

Work Programme 2017-2018



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Rathenau Instituut 2017-2018 Work Programme

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Foreword

Confusion reigns in the world today, it seems. The UK's Brexit vote has got all of us thinking. Researchers at Turkish universities are finding it impossible to do their work. Educated Dutch citizens refuse to have their children vaccinated, against the advice of their doctors and the authorities.

In a world of confusion, we must go in search of what unites people, now more than ever. And what unites us, in my view, is our humanity. We want autonomy and independence on the one hand, but we want to be part of something on the other. Science and technology can help us with this, if we can connect with society in the right way.

On the cover of this work programme is a photograph of a ferry. It is a metaphor for the way the Rathenau Instituut works. For the past thirty years, the institute has linked science, politics and society.

Note that the photo shows a ferry, not a bridge. That's because we are flexible, linking banks where and when necessary. One good example is the debate about genetic modification and cloning. The Rathenau Instituut first became involved in this debate some 15 to 20 years ago. Things were relatively quiet for a time, but now, as new genetic techniques evolve, the institute is once again being asked for its expert opinion.

The work programme set out in this document consists of two parts. The first outlines the values that underpin our mission and how the institute works. It reveals the three priority areas in which we intend to fuel debate as an expert body. The areas are: trust in digitalisation, expert and citizen input in policymaking and political decision-making, and the transition to a futureproof knowledge ecosystem.

The second part of the work programme describes new studies that we have planned for the coming two years. They will keep our expertise up to date and explore new territories that the institute and its stakeholders believe will become relevant to our elected officials and policymakers in the medium and long term.

Scientists today have the feeling that their knowledge is being called into question. And society has the feeling that its questions are not being answered. It is in this rapidly evolving environment that the Rathenau Instituut is seeking common ground. Have you noticed the name of the ferry, 'Steeds Voorwaarts'? It means 'Always Onwards'. A perfect motto for our work.

Gerdi Alida Verbeet
Chair of the Rathenau Instituut Board
December 2016

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Introduction

The Rathenau Instituut presents a new work programme every other year. The work programme described in this document identifies the themes that the institute intends to address in 2017 and 2018. We start by sketching the values that underpin our mission and how we work. The three subsequent sections describe our contribution to three urgent public debates:

- 1. Digitalisation: trust in digitalisation**
- 2. Knowledge for policy: expert and citizen input in political decision-making**
- 3. Knowledge ecosystem: transitioning to a futureproof knowledge ecosystem**

Over the next two years, we hope to fuel these three urgent debates, in keeping with our mission and by drawing on cutting-edge expertise acquired through our own research. All three are areas in which stakeholders have asked us for input. Section 4 covers new studies that we plan to conduct over the next two years. They will update our expertise and explore new territories that we and our stakeholders believe will become relevant to elected officials and policymakers in the medium to long term. How, *for* whom, and *with* whom the Rathenau Instituut will work on these studies will be decided in the next few months. The appendices, finally, identify sources of input for our work programme.

A unique institute

The Rathenau Instituut is unique in combining expertise in broad areas of research with an understanding of how science is actually practiced and how science, technology and innovation are embedded in society. That means that it is adept at analysing and managing the many different factors involved in an issue. The public puts considerable trust in science. That means that it also expects science to come up with solutions to global challenges, putting ever more pressure on science and technology to demonstrate why they are crucial to wellbeing, prosperity and innovation. The Rathenau Instituut has been tasked with gathering reliable information on the impact of science, technology and innovation on society, and on the dynamic nature of the knowledge ecosystem. The institute further develops internationally recognised policy frameworks and parameters for determining such impact, and contributes to international initiatives linking public policy and research agendas.

As an expert body, the institute's purpose is to analyse how science and technology change human lives, and to ask what we need to ensure that such changes are beneficial to society. What does a certain change mean for people, and where do political issues arise? Should we remove existing barriers, or do we in fact need to take steps to protect people against unwanted effects?

Our wish at the institute is to offer our expertise in ways that serve democratic dialogue best. That may take the form of public discourse, an expert meeting, a foresight study, a factsheet, focus groups, an essay drawn from research and expert insights, or a weblog. When we lack vital information in the public interest, we conduct our own research. In everything that we do, we seek to cooperate with other researchers, the public and political representatives. And although the

institute has not been asked to venture into scientific theory-building, we nevertheless reflect on the data we have acquired and publish our reflections, either ourselves or in co-authorship with others. Most of our activities, however, are geared to our main target groups: the public and political representatives. As a result, we try to make our communications as accessible as possible.

Values and objectives underpinning our work

In everything that the Rathenau Instituut does, we show how science and technology can contribute to 'public value creation', otherwise referred to as 'the good life' or 'a just society'. What counts as public value creation is always open to debate in a democratic society, as a matter of principle. And in a representative body like the Dutch parliament, which is made up of so many parties, it is important to see that all the various opinions on this subject are expressed. At a higher level of abstraction, of course, there is broad consensus about the elements of public value creation – a consensus that has the Rathenau Instituut's commitment. This includes consensus on the constitution, the Universal Declaration of Human Rights, the Council of Europe and the United Nations' Sustainable Development Goals. Not only governments, but also knowledge-based organisations, private businesses and civil-society organisations are committed to these elements.

The Rathenau Instituut would like to do more than point out the risks involved in change. We want to focus on the opportunities for public value creation in our discussions of scientific and technological advances. That is why we have decided to devote more and more of our energies to examining how and under what conditions a certain trend in science or technology can make a positive contribution to acknowledged individual human rights and to the shared objectives of transition.

That is also the thinking behind the Dutch National Research Agenda. We intend to align our activities and research with the themes identified in that agenda, and with the partners that have connected with one another while plotting out the various 'routes'. One issue that the Rathenau Instituut will be highlighting in the years ahead is the role of stakeholders and the public in these routes. Their involvement is necessary to achieve economically, ecologically and socially sustainable innovations in such fields as energy, food, safety, health, physical integrity and nature conservation. This train of thought also fits in with the EU and UN agendas, which place great emphasis on partnerships.

Focus on governance

The United Nations' Sustainable Development Goals¹ and the EU's Societal Challenges² identify tangible, quantifiable goals (for example food and energy for all), but also process goals (such as good governance). The work undertaken to achieve these goals differs from one region to the next and is increasingly regarded as a process in which not only the state but also cities, universities, companies, the public and other societal partners have a role to play. In each study that it undertakes, the Rathenau Instituut will explore which form of governance suits the rapid advances in science and technology that it is addressing. One promising model involves 'ethics by design', i.e.

¹ The UN's 17 Sustainable Development Goals: www.un.org/sustainabledevelopment/sustainable-development-goals/

² The EU's 7 Societal Challenges: <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/societal-challenges>

focusing on socially desirable outcomes in the research phase. Another approach is to enact new laws and regulations that allocate responsibility across the board in civil society, ensuring that checks and balances and oversight are in place.

Because it has become so much easier to communicate and share information with one another, new forms of IT can support such innovations.

Focus on long-term targets

The Rathenau Instituut is considering how the rights of future generations can be allowed for in science and technology decision-making. One way is to involve young scientists, the youth branches of political parties, the UN Youth Ambassadors programme, or the Worldconnectors Round Table, for example. Foresight and scenario studies can also be useful methods. The concern for future generations is clearly visible with respect to older technologies, for example nuclear power and issues of radioactive waste disposal, leading to such requirements as retrievability and monitoring options. A recurring issue in the debate about genetically modified organisms, for example, is the long-term impact of GMOs, although that concern has not led to a common review mechanism. A child's 'right to an open future' also plays a role in medical diagnostics. Do we really want to know everything?

When deciding what research to undertake, it is also important to look at the time scale. The length of time needed to carry out basic and applied research goes beyond a single cabinet period. By gathering facts and figures and testing associated assumptions, we will continue nourishing the debate about how much time it takes for science to produce socially relevant and economic results.

1 Digitalisation

Over the past thirty years, the Rathenau Instituut has studied the impact of computers and digitalisation in many different areas of society. With the pace of change quickening, we have decided that our recent studies of digitalisation should be high up on the societal and political agenda in 2017 and 2018. There are two sides to digitalisation: it gives us access to knowledge and more autonomy, but it also influences our lives in ways that we often do not perceive. To build trust in digitalisation, we need public debate and the clear allocation of responsibilities.

The Rathenau Instituut recently showed just how much robotisation and digitalisation are affecting employment, cybersecurity and health care. We also revealed the impact of big data, augmented reality, the Internet of Things and other technologies on our fundamental rights and freedoms, human rights, patient rights and consumer rights – and what is needed to safeguard them. But digitalisation also has enormous potential for supporting digital democracy in the Netherlands and Europe.³

Exponential growth

Online banking, booking a trip on your mobile phone, letting your house through Airbnb: digitalisation now permeates almost every aspect of daily life. New services are turning the world of work and standard employment relationships upside down. The driver behind the rapid evolution of IT applications is nanotechnology, which is making devices faster, smaller and cheaper. A sensor that cost 20,000 euros in 2009 now retails for less than 80 euros. Pretty soon, we'll see that these rapid advances in technology have given us an intelligent habitat. Cameras and sensors will monitor our behaviour, our bodies and our communications 24 hours a day. People in public areas, in shops, at airports or online have no idea who is monitoring their behaviour and collecting data on it.

The studies that we have undertaken in the past two years show that the widespread use of digital applications and the sweeping manipulation of data behind the scenes have made digitalisation a threat to human rights.⁴

More than privacy

Infringement of privacy is a hot topics, but there is more going on than an invasion of our personal data. Not only do we need to ensure that data collection occurs safely, rationally and according to the rules, we also need to consider how data is being combined and how it affects our decision-making and behaviour. There is a great deal of work to be done in this area. Digitalisation can open the door to a new economy, but it is up to all those involved to guide it in the right direction.

³ See for example: www.rathenau.nl/en/themas/smart-society

⁴ The Dutch Senate asked the Rathenau Instituut to investigate whether our rights as human beings will still be secure in the future: www.rathenau.nl/en/page/dilemmas-digital-democracy

New relationships

Digitalisation gives individuals more autonomy (e.g. access to information about sickness and health), but also puts pressure on existing relationships. Relationships between doctors and patients, employers and employees, consumers and companies, and citizens and governments are also changing. New parties have entered such domains as health care and financial services that often fail to adhere to the customary agreements and traditions. Because it is far from clear which practices and relationships are desirable and fair in these new circumstances, all relevant parties must take action.

Starting points for desirable trends

The Rathenau Instituut will continue to stress that advances in science and technology must not pose a threat to real-life rights. All the stakeholders must work to ensure that IT applications actually generate economic opportunities and move us closer to banishing society's ills.

We believe it is our task to show Dutch political representatives that there are options and to identify how much latitude individuals have to make their own choices. We will continue fuelling the global discussion by working with international partners to draw attention to the impact of digitalisation on human rights and to the UN's Sustainable Development Goals.

Working on the robot society

In its report *Working on the robot society*, the Rathenau Instituut spelled out for the Dutch House of Representatives what we know about the impact of robotisation on job losses.⁵ We developed scenarios showing the conditions under which technology can be useful and help create new jobs. History shows that social and economic transition requires an investment in socially relevant research, in training and retraining, and in new rules of the game. The Rathenau Instituut compares the present day with the 1980s, when Gerhart Rathenau realised that training, legislation and awareness-raising were needed to guide automation in the Netherlands and create a platform for change. Back then, Rathenau referred to the 'information society', a term that was both galvanising and forward-looking. Our conclusion is that digitalisation will once again require an enormous effort on the part of all stakeholders. *Working on the robot society* is also meant to galvanise and look ahead: there is much to do, but it is doable.

⁵ www.rathenau.nl/en/publication/working-robot-society

Diabetes: from notebook to website

Diabetes patients used to keep a notebook in which they recorded what they ate and did and how that made them feel. They would take the notebook to appointments with their diabetes nurse. Nowadays, many diabetics input this information on a commercial website, after which special software links the data to their lifestyle data. The system gives patients constant feedback on their behaviour. While this can be helpful and reassuring, there is no guarantee that the website's advice is professional, safe or healthy. It is also not clear what the commercial parties involved in this website do with the data that the patients enter. This example shows that digitalisation is changing practice, and that this, in turn, is changing vested interests and responsibilities. Digitalisation does not simply transform existing practices into digital ones; it creates new practices and involves new stakeholders. Who decides whether someone is an 'irresponsible patient'?⁶

⁶ The example is taken from our study 'Meetbare mens': www.rathenau.nl/nl/publicatie/de-meetbare-mens-digitaal-meten-van-het-zieke-en-gezonde-lichaam (only available in Dutch)

2 Knowledge for policy

In 2017 and 2018, we intend to use our longstanding expertise in evidence-based policy as input in new political and policy discussions, both in the Netherlands and beyond. One example is the debate that recently flared up about cloning, thanks to the cloned pet dog Pipo. The Rathenau Instituut began organising debates about cloning and the values and interests that play a role in this area ten years ago. We have used our expertise to engage scientists and the public in dialogue and stress the importance of having input from both sides in policy and decision-making.

Evidence for policy

Politics is about assessing suitable options and about the possibility of regulating those options. This requires knowledge. Research outcomes need to be recast in practical terms, as they can rarely be utilised in full and without adaptation. For the past thirty years, the Rathenau Instituut has been exploring the role of knowledge in policymaking.⁷ Based on its mission, the institute has consistently tracked the importance of basic and applied research, but also the interests of stakeholders, collective values, and the often widely divergent opinions of the public. The institute considers how different types of knowledge can be utilised constructively in democratic dialogue and decision-making. One example is the discussion concerning animal welfare. It is an issue in which many different factors play a role: the ability to manage public and animal health risks, whether it is desirable to intervene in nature, and how we handle long-term risks.

Disputed facts

Science, it is often hoped, will provide common and undisputed foundations for specific policy issues. However, there is a realistic chance that scientific facts will themselves be disputed, for example if they touch on such publicly controversial issues as climate change or genetic modification. Scientists hope that scientific facts will bring discipline to highly charged debates, but what in fact happens is that science itself sometimes becomes politicised. The Rathenau Instituut knows how dynamic the intersection between science, the public, policy and politics can be, and it aims to use its insights to promote the necessary dialogue.

Public knowledge organisations

We have devoted considerable attention in recent years to the exceptional role in policymaking and public dialogue of Dutch public knowledge organisations, such as the National Institute for Public Health and the Environment (RIVM) and the Royal Netherlands Meteorological Institute (KNMI).⁸ These organisations are the link between academic research and policy issues. We have also developed a framework for assessing such organisations. Key questions are: how can Dutch ministries that depend on science offer these organisations the right guidance and invest in

⁷ Often referred to internationally as 'evidence-based policy'.

⁸ www.rathenau.nl/nl/publicatie/verstand-op-veilig (only available in Dutch) and www.rathenau.nl/en/publication/public-knowledge-organisations-netherlands

research in the future? What is the relationship between an animal welfare specialist who issues a warning and a legal specialist who asserts that a ban is impossible to enforce? And what do we do when a discrepancy arises between an issue of principle and a pragmatic agreement? Public discussion is needed to clarify these considerations, and journalists also have an important role to play in this regard.

Policy for science

Our studies show the importance to our country and the world of making scientific knowledge publicly available, so that it provides a sound and up-to-date basis for political decision-making and policymaking. The rapid advances in modern biotechnology are a good example, especially since such advances tend to ignore national borders.

A further issue is whether Dutch science and innovation policy is organised to best advantage. The Dutch National Research Agenda, for example, requires both basic scientific research and research that will promote our country's economic and social agenda. But the Netherlands' knowledge requirement is not isolated from that of the rest of the world. How can research in the Netherlands respond to the demands of the public and politicians while furthering progress towards European and worldwide economic and societal transition goals?

Digital democracy

IT facilitates the public's involvement not only in scientific and technological advances but also in political decision-making. Over the past few years, the Rathenau Instituut has investigated the rise of digital democracy. We are working with our counterparts across Europe and are in touch with various national parliaments, the European Parliament and the Council of Europe.

Modern biotechnology

Modern forms of biotechnology (such as synthetic biology) promise to alter plant and human DNA much more precisely than is now the case. Their practical application in health care and the bio-based economy is within reach. Conversations with stakeholders reveal that public opinion concerning the desirability of these new forms of modification depends not only on the technology itself, but also and above all, on the degree of trust the public has in those who introduce the technology. Many people have the feeling that the technology is only profitable for a few large corporations. They question whether ownership of these technologies has not given these corporations too much power and wonder who is capable of assessing what is safe and advisable. Various stakeholders would like to see a broad public discussion of how best to organise our agricultural system and food production. A narrow discussion of science and technology is not enough.

Examples of public knowledge and evidence for policy

The Rathenau Instituut's insights have been documented in such publications as *Policy and the evidence beast*, which offers recommendations for a productive division of roles between scientists and policymakers.⁹ The institute has developed an international training programme for researchers and policymakers focusing on 'knowledge for policy'. We give workshops on this topic in cooperation with European partners and have made a series of magazines and other publications available intended for a broader readership. We are also constantly working to develop new methods, for example the social incubator, which allows various stakeholders to 'test' a nanotechnology innovation at an early stage.¹⁰ In the past few years the institute has zoomed in on specific cases in which scientific evidence had a direct impact on controversial policy dossiers. For example, it studied the involvement of scientists and the public in the disposal of radioactive waste,¹¹ identified the components of a review mechanism for GMO crop cultivation in the Netherlands,¹² and described the status of the debate concerning the slaughter of day-old chicks. It recently also published a report identifying eleven lessons for an effective energy dialogue. The purpose of the eleven lessons is to support public dialogue about energy in the Netherlands.¹³

⁹ www.rathenau.nl/nl/publicatie/policy-and-evidence-beast

¹⁰ www.rathenau.nl/nl/publicatie/van-draagvlak-naar-meer (only available in Dutch)

¹¹ www.rathenau.nl/en/page/public-participation-national-programme-storage-radioactive-waste

¹² www.rathenau.nl/nl/publicatie/afwegingskader-nationale-teeltbevoegdheid-gg-gewassen (only available in Dutch)

¹³ www.rathenau.nl/nl/publicatie/elf-lessen-voor-een-goede-energedialoog (only available in Dutch)

3 Knowledge ecosystem

In 2017 and 2018, the Rathenau Instituut will investigate how to make the Dutch knowledge ecosystem successful, but also futureproof. We will do that by sharing our knowledge of international trends. We will explore the impact of policy by developing a set of well-chosen indicators that can facilitate a more effective debate about the relationship between scientific knowledge and societal challenges. The interaction between different types of knowledge-based organisations is especially important in this context.

Dutch science compares very favourably in international rankings. What politicians want, however, is a better grasp of the benefits of science, technology and innovation for the economy and society of the future. One important question, then, is how parties in the knowledge ecosystem – which consists of universities, public knowledge organisations, institutes of higher education, and businesses – can cooperate on tackling societal challenges and make the work they are doing comprehensible to others. Our research shows that the public places considerable trust in science and that, while it appreciates the importance of basic research, it also expects scientists to help solve society's problems.¹⁴ In the real world, however, scientists have little opportunity to come up with innovative responses to this expectation, in part because they are restricted by the funding system.¹⁵

Key figures in context

One of the Rathenau Instituut's designated tasks is to deliver key figures on science, technology and innovation that will help politicians and policymakers evaluate and amend policy. For example, the institute has analysed the impact of funding streams on science and on researcher careers, giving us an idea of how science and technology function and what we can and cannot measure in any real sense. The ultimate aim is to ensure the long-term social and economic improvement of our society. The data that the Rathenau Instituut collects and classifies fuels the discussion. Our studies also reveal the diverging and at times contradictory requirements that knowledge-based organisations must satisfy. Such organisations seek to strike the right balance between publicly funded research and private spin-offs, between their national role and international challenges, between institutional autonomy and government responsibility, and between societal relevance and pure independence. Government, governing boards and professionals together bear responsibility for organising knowledge-building. The Rathenau Instituut is actively helping to nourish these discussions.

¹⁴ www.rathenau.nl/en/publication/trust-science-netherlands-2015

¹⁵ See, for example: <https://www.rathenau.nl/en/publication/spinning-plates-funding-streams-and-prioritisation-dutch-university-research> and www.rathenau.nl/nl/publicatie/de-ontwikkeling-van-vakgebieden-nederland-de-effecten-van-beleid-op-het-nederlandse (only available in Dutch)

Dialogue

The ultimate aims are to help political representatives make informed decisions and to support stakeholders and the public in forming opinions about the targets pursued by knowledge-based organisations. Many parties have noted that policy is fragmented and that they would like a better overview. The Rathenau Instituut produces long-term analyses of recent policy and scientific practices. At the request of the Dutch House of Representatives we have investigated the robustness of a vast number of policy options in various scenarios,¹⁶ and the Dutch Senate has asked us whether the Netherlands is encouraging the right innovations, given all the government measures in effect.¹⁷

Policymaking in practice

The underlying principles of policy, for example innovation and talent development, have indeed been effective. Our studies show that they also have unintended side effects, however. Examples include work pressure and research waste in medical practice.^{18,19} There have also been budget cuts in part of the Dutch knowledge ecosystem, even though society and politicians expect a great deal of science. There is general consensus about the need to conduct basic research alongside applied research. There is also consensus that investing in large-scale research facilities is vital to the future of Dutch science. In 2017 and 2018, the Rathenau Instituut will investigate how to make the Dutch knowledge ecosystem successful and futureproof.

Recognising the value of partnership

Collaboration between partners in science and technology – known as co-creation – is becoming increasingly important. We have seen this in the Dutch government's Top Sector policy, in the Dutch National Research Agenda, and in 'smart cities' initiatives. The emphasis in co-creation is on collaborating and achieving a collective impact. The Rathenau Instituut has developed a conceptual framework for tracking and assessing the value of partnerships in science and technology. The framework complements statistics on publications and funding streams that often serve as yardsticks in that regard. We have used our methods to assess partnerships between organisations for applied scientific research (known in the Netherlands as 'TO2 institutes'), including TNO. In the next four years, we will join European partners in a European Commission project examining large-scale infrastructure. We will also help develop new ways for citizens to engage in setting the research agenda and in research itself. We did this recently for the Dutch National Research Agenda.²⁰ We have noticed that the European Commission is taking a similar approach in its policy of open science and responsible research.²¹ We have also developed parameters for charting the valorisation activities and impact of universities.²² We will share these insights in the public debate, where necessary with our stakeholders.

¹⁶ www.rathenau.nl/nl/publicatie/keuzes-voor-de-toekomst-van-de-nederlandse-wetenschap (only available in Dutch)

¹⁷ Via the Ester motion: www.rathenau.nl/en/news/new-book-how-do-we-make-information-society-ethical-society

¹⁸ 'Research waste' concerns research that is not replicated and does not generate new knowledge because others do not build on the results.

¹⁹ www.rathenau.nl/nl/publicatie/publicatiedruk-bij-medisch-wetenschappelijk-onderzoek (only available in Dutch)

²⁰ www.rathenau.nl/nl/nieuws/verslag-van-conferentie-wetenschap-en-maatschappij-gesprek (only available in Dutch)

²¹ With *Open Science* <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/open-science-open-access> and *Responsible Research and Innovation* <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation>

²² <https://www.rathenau.nl/en/publication/valorisation-researchers-do-more-they-realise>

Information provider: science in figures

Last year, the Rathenau Instituut launched the interactive website 'Science in figures' (www.rathenau.nl/en/science-in-figures). The site offers an accessible and coherent presentation of relevant statistical parameters. It is a favourite site for journalists, policy officials and other stakeholders. Where necessary, our staff provides additional information by telephone. We update the site whenever new Dutch or international data becomes available. Last year, we also added the results of our own research, for example on the impact of European science policy on Dutch knowledge-based organisations. We also surveyed funding streams and staffing at public knowledge organisations in the Netherlands. The site has been set up in accordance with internationally recognised parameters, for example from the OECD. The Rathenau Instituut actively contributes to the formulation of these parameters, and also works with the European Commission on collecting relevant data.

4 Research agenda for 2017-2018

The foregoing sections highlighted the three priority areas in which we will fuel debate as an expert body. We also indicated how these priority areas are an outcome of our mission. In this section, we describe the new research projects that we are planning for the next two years. The studies we describe here are meant to keep our existing knowledge up to date, explore new trends, and conduct in-depth research that will maintain and boost our expertise going forward. We explain why the Rathenau Instituut has decided to embark on each of these studies and for what purpose. We will naturally seek to collaborate with partners in each case.

Health-related data and the electronic health record

Health data remains an important subject of study, now that legislation concerning a nation-wide electronic health record has been passed. In recent years we have studied the way in which quantification and 'nudges' target our body and behaviour. Additional rights have been defined in the medical domain, making it especially important to study which assurances have been given. The ability of technology to link different sets of data has brought new commercial parties into the realm of health and health care. This new study will support our activities in the priority areas of digitalisation and knowledge for policy and politics.

Broad concept of health and personalised medicine

We will study the emerging reconceptualisation of health that implies a broader definition of wellbeing and places more emphasis on preventive medicine. This trend is of relevance to the Rathenau Instituut because app-driven self-monitoring has been the subject of European and Dutch policy. The topic of e-health also requires new forms of cooperation between researchers in different disciplines, between professionals, and between individuals. This study will support our expertise in the priority area of digitalisation and inform discussions about innovation in health care and research.

The human brain, artificial intelligence and neurosciences

The Rathenau Instituut recognised the importance of the neurosciences early on and will continue to update its knowledge of this subject. The latest neuroscientific breakthroughs brought us a range of different technologies to intervene in the physical brain and influence individual behaviour and wellbeing. The availability of big data allows us to develop self-learning systems. Commercial parties such as Google are at the forefront of this development. But these trends also raise fundamental questions about human nature. This study will support our expertise in the priority area of digitalisation and inform discussions about science and innovation.

Emerging IT

In line with our research into robotics and artificial intelligence, we are keeping close track of developments in multimodal biometrics, virtual reality (VR) and augmented reality (AR). Advances in IT and nanotechnology are unfolding at lightning speed and becoming available to consumers. Multimodal biometric systems combine various biometric features to allow automatic recognition of

individuals, for example at an airport or on the street. VR and AR plunge users into digital environments, both physically and emotionally. These techniques will change social life. Another new development is the quantum computer. Can the Netherlands show the rest of the world how to use these technologies responsibly?

Internet of Food, Money, Energy and Mobility

We want to zoom in on a number of practices in which digitalisation and robotisation are becoming increasingly important, for example with regard to food, money, energy and mobility. Under the label 'the Internet of Food', we will study the significance of big data, robotics and AI for the food sector. Our 'Internet of Money' study sketches the transition from a monetary system that is centrally regulated by banks to a decentralised network that makes use of blockchain technology (Bitcoin being the most famous example). With regard to energy and mobility, we see a growing role for smart grids, with IT maintaining the balance between supply and demand. These digitalisation trends are changing our lives once again, and raise questions about where public interests come in. They also require new ways of organising knowledge and an investment in the digital infrastructure, for example 5G.

New biotechnology

Driven by the digitalisation and robotisation of laboratory procedures, the genetic modification of organisms is becoming easier, more precise, cheaper and, consequently, more accessible. A typical example is the rise of synthetic biology, which began by modifying existing life forms and is now gradually transitioning to creating new, artificial life forms such as synthetic cells. We will continue to investigate the way knowledge of the latest forms of biotechnology is organised and how research allows for the associated opportunities, risks and public opinion.

Fertility, beauty and health

Unable to get pregnant, or ashamed of your appearance? People struggling with these issues are more inclined to search for technological solutions. Our research shows that there is a worldwide market for such interventions and that cosmetic and therapeutic applications increasingly compete with lifesaving treatments. The European Parliament will most likely address this problem within the next two years. We will undertake new studies in this area in line with the globalisation of research, in which we examine how local legislation and ethical codes restrict research even though patients and consumers are located around the world. Digitalisation also enables customisation, for example in 3D printing of teeth. This study will support our expertise in the priority area of digitalisation as well as discussions about innovation in health care research and policy-related ethical matters.

Global ethics

Health, food and other policy dossiers raise the question of how responsible research and innovation can take shape in a globalising world. According to the European Commission, part of the answer lies in committing to existing standards of Corporate Social Responsibility. As a member of a worldwide consortium, we will once again turn our attention to global ethics, in keeping with the GEST project (Global Ethics in Science and Technology). The EU's Parliaments and Civil Society in Technology Assessment (PACITA) project has improved the network of organisations that, like the Rathenau Instituut, serve as expert and parliamentary technology assessment bodies for complex scientific and societal issues. This network makes it possible to build our knowledge of global

ethics, evidence-based policy, responsible research and innovation and public engagement within and beyond Europe.

Open data and open science

The volumes of data produced by research are growing exponentially, driven in particular by the rapid digitalisation of science. Large databases play an important role in every discipline. By analysing and combining data files, researchers are generating insights that would not emerge on a smaller scale of research. The university is becoming a data platform for research conducted by multi-institutional, multisector and multinational teams. The Rathenau Instituut will combine its knowledge of the ethics of big data and digitalisation with its expertise on the organisation and funding of research.

Knowledge co-creation

Scientists are expected to address societal issues. The Rathenau Instituut has already demonstrated that stakeholders can become involved in research at any given stage and in any given role, and that the nature of their involvement may define the societal impact of the research. Despite its promise, knowledge co-creation is not always successful. The Rathenau Instituut wants to continue exploring challenge-oriented research. Do the Netherlands and knowledge-based organisations have the right combination of basic, applied, practice-based and mission-oriented research? This study will chart the knowledge ecosystems associated with a few major societal challenges and analyse their resilience. We will seek to link up with the 'research routes' identified by Dutch National Research Agenda and the Top Sectors policy.

Scientific integrity

The world of science is facing critical and fundamental questions about its methods. Fierce competition and enormous pressure to publish may lead to irresponsible behaviour. Some even refer to research waste, i.e. research that is neither scientifically or socially relevant. Researchers themselves are demanding change. The Rathenau Instituut can contribute to the necessary transition by exploring how the status of research organisations in society influences scientific integrity. We will interact with other Dutch and international partners to develop a framework for assessing scientific integrity as a public expectation. In 2017, the Rathenau Instituut will organise a session on scientific integrity at an international conference.

Role of regulation in the governance of innovation

Radical technological advances make disruptive innovation possible. The aim is not only to avoid risk and damage, but also to exploit opportunities and guide matters so that technology is properly embedded in society, with the principles of socially responsible innovation and corporate social responsibility governing regulatory measures. That makes the regulation of technological innovation a shared responsibility. One of the perspectives put forward under this theme is the role of regulation in the globalisation of research and innovation. Building on earlier case studies, for example in such areas as synthetic biology and mobility, we intend to expand our knowledge of this subject.

Measuring the valorisation and impact of large-scale infrastructure

Politicians raise questions in parliament about how research actually benefits society. Funding

bodies want systematic proof of the impact of research. Better indicators, innovative approaches and persuasive narratives are needed. The Rathenau Instituut has helped shape the thinking in this area in recent years. In the period ahead, we will join partners in Europe in helping a number of large-scale research facilities track their impact on society. We will also help develop a model for assessing the societal and economic impact of large-scale research facilities.

Role of cities and regions in the new dynamic of research and innovation

We see the rise of the 'smart city' within the broader context of urbanisation and the regionalisation of knowledge. We have seen countless partnerships between knowledge-based institutions, businesses and small firms, users, managers and other stakeholders in cities and metropolitan regions. The responsibility for setting the research agenda and research programmes, for funding and conducting research, and for valorising its outcomes is thus shared between public and private parties, as is the task of tackling societal challenges. We are conducting quantitative research and qualitative studies into trends in Dutch metropolitan regions. Our research builds on an earlier study of the globalisation of research, which revealed that regionalisation and urbanisation are the flipside of globalisation.

Local digital democracy

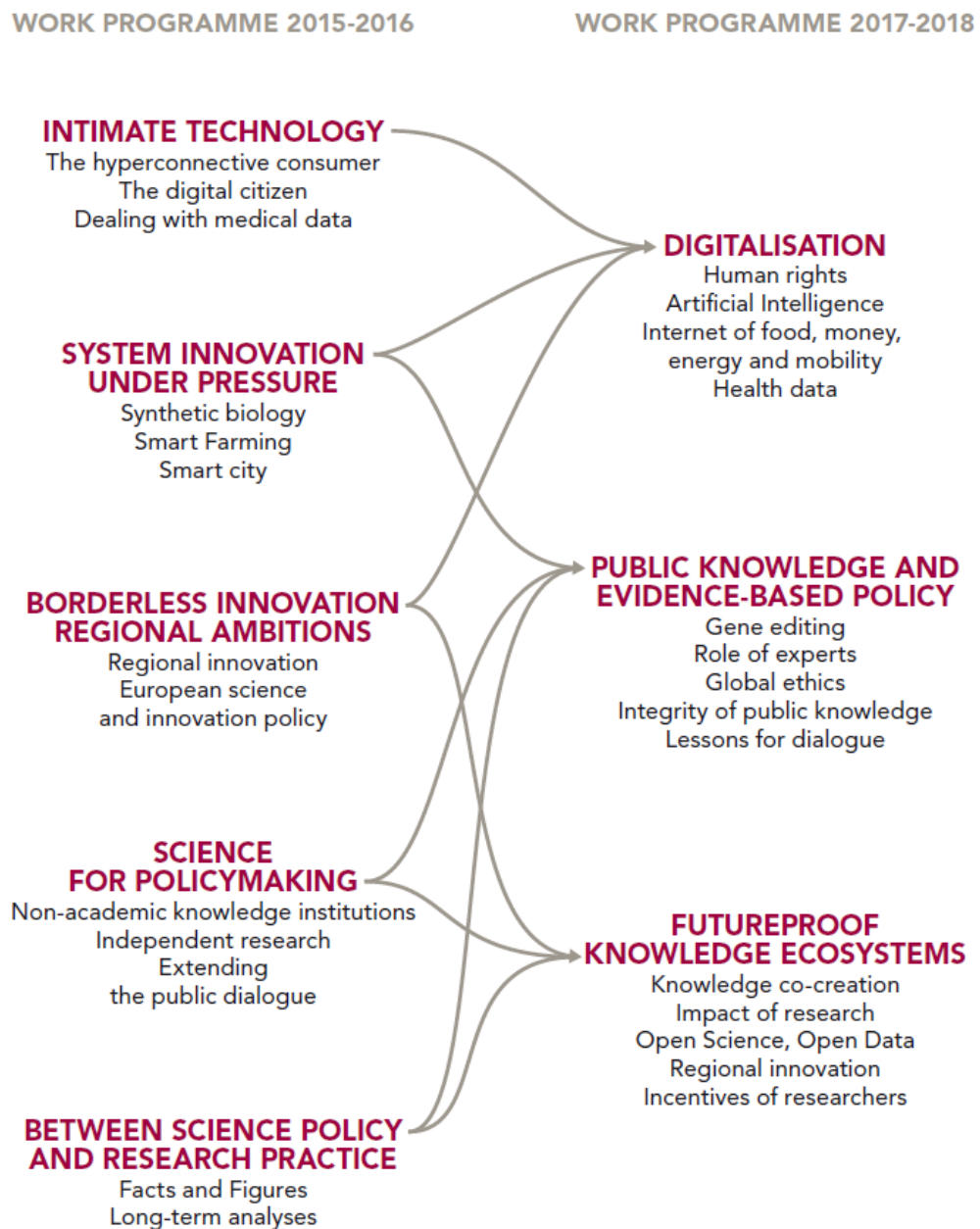
The smart city also involves the use of digital tools, such as the Internet of Things and artificial intelligence, as solutions for urban issues of mobility, pollution, safety, energy and health. One major issue is how to design a smart city in a socially responsible manner. How can city-dwellers become involved in policymaking and help decide how smart technologies are developed and used? This study builds on our understanding of digitalisation and on our research into digital democracy in the Netherlands and Europe. It also complements our understanding of the role of knowledge and citizen engagement in policymaking.

Boosting our role as information provider

In the 2017-2018 period, we will update our regular publications and factsheets on research funding, what motivates researchers, internationalisation, and careers in science. We will extend our information provision tasks in a number of areas:

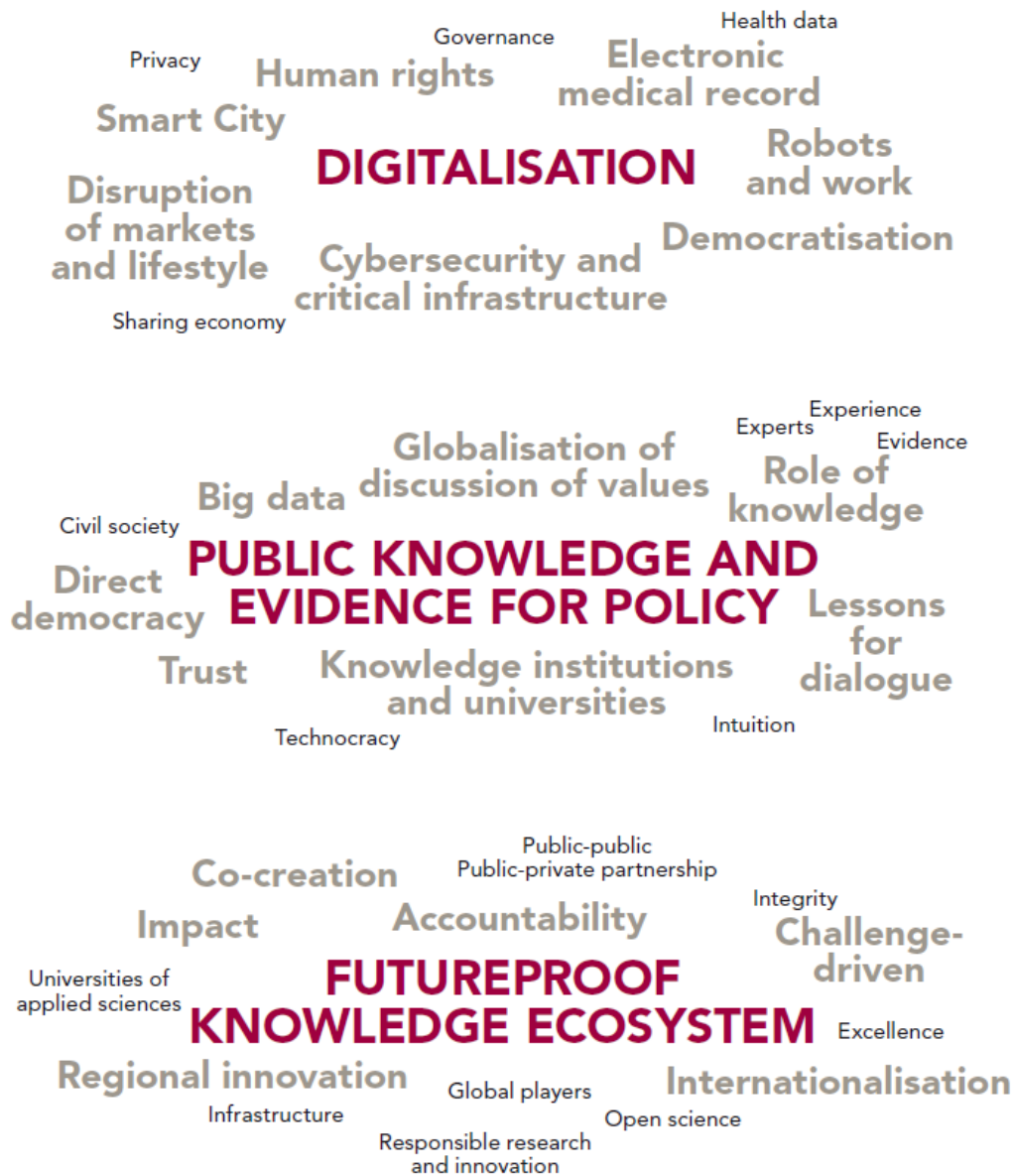
- **Diversity:** looking specifically at the labour market for women scientists.
- **International mobility:** interaction between universities, knowledge-based organisations and businesses.
- **Impact parameters:** how does research contribute to prosperity and wellbeing?
- **Corporate R&D:** for a better understanding of innovation and valorisation, hotspots and co-creation.
- **Regional and sector analyses:** to supplement our national and international data.
- **UMCs:** improving our knowledge by adding microdata across multiple years.

Appendix 1: Relationship to previous work programme



Appendix 2: Themes

Word clouds of each of the three themes with relevant subjects and trends



Appendix 3: Sources

We have used the following sources of information in drafting our 2017-2018 work programme:

- Conversations with stakeholders
- Workshops with stakeholders marking the 30th anniversary of Rathenau Instituut (see also Appendix 4).
- The suggestion box on the institute's website
- The Dutch National Research Agenda and the related conference that we organised in July 2015
- Conversations with our Programme Panel. The Programme Panel's members come from different sectors of society and advise our Board on the substance of our work programme, in keeping with our charter (see also Appendix 5).
- Focus groups consisting of high-educated individuals, low-educated individuals, and young persons
- Analysis of policy documents published by such international organisations as UNESCO, OECD and the European Commission, and of policy documents issued by Dutch ministries
- Analysis of Parliamentary papers

Appendix 5: Programme Panel

The Rathenau Instituut's programme panel meets a number of times each year to discuss new developments and the institute's research programme. The panel was set up by the Rathenau Instituut Board.

- **Gerdi Alida Verbeet** was president of the Dutch House of Representatives (for two terms, 2006-2012). After 2012, she took on a range of new roles, some of them board positions, including the chairmanship of the Board of the Rathenau Instituut.
- **Annet Aris** teaches digital strategy at INSEAD Business School in France. She also writes a weekly column on digital transformation for the daily financial newspaper *Financieel Dagblad*.
- **Marien Baerveldt** is a communication facilitator and offers training in participative leadership and teamwork. He also studies the interface between grassroots communities, leadership and meaningfulness.
- **Rob Bijl** is deputy director of the Netherlands Institute for Social Research (SCP). He also has various management and advisory positions, including at the interface of science and society.
- **Marc Chavannes** is a journalist and emeritus professor of journalism (University of Groningen). He writes about politics for *De Correspondent*, a web-based news platform.
- **Felix Cohen** has been the director of the Dutch Traffic Safety Association since 2015. Before then, he was the director of the Netherlands Nutrition Centre and director-general of the Dutch Consumers' Association.
- **Linda Duits** is a researcher, publicist and teacher.
- **Bas Eickhout** represents the Dutch political party GroenLinks in the European Parliament as a member of the Greens/Free European Alliance political grouping. His main interest is environmental and climate policy.
- **Bert Fokkema** is part of an international team at Shell that develops policy and internal standards for the decommissioning of oil and gas production systems. He is responsible for external relations.
- **Yuri van Geest** is the Dutch ambassador of Singularity University and the initiator of Singularity University Netherlands. Singularity is the synthesis and indissoluble connection between emerging technologies such as robots and artificial intelligence.
- **Peter Giesen** is an editor and Paris correspondent for national newspaper *de Volkskrant*.
- **Rob Hamer** has been the director of Unilever Vlaardingen R&D Laboratory since 2012.
- **Rob van Hattum** is Science editor-in-chief for Dutch public broadcaster VPRO. He makes radio and television programmes about science and technology. He is also Chief Science Officer at Science Center NEMO.
- **Janneke Hoekstra** is head of the Faculty of Engineering at HAN University of Applied Sciences.
- **Yori Kamphuis** is co-founder of Cobblue, which offers safe software and security systems. Yori is also a Global Shaper of the Amsterdam Hub.
- **Annette Klinkert** founded the firm city2science. She supports innovation by linking local urban parties in new ways and building expertise in this area.

- **Laurien Koster** was president of the Netherlands Institute for Human Rights until June 2015. Before then, she chaired the Dutch Equal Treatment Commission. She has worked as district court president, judge and lawyer.
- **Chris Kuijpers** has worked for the national government since the early 1990s. Since 2012 he has been director-general for Environment and International Affairs at the Office for the Senior Civil Service.
- **Willem Lageweg** was director of CSR Netherlands. He now has various part-time management and advisory positions.
- **Jolien Morren** is a student. She is working on her Master's in Biology and Science Communication & Society at Leiden University.
- **Dirk Pilat** is deputy director of the Science, Technology and Innovation Directorate of the Organisation for Economic Co-operation and Development (OECD) in Paris.
- **Stientje van Veldhoven** has represented the Dutch political party Democrats 66 in the Dutch House of Representatives since 2010. Her main interests are climate change and energy, the environment, agriculture and development cooperation.
- **Marijke Vos** was a senator for the Dutch GroenLinks political party (until mid-2016). She was previously the party chairperson, a member of the House of Representatives, and an executive councillor in Amsterdam.
- **Jeanine van de Wiel** is Global Regulatory Affairs Manager at DSM for food ingredients and health.
- **Lynn Zebeda** co-founded Dr. Monk innovation studio and is a member of the board of Worldconnectors. She plays various advisory roles in the world of sustainability and international cooperation.



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'.

Rathenau Instituut

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