMG/Senate PvdA
Peter Rem	TUD

Tijmen Schep	Virtual Platform
Willem Schoonen	Editor-in-chief *Trouw*
Wim Turkenburg	University of Utrecht, Professor of Natural Sciences and Society
Kars Veling	Prodemos
Pieter Vos	Council for Public Health and Care
Marijke Vos	Senate Groen Links, Programme committee RI
Tjerk Wagenaar	Stichting Natuur & Milieu

Who was Rathenau?

The Rathenau Instituut is named after 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 significance 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'.