Rathenau Instituut

Work programme for 2021-2022

Contents

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Photograph on previous page: An intelligent pavement slab warns Amsterdam children about traffic on the adjoining cycle path.
Photograph: ANP

Foreword

This publication is the Rathenau Instituut's work programme for 2021-2022. At the time of writing, we are leaving "corona year" 2020. The other day I saw a striking image of the new year: the 1 of 2021 was depicted as a vaccination syringe. This is an expression of the desire we undoubtedly feel to get back to normal in the new year. But it also expresses society's need for scientific knowledge that will provide us with a safe vaccine.

At the same time, there is also something exciting about a syringe. Just as it can be exciting to see whether there is still sufficient support in society for the measures taken to tackle coronavirus - including the vaccination programme.

The Rathenau Instituut studies the impact of science and technology on our lives. The coronavirus has placed the questions that the Rathenau Instituut has been working on since the 1980s at the centre of public and political debate.

Now that physical meetings are no longer possible, we are communicating digitally more than ever. What does this mean for our work and education, for example? How do we maintain trust in science? And what is needed to make policy based on informed choices, policy that can also rely on sufficient support from individuals with diverging interests?

Although these questions may take on a greater significance than before in times of coronavirus, they are not new. Over the next two years, the Rathenau Instituut will therefore be able to build on years of experience in research and dialogue on the societal aspects of science, technology and innovation. The 2021-2022 work programme deepens and broadens our previous work.

A lot in our lives last year went differently from what we are used to. But what remains unchanged is the idea that a broad public and political debate is needed on how science and technology affect our lives. The Rathenau Instituut intends to contribute to this debate over the next two years by undertaking research and dialogue projects.

Gerdi A. Verbeet
Chair of the Board of the Rathenau Instituut

Part 1
Introduction

The Rathenau Instituut initiates, encourages and supports dialogue, decision-making and policy. In this part we provide a brief introduction to our organisation and our work programme.

A businessman shakes hands with a robot.
Photograph: Andrey Armyagov/Shutterstock

Introduction

Science, technology and innovation are part of our lives. They are essential for well-being, prosperity and resilience in our society. The Rathenau Instituut's mission is to help form public and political opinion, to inform decision-making and to promote the idea that developments in science, technology and innovation benefit society. To this end, we conduct research, organise and stimulate dialogue and inform the public and politicians of the impact of science, technology and innovation on society. We have a specific mission in relation to the Dutch parliament and society as a whole. This task is laid down in our constitution.

Work programme

We adopt a work programme every two years setting out how we will be carrying out our social mission. We explain the issues we intend to zero in on for the period in question. We identify the themes and formulate the questions that will give direction to our work. These themes form the framework within which we address current, urgent societal aspects of science, innovation and technology. And they make it possible to establish links between the individual research projects. The work programme shows the coherence of all our research and dialogue projects and is intended to strengthen the impact of our work.

This is our work programme for 2021 and 2022, in which we show how our work will develop over the coming years. It builds on our previous work programme. But it also expresses the way in which our work keeps pace with developments in society and emerging issues. Just like our previous work programmes, this work programme illustrates both the continuity (see Appendix 1) and the novel aspects of our work.

For this work programme we have explored the issues that will be relevant to our institute's mission over the coming years. To this end, we have organised several meetings, held discussions with key stakeholders and organised round table discussions with members of our Programme Panel. A digital mailbox was also used to collect ideas from the public. During the discussions, we not only considered relevant issues, but also how the Rathenau Instituut can make an impact based on its specific role and positioning.

Role and working methods

The Rathenau Instituut conducts research and organises dialogue on the impact of science, technology and innovation on society. We are attuned to public values and interests and the perspective of different groups and stakeholders. Our working methods are also characterised by the active involvement of specific target groups in our research. By bringing together the perspectives of different parties, we try to build bridges between politics, the research community, government and the public. With this in mind, we aim to reach out to policymakers, businesses and individuals to make science and technology as valuable as possible to society.

In everything the Rathenau Instituut does, we show how science and technology can contribute to "public value creation", otherwise known as "the good life" or "a just society".
What exactly counts as public value creation is always open to discussion in a democratic society, as a matter of principle. This is particularly true of the Dutch parliament, where many parties are represented and it is necessary to reflect their different points of view on the subject. Guidance is provided by the broad consensus that has emerged in many areas.

For example, we can base our approach on the Dutch Constitution, the Universal Declaration of Human Rights, the Council of Europe and also the Sustainable Development Goals of the United Nations. They have the commitment not only of governments, but also knowledge institutes, industry and civil society organisations. The Rathenau Instituut always examines how trends and developments in science or technology can make a positive contribution to the human rights and public values that have been defined. We continue to fuel debates on the development of science by collecting facts and figures and by testing assumptions about them. We learn how these provisions are implemented worldwide through national and international cooperation. In 2021, for example, the Rathenau Instituut will chair the network of institutes with a similar function worldwide and we will bring together knowledge of our sister institutes by organising two conferences.

Developing the work programme

The preparation for this work programme has once again shown us how much science and technology are part of the way we work, live and interact with each other. Many references were made to societal challenges and topics of public debate to which the Rathenau Instituut could make a worthwhile contribution, highlighting issues of inclusion and cohesion in a society in which our news is offered in an increasingly personalised way. Or a shifting global balance of power, while - or because - we are becoming increasingly dependent on Chinese and American technology. Climate change and loss of biodiversity require new knowledge to enable innovation and to inform the political and public debate. How can we make the transition to a sustainable agri-food system? And what does the current data hunger mean for our use of energy? The coronavirus crisis has now put the spotlight on all kinds of developments, such as the digitalisation of education and work and the role of science and public knowledge institutions in policymaking.

The study also showed that the themes the Rathenau Instituut focused on in 2019 and 2020 are still topical: Digital Society, Making Perfect Lives, Robust Knowledge Ecosystems and Knowledge-Driven Democracy. These themes provide a solid foundation to build on over the coming years.

Our ambition is to further develop the existing themes over the coming years and to link them up with current and emerging issues. This work programme was drafted in the midst of the coronavirus crisis. For the Rathenau Instituut, the consequences of this crisis not only raise new questions for research and dialogue but also affect the way we do our work. Whereas physical meetings are normally an important part of our way of working, we are forced to make increasing use of digital tools to hold discussions, organise meetings and support dialogue. The impossibility of seeking people out and physically bringing them together feels like a handicap and at the same time challenges us to facilitate dialogue and cooperation in a creative and sometimes innovative way. We have developed our own online platform to bring groups of people together and organised our annual event in a virtual environment, precisely to reflect on this development.

At the time of writing, it was still unclear what impact the coronavirus crisis will have on our work in 2021 and 2022. Despite this uncertainty, we are making conscious choices about the content of this work programme for the coming years. Coronavirus and the way in which society can deal with it is reflected in all our themes, both in terms of content and in our way of working. Should circumstances demand it, we will continue to adapt our working methods to the special conditions of these times. We will continue to invest in dialogue with and the involvement of various social actors in our work, through physical encounters and with digital support.

Structure

Part 1 outlines the societal challenges identified in the study in relation to science and technology. Part 2 describes how societal issues are reflected in our work. We describe the themes and research questions and what new emphases we will be placing on them. This is how the Rathenau Instituut will specifically focus on over the coming years.

Science, technology and society in transition

In preparation for this work programme, we asked stakeholders which issues the Rathenau Instituut should focus on over the coming years.
Many interviewees explained the relationship with current issues and the public debate about them. In doing so, the Rathenau Instituut was encouraged to contribute to the public debate based on its own expertise and specific role. The suggestions put forward relate to four societal challenges.

1. Inclusion and cohesion in a fragmented information society;
2. Shifting power relations and the strategic significance of science and technology;
3. Climate change and the loss of biodiversity as a technological and political challenge;
4. The coronavirus crisis as a game changer.

Each of these four challenges relates to the impact of science, technology and innovation on our society. They therefore fall within the Rathenau Instituut's mission and remit and give direction to this work programme.

Although the four issues differ from one another, we also see similarities. As stated above, they are closely related to science and technology development and stimulate a lot of public and political debate. The discussions are often held by experts. And although they have a major impact on society as a whole, not everyone finds it equally easy to join the debate. These developments can also extend over years, but suddenly gain momentum.

It is therefore difficult for politicians to get to grips with them. And it is difficult for society to find solutions to these major issues. In short, they require research and dialogue. This puts them at the heart of the Rathenau Instituut's mission. In the sections below, we explain why these societal challenges are relevant to the work of the institute.

Inclusion and cohesion in a fragmented information society

A free and flourishing society allows room for differences. Diversity of opinion and debate are important foundations of our democratic society. And certainly in Dutch politics.

An important democratic value here is that different voices are heard and have a place in the decision-making process. This ensures that different views and interests are taken into account and vulnerable groups are not ignored.

According to research undertaken by our institute, there is still a relatively high level of trust in democratic institutions in the Netherlands. At the same time, there is perceived to be a risk of fragmentation in society and mutual incomprehension. Research by the Rathenau Instituut shows that trends have been developing rapidly in recent years. For example, the personalised use application of technology enables individuals to receive information about current affairs, knowledge and opinions in their own way.

The impact of this is clear to see in the United States, where individuals obtain most of their information from their own perspective or filter bubble. The way that digital platforms reinforce polarisation is more evident there than in the Netherlands.

But the technical possibilities are increasing. Social media and platform companies offer people an information environment that increasingly matches their own preferences and search behaviour. Because technology is increasingly able to adapt to unique user characteristics, individual users are increasingly seeing and interpreting the world from their own specific perspective. This can lead to misunderstandings between population groups. The personalisation of information can also put pressure on social cohesion and joint decision-making.

It will therefore be important over the coming years to examine how government, industry and societal actors can promote the use of digital technology that contributes to social cohesion and trust. How can we increase the quality of a debate in which knowledge and emotions are allowed to play a role, without polarising? How can all kinds of points of view based on facts and values find a place in the public debate? How can we conduct a dialogue on norms and values when it comes to subjects which are highly technical but have far-reaching consequences for the quality of life? And how can knowledge development respond to questions and concerns from the public? Science and disputed evidence play a specific role in digital media, as clearly shown by the coronavirus crisis. In the coming years, too, our stakeholders will expect the Rathenau Instituut to provide guidance to politicians and the public in addressing these questions.

Our social partners will also expect us to once again to help find ways in which digital applications can mobilise people and get them involved in democracy. At the same time, they point to worrying developments. In addition to the above-mentioned filter bubbles and possibilities for personalised news, we can see that technology also assists in the production and distribution of disinformation. This engenders polarisation and has a disruptive effect on public debate and the democratic society, especially when technological advances mean that it is no longer clear what is real and what is fake.

Another way in which science and technology reinforce fragmentation is that not all groups within society benefit equally from scientific and technological developments. Innovations do not automatically become embedded in society. Attention must be paid to different views and interests. This concerns both inclusion within science and technology development itself and the question of who benefits from its results. Who is involved and is allowed to have a say in the direction of science, technology and innovation? It is the mission of the Rathenau Instituut to ensure that science, technology and innovation are of value to society as a whole. That is why we are being asked to pay extra attention over the coming years to groups that are not automatically involved in new developments or derive no benefit from them. The Rathenau Instituut is being asked to use its expertise to promote cohesion and inclusion.

> It is an important democratic value that different voices should be heard and given a place in the decision-making process.

It is essential to establish the conditions that make cooperation with knowledge institutions and technology companies outside Europe desirable.

Shifting power relations and the strategic significance of science and technology

In recent years, we have seen an accelerated shift in the balance of power. Geopolitical trends, changing international relations and the concentration of power in large tech companies have a direct, major impact on science and the development and use of technology, and vice versa. The technology we use often comes from the US or China and Dutch universities are increasingly seeking international cooperation. Cross-border cooperation is a core value in science. And people expect to benefit from knowledge developed anywhere in the world - vaccines, for example. Yet nowadays the regaining of digital sovereignty over superpowers such as America and China and the Internet giants from those countries is also high on the political agenda at European and national level. The development and deployment of AI and algorithms have acquired strategic significance.

What can be done to design a strategic science and technology policy that supports Dutch and European values and interests? It is important to strengthen our own innovative capacity in order to reduce unwanted dependencies. This requires a good understanding of the implications of the changing market forces for science and technology development and the possibilities of adequately responding to them. It is essential to establish the conditions that make cooperation with knowledge institutions and technology companies outside Europe desirable. The Rathenau Instituut has identified these trends in recent years and highlighted forms of governance for successful innovation and socially responsible science, with regional impact and world-beating quality. We have also highlighted issues such as cyber security and new dual-use technologies.

In recent years, the influence of large multinational corporations has rapidly set nation states new societal challenges. They are dominant not only in research, technology development and innovation, but also in other areas of society. For example, digitalisation and platforming can give large tech companies a dominant position in value chains, including digital health data and agricultural data. Take the US tractor and farm equipment manufacturer John Deere, which, through data collection, has better idea of what a piece of land is worth than the farmer who owns it. This raises the question of how these often foreign companies fulfil their social responsibility in the Netherlands. New agreements and new forms of cooperation are needed between politicians and public and private parties. Stakeholders expect the Rathenau Instituut to understand the mechanisms of this data economy in all kinds of areas and to show how trust and innovation with an impact on society can go hand in hand, while maintaining public values and regaining control of the technology.

Climate change and loss of biodiversity as a technological and political challenge

Climate change and loss of biodiversity have been high on the public and political agenda for several decades. Despite all this attention, there has still been little success in reversing the impending consequences of these crises. In addition to measures to counteract climate change and loss of biodiversity, thought is increasingly being given to measures to help us cope with the possible consequences, such as rising sea levels, localised droughts and food shortages.

Science, technology and innovation have an important part to play in both preventing and adapting to these consequences. But there is also uncertainty and high stakes, which do not make it easy to make targeted investments or cooperate internationally across sectors. The full potential of both technological and social innovations will be needed to provide support for desirable and necessary transitions.

This involves a radical revision of the production and consumption of both energy and food and the use of alternative resources. These big choices call for new knowledge development, new forms of cooperation and for public debate and political legitimation.

The Rathenau Instituut has previously helped to clarify the various types of issues raised in such debates. It has also provided support for the creation of debate agendas and contributed ideas on how to include the interests of future generations in these debates.

Besides stimulating innovations, science can also provide insight into the societal determinants and consequences of climate policy and technological solutions. This requires different types of independent knowledge in order to arrive at informed policies. Stakeholders anticipate that the specific knowledge acquired by the Rathenau Instituut will be what is needed now.

While technology can provide options for reducing energy consumption, it is itself a major consumer of energy and other scarce resources. For example, we can see that the amount of energy consumed by data centres is increasing rapidly. The solutions proposed may have major, often unintended consequences for groups in society. There is a risk that this will undermine support for the energy transition. Public trust and involvement in science and technology development is important if an effective, widely supported approach is to be achieved.

Coronavirus as a game changer

The coronavirus crisis has acted as a pressure cooker for all kinds of developments in society, such as the rapid digitalisation of education and work. The coronavirus crisis also magnifies the impact of digitalisation on society. In recent years, the Rathenau Instituut has joined forces with partners to initiate studies to investigate digitalisation in the sectors in which the coronavirus forced its acceleration. We will be using the knowledge gained in our work over the coming years. The coronavirus crisis has also served as a stress test on the knowledge ecosystems that develop knowledge for healthcare or policymakers. In this crisis, politicians and the public have relied on scientific knowledge and experts. It is useful to investigate the trade-offs between values and knowledge sources. This crisis provides an opportunity to learn where knowledge systems work well and where they do not. In recent months, the Rathenau Instituut has assisted the political and public debate by showing which questions need to be asked in order to make widely supported, sensible decisions. Over the coming years, stakeholders would like to see the institute help to evaluate public and political decision-making and lessons learned for knowledge, policy and society in the future.

The coronavirus crisis shows once again that we live in a risk society. The crisis teaches us how to deal with uncertainty and to communicate well on the subject. Uncertainty and inconsistencies in scientific knowledge claims can put a strain on trust in science and fuel distrust among the public. Science can also come under political pressure to legitimise policy. Although the Dutch still have a high level of trust in science, the question arises as to how science can retain this trust and how the practice of "open science" can be further developed. How can science be both independent and engaged? This crisis shows the importance of making a clear division of roles between politicians, science, the general public and the professional practice of policymakers and decision-makers.

The coronavirus crisis has acted as a pressure cooker for all kinds of developments in society, such as the rapid digitalisation of education and work.

The race to find a vaccine to combat coronavirus reveals the strengths and, above all, the weaknesses of the way science and medical technology development are organised. The development, production and supply of essential products (such as a vaccine) and services (such as a treatment) transcend the interests of individual researchers, competing national and international groups and the private interests of market players. Internationally, the term "global good" is used to describe the knowledge required for a vaccine. Who shares in this knowledge worldwide? The Rathenau Instituut's task is to investigate the workings of the science system and to present a quantitative and qualitative analysis of this system, and to do so from an international perspective. We collaborate with sister organisations worldwide. Our stakeholders indicate that they would like to see the Rathenau Instituut continue to maintain an interest in global ethics and develop this international perspective over the coming years. The question is which aspects are important, besides developing a vaccine, in a pandemic like this. A broader public health perspective is needed, as well as an understanding of socio-economic and broad ethical issues. Only from such a broad perspective will we be able to face this and any future pandemic. What institutions need to be built for this? And what questions should be asked? How can governments, knowledge institutions, the education sector and industry work together to come up with joint solutions for major social challenges? And how do we involve the public in lifestyle changes, making people healthier and more resilient? Who will take political responsibility for this at various levels of government?

The coronavirus crisis also encourages us to think about the desired role of technology within society. The centralised records of diagnosis, storage of DNA samples and surveillance technology limit freedoms.

The accelerated introduction of digitalisation in education also raises questions about the consequences for equality of opportunity, the responsible use of data and the mental and physical health of children and students. The lockdown can be regarded as a social experiment, which has radically changed our lifestyles over a short period of time. In addition to disruption, inconvenience and the lack of physical meetings, people also experience benefits from working with digital tools. Over the coming years, the Rathenau Instituut can help answer the question as to how these changes in living and working can be made permanent. How do we perceive these developments and how can we regain control of them?

Science and technology for public value creation

The four challenges referred to above show how deeply science and technology are intertwined with the world we live in. How they create new opportunities but can also give rise to new questions or problems. The rapid rise of digital technology has radically changed our society within just a few decades. Development in biomedical science makes it possible to intervene in life and nature. History teaches us that scientific and technological breakthroughs change society according to a fixed pattern. After a period in which technology mainly provides new opportunities, there comes a time when social consequences emerge and have to be managed. Many of the issues that the Rathenau Instituut addresses concern the tipping point between these phases. New technologies initially present themselves as a potential boon to society. During this first phase, innovation is stimulated and social applications are developed.

History teaches us that scientific and technological breakthroughs change society according to a fixed pattern.

There is scope for innovation and new business activity is encouraged in order to give free rein to technological and commercial development. The moment technology makes its way into our lives, unforeseen and sometimes unintended consequences emerge. These consequences raise questions as to the desirability of embedding the technology in society. How do we use the technological opportunities in order to live in the society we want? How do we get a grip on the technology and avoid the undesirable consequences? Some of the societal challenges described in this section can be understood as the transition from the phase of new applications being embedded in society to the phase in which the societal consequences emerge and have to be managed.

There seems to be a growing awareness that the way in which a society directs, finances and organises scientific research, technological development and innovation determines the way scientific knowledge and technological opportunities are exploited – and who experiences the advantages and disadvantages. More and more voices are calling for society to get a better grip on the development and use of science and technology. One concrete reason is the dominant role of large American and Chinese tech companies in determining the way the digital revolution is going. But the inability to actually set sustainability transitions and systemic changes in motion is another contributory factor. Governments at local, national and European level are increasingly looking for effective ways to make societal values and problems guide science and technology. This requires vision, strategy and new policy. We want to be part of the process. How can we manage developments on the basis of societal values?

Science and technology set challenges not only for politicians and governments, but also for other social actors and the public.

It is therefore important for everyone in society to understand science and technology and possess or develop the skills to be able to participate and interact in the technological information society. Based on its mission, the Rathenau Instituut wants to help society at large to get more closely and more proactively involved in science, technology and innovation.

In recent years the Rathenau Instituut has been working on four themes: Digital Society, Making Perfect Lives, Knowledge-Driven Democracy and Robust Knowledge Ecosystems. Over the coming years, we will continue to work on this and introduce new emphases that are related to the challenges of our time, as outlined above. This means that our views on these challenges will guide the implementation of the themes in this work programme. This continued development will result in a renewal of the underlying sub-themes and of the subjects for research and dialogue that the Rathenau Instituut will be focusing on over the next two years. The following section explains how we intend to achieve this. The theme “Knowledge-Driven Democracy” is renamed “Democratic Information Society”, and “Robust Knowledge Ecosystems” becomes “Robust Science and Knowledge Ecosystems”. This is an expression of the Rathenau Instituut’s specific task of monitoring and analysing developments in science.

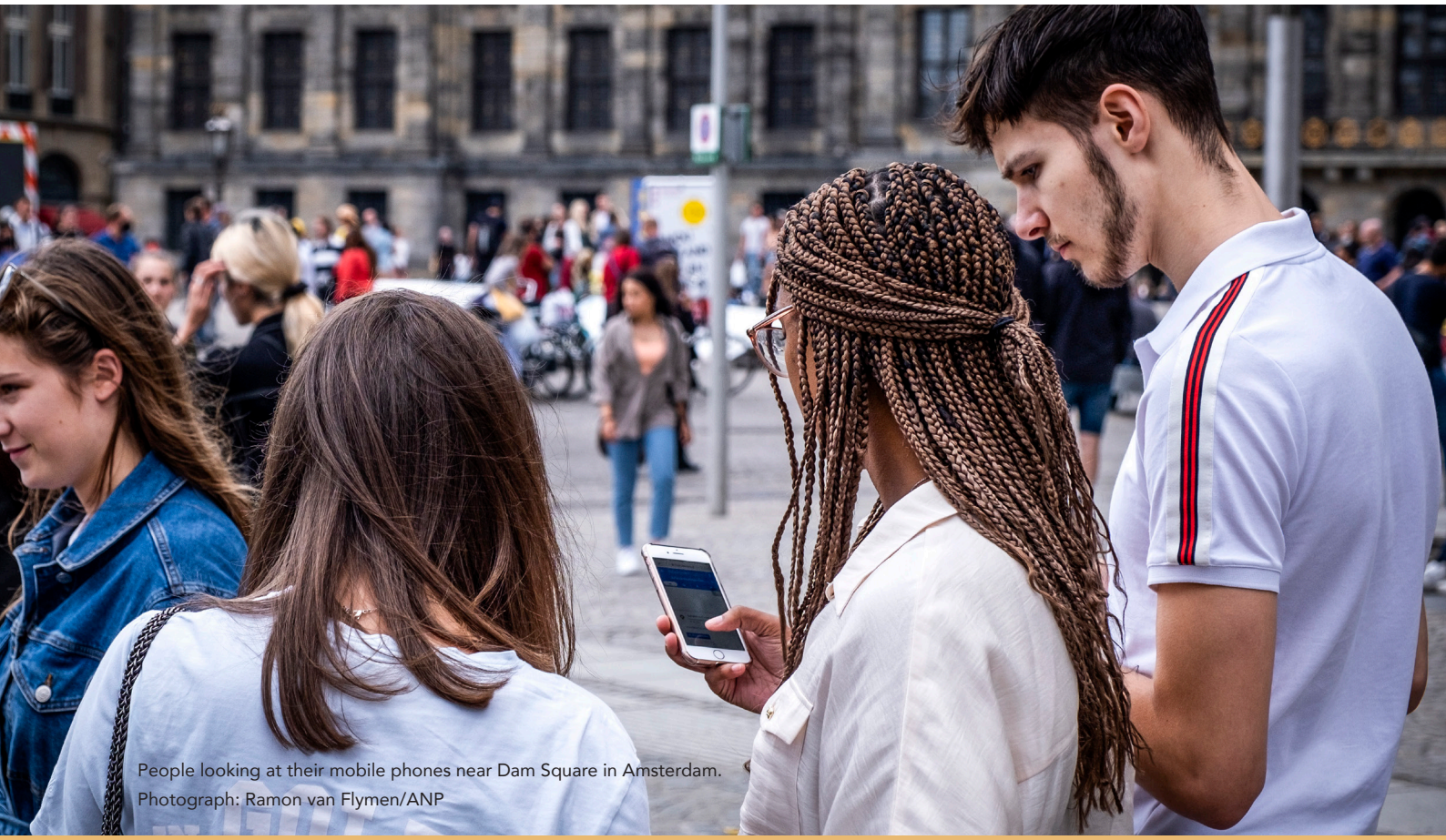
The societal challenges described in this section are therefore given a place within the various themes of this Work Programme. In order to make the insights gained from our work on societal challenges more easily accessible, our ambition is to make these accessible via our website in the form of “dossiers”. In 2021, we will make a start by opening a dossier on the role of science and technology in dealing with the coronavirus crisis. In this way, we will be trying to contribute to and inform the debate on this current societal issue in line with our knowledge base and specific mission.

Part 2
Themes

These themes will be developed by the Rathenau Instituut in 2021 and 2022: Digital Society, Making Perfect Lives, Democratic Information Society and Robust Science and Knowledge Ecosystems.

The ferry from Lauwersoog to Schiermonnikoog.
Photograph: Venema Media/ANP

1 Digital society



People looking at their mobile phones near Dam Square in Amsterdam.
Photograph: Ramon van Flymen/ANP

In the early 1990s the Rathenau Instituut studied the rise of the Internet and the significance of this new infrastructure for government, individuals and other parties in society. Nowadays, digitalisation, AI and algorithms are affecting all areas of our daily lives and new technologies are emerging. Our digital society raises urgent questions about the degree of control the Netherlands and Europe have over technology, the economy and democracy.

Digital society

The following three questions will be central to the "Digital Society" theme over the coming years:

1) **How do we regain digital control of critical infrastructure and the public sector?**
2) **How do we live together digitally in intertwined real and virtual worlds?**
3) **How can sustainability go hand in hand with digitalisation?**

Digitalisation is causing societal changes that raise questions about security, discrimination, influence and the power of technology companies. European countries, businesses and citizens are now concerned about their limited ability to shape the digital world technologically, economically and democratically. European citizens are becoming more dependent on digital technology, mostly provided by technology companies in the United States and China. Platform companies are increasing their influence in a growing number of sectors and are themselves fulfilling a social utility function. Digital technology is inherently insecure; malicious and state actors exploit any gaps in the digital infrastructure. Election systems are hacked and trade secrets stolen. Social media connects people, but also stirs up divisions. As such, the digitalised society challenges our democracy, security and earning power. The Netherlands and Europe are therefore looking for opportunities to create a value-based digital society.

The coronavirus crisis magnifies the above issues. Digital technology is proving to be a godsend during lockdowns. The healthcare and education sectors are digitising out of necessity. Industry and government have switched to working from home within days. At the same time, the limitations of digital contact are becoming apparent. Alienation, educational disadvantage and poor interaction between therapist and patient are examples of the social and mental consequences of extensive digitalisation. How do we ensure good digital healthcare, education and work, where the focus is not on smart algorithms, but on people? How can we shape the digital world together? Dominant technology platforms, meanwhile, are increasing their influence by supplying free laptops and meeting tools. This makes us even more dependent on a few dominant players. Another downside of digital applications is also becoming apparent: energy consumption. Can a digital society also be a sustainable society?

New research and dialogue

As part of the "Digital Society" theme, we will be working on the following topics with new research and debate over the next two years.

Digital governance

Regaining digital control from superpowers like the United States and China and global technology companies is a priority for European and national politicians. Government actors are seeking to change their approach to algorithms, now AI and digital platforms increasingly become the basis for corporate and government decision-making. There is a need for more control around infrastructure, software and digital platforms.

Having a say in public administration, supervision and public services

In recent years, we have conducted research aimed at understanding the impact of digitalisation. Algorithms and artificial intelligence are often behind the scenes, making it difficult to fully grasp what data is collected and making the profiles that are created invisible. In this way, governments, industry and politicians lose control over decision-making. We teamed up with local, provincial and national authorities to develop tools and frameworks. We supported the Council of Europe, the European Commission and the European Parliament, the OECD, UNESCO and other political leaders. We helped them think about policy, for example, via the European High Level Group on AI, the Dutch AI Coalition and other initiatives. How can universal human rights, our fundamental rights and public values be safeguarded in the digital society? How do we keep a grip on AI and algorithms, for example, used by private parties in public administration? Who is responsible for what? But also: how can the government continue to properly perform its duties as supervisory authority or market regulator? What treaties, standards and implementation practices are involved?

Control over the digital infrastructure

The development of AI, 5G, 6G, satellites and quantum is in full swing. In recent years we have shown that the Netherlands and the EU have become increasingly dependent on international suppliers, particularly from the United States and China, for the establishment and protection of digital systems. This dependence leads to questions about cybersecurity, supervision, control over data and new forms of internet governance, for example in space.

And who is making money from new technology? Over the past few years, we have been studying what technology means for cybersecurity and democracy. Over the next two years we will be discussing the agreements that are needed in the light of the latest technological developments and changing geopolitical relations. We will be examining the development of technology and ascertaining what strategy the Netherlands and Europe can adopt to regain control of their digital infrastructure. And we will be setting out the rules of the game that are required for this.

Control over digital utility functions

From the public interest point of view, it is crucial to give timely consideration to the ownership of digital platforms with a social utility function. This includes the influence of, mostly global, platforms on the digital infrastructure, for example in the port of Rotterdam, the Dutch electricity grid, road networks, public spaces, healthcare and education. Who will benefit and who will bear the costs? How do we ensure that Dutch industry, employees and society benefit from digital innovation? Do we dare ask what technology really does for us? To what extent is the government willing and able to manage critical digital infrastructure with a utility function? And should the ownership of these platforms be in private or public hands?

In recent years, we have studied societal practices in which digital technology is deployed, collaborating with the education sector, the police and municipalities, among others, because ultimately technology has to work for people. We will continue to do so over the coming years, and also assist the Upper and Lower Houses of the Dutch Parliament. We contribute to the international debate through cooperation with our sister organisations. Together with partners in various sectors, we are developing tools to guide the digital society based on social values.

Living together in a digital world

Over the past two years, we have been studying "immersive" technologies, such as augmented reality, virtual reality and speech technology. During Dutch Design Week, we presented a manifesto based on our findings, containing ten demands for the digital society. Over the next two years, we will be engaging with various groups in society. In doing so, we will be finding out what they need to navigate the new digital world and stay healthy – physically and mentally. Where are new social rules of conduct needed? And where is legislation needed, to protect consumers from abuse of power or manipulation?

Navigating the virtual world

It is clear by now that smartphones, the Internet and social media have a substantial effect on the way we live and interact. When these devices emerged, little attention was paid to possible desired and undesired physical, mental and social side-effects. It is high time to review the available knowledge and start a conversation. With social media, games and the growing number of private AR platforms, people are starting to live more in their own hybrid worlds, which are part physical, part virtual. How far are we willing to immerse ourselves in the digital world? How does public debate come about, if everyone is livings in their own space? To make the impact of technology clear and stimulate debate, we are collaborating with our artist-in-residence, with organisations like SET-UP and startups such as Beemup in Utrecht.

Digital nudges

With immersive technology, the digital society is entering a new phase with unprecedented possibilities, including possibilities for biometric surveillance of citizens, digital mimicry and modification of someone's body or environment. And opportunities for digital nudges, often without us realising it. How far is the government allowed to police and influence citizens, or citizens each other? What are the roles of government and industry? Where does legislation need to be amended?

Digital and sustainable

In recent years, the Rathenau Instituut has shown that the energy transition goes hand in hand with the digitalisation of the energy system. Digital data can help to match the supply and demand of decentralised energy generation, such as energy from wind and solar power. But the digitalisation of the energy system itself also consumes a lot of energy.

Digitalisation as part of the energy transition

In recent years we have worked with the energy sector and the Dutch Council for the Environment and Infrastructure, among others. Over the coming years we will continue to investigate ways of shaping the sustainable energy transition, while retaining the principles of the Dutch Energy Act: sustainable, affordable, available to all and safe. Will it again be the platforms with the most data that will determine the price and availability of new energy?

Data: the new oil

The digitalisation of our work, the services we use and our social contacts has set enormous data streams in motion. This accounts for 3% of global power consumption and that figure is growing rapidly. Information technology developers are interested in data streams, to be used in training artificial intelligence. But producing, transporting, storing and processing data requires ICT infrastructures, such as computers, network cables and data centres, which in turn depend heavily on energy. Data is "the new oil". This analogy indicates both that a lot of money can be made from data and that data use puts a strain on our environment and our climate. Over the next two years, we will investigate what our data hunger means for energy production and national and global climate targets. We are developing tools to shape the digital transition in a sustainable way.

2 Making perfect lives

Participants in the national DNA dialogue in discussion during the first meeting in Rotterdam. The DNA Dialogue travelled the Netherlands in 2020. For example, they investigated what the Dutch think about adapting embryo DNA.
Photograph: Chris van Koeverden

The Rathenau Instituut has been studying the impact of medical scientific research for many years. There are very different views on health technology issues in Dutch society. Our relationship with nature and our living environment also often presents us with dilemmas. In the years ahead we will be supporting the political and public debate on this subject with new forms of dialogue.

Making perfect lives

The following four questions will be central to the "Making Perfect Lives" theme over the coming years:

1) **How do we ensure that bioethical issues receive sufficient attention in the political and public debate?**
2) **What societal values are key to improving health and healthcare in practice?**
3) **How do smart healthcare innovations remain people-centred?**
4) **How can we reconcile human health, animal health and sustainable food production?**

Some people are calling the twenty-first century the century of biology. Science seems increasingly able to accurately describe, classify, predict and modify life. The various applications of (medical) biotechnology create the impression that, more than ever, we can make life perfect. Science, technology and innovation therefore seem to define not only what biological life is, but also what a "good" life is. And yet; the coronavirus crisis reveals how fragile our health is and that "the good life" relates not only to our physical health but to well-being and social values as well.

With smart healthcare innovations that turn our body into a "digital body", we are looking to make our own health perfect. But despite all the opportunities for personalisation in healthcare, it is still hard to encourage healthy behaviours. Our social position still determines our lifelong health and not everyone benefits from progress. Moreover, when we use smart care innovations, we come up against the question of who has control over our bodies and our most intimate data, including our DNA profile. And the human side of healthcare, particularly for older people, cannot be replaced by smart technology.

The health of all life on earth - whether human, animal or the environment - is under pressure in multiple ways. Although nature appears to be largely malleable in our hands, we have little control over climate change and biodiversity is declining dramatically. Meanwhile, no agreement has been reached in the public and political debate on policy for agriculture and livestock farming. How can we conduct the conversation we urgently need to have about making perfect lives and the limits of this idea?

New research and dialogue

Within the theme of "Making Perfect Lives", we will be working on the following subjects, undertaking new research and stimulating debate, over the next two years.

Social and political debate on bioethics

Individual needs and collective values can sometimes be at odds. Society is facing complex challenges: a pandemic like COVID-19, zoonoses (e.g. Q fever and SARS) and the effects of climate change. But there are also the major health differences, worldwide and between people with low and high incomes.
New technological developments in agriculture and medical care raise recurring questions. Should these technologies be allowed? Who decides that? Should scientists be held accountable by society for these matters? How can we make collective care for health, nature and the environment a matter of extreme urgency? How can we continue to focus on the perceived "values" of life, which are decided not only by health, but also by happiness, well-being and security, for example?

We have extensive experience in analysing bioethical issues and identifying the perspectives and interests involved. Over the coming years we intend to use this expertise in debates on current issues. We assist others to conduct dialogues in an inclusive manner. In this way, we help create more sustainable agricultural systems and a future-proof health care system. We work with patient associations, the Health Council of the Netherlands, the Ministry of Health, Welfare and Sport and the Ministry of Agriculture, Nature and Fisheries. We also take a close look at international differences. Countries think differently about ethical, social and legal issues in bioethics. The race to find a COVID-19 vaccine demonstrates the strengths and weaknesses in the way science and medical technology development are organised internationally.

Individual perfection for birth, body and long life

Medical technology developments for perfection and longer, healthier lives continue apace. Without exception, these technologies have a considerable impact on society. The Rathenau Instituut continues to engage in dialogue with stakeholders. We use research to study ways of shaping this technology while taking account of social values.

Pregnancy and birth

We intend to work with scientists and civil society representatives in various consortia over the next two years. We will investigate social attitudes towards the development of reproductive cells from skin cells and the creation of embryos from them, which is consistent with our long-standing line of research into citizens' opinions on embryo research. We will also be looking into cooperation for research and dialogue on the social acceptance of the artificial uterus.

We will examine how the culture of pregnancy and women's autonomy is changing as a result of the commercial provision of genetic carrier screening and "femtech" (e.g. ovulation tests and "social freezing" of eggs).

Regenerative medicine

Through research and dialogue, we will lay down the legal and moral frameworks for the socially responsible use of regenerative medicine, including gene therapy and brain-computer interfaces. The Rathenau Instituut is bringing together a group of parties in the Netherlands to conduct a social dialogue on "growing organs in animals". After all, technologies that combine human and animal material into a "human-animal hybrid" promise to offer a long-term solution to the shortage of human donor organs. In this case, we will be using our experience gained over the past two years, in which we have conducted a wide-ranging social dialogue with a national consortium of partners on adapting the hereditary DNA of embryos.

Digital healthcare

"Smart healthcare" (eHealth, robots, lifestyle apps, AI decision-making tools) has penetrated all areas of our healthcare system. The Dutch government gave an app a prominent role in finding a way out of the coronavirus crisis. We know from previous research that digitalisation in healthcare has consequences for our autonomy, privacy and the balance of power between government, tech companies and individuals, i.e. patients or clients.

Smart healthcare is more than data

Over the next two years, we will be investigating the consequences of "smart healthcare" for the responsibilities of healthcare professionals, informal carers and technology developers.

An important question raised by digitalisation in healthcare is whether we are able to make sufficient use of informal and social knowledge about what constitutes good care. This knowledge is not so easy to capture in data. We will once again give a voice to medical and ethical experts as well as patients, professionals, older people and young people. What do they say they need for good digital healthcare?

We will also focus on ways of achieving a good quality of life into old age. It is essential to determine how government, science and industry can work together to ensure that this becomes achievable for more Dutch people than is currently the case.

Better protection of health data

We will continue to follow closely the developments in personalisation of lifestyles, for example through DNA profiles and biometrics. We will be focusing in particular on national and international legislation and whether it is up to date. How do I stay in control of my digital body? We will be offering governments and businesses options for actions to be taken to steer these innovations in the right direction.

Which public values and specific interests does this involve? There is a lot of money to be made in digital health technology. Digitalisation means that big tech companies are gaining a dominant position in value chains, such as those of digital health data. DNA research in particular is booming. And knowledge of all this data is taking on geopolitical significance. Global agreements are needed, both to protect individuals and to safeguard collective values and the rights of future generations. To this end, we are collaborating with sister institutes worldwide, scientists and UN bodies, such as the IBC, UNESCO's International Bioethics Committee.

Growing up healthy in a digital world

The impact of digitalisation on the mental development (cognitive and social) of children and young people is our specific focus. What do they themselves think about the responsible use of immersive technology, such as virtual reality, augmented reality or speech technology? What do education and healthcare professionals think about this? Through research and dialogue, we will set out the social consequences of the digital society for children and young people. For example, what do they need in terms of prevention and training?

Sustainable agriculture and food production

The Netherlands can lead the way in the transition to a sustainable agri-food system that prevents further loss of in biodiversity. The European and global context of science, legislation and trade in data is the determining factor in this regard. Researchers, tech companies, farmers, the food industry and consumers will each play their part in the transition to a sustainable agri-food system. Scientific knowledge can help to provide a better understanding of the limits and make food production systems more sustainable. At the same time, agriculture and climate policy must not lead to an unwanted or unintended technologisation of our agriculture.

Technology as a solution for sustainable agriculture and food production

The Rathenau Instituut has previously investigated the role of digitalisation and genetic engineering as solutions to the issues facing agriculture. We will continue to focus on the rapid developments in this area. For example, intensive agricultural technologies can provide food for a specific group in the short term. But, in the long term, these technologies will run up against planetary boundaries. We will continue to explore how we as a society can make the transition to sustainable agriculture and food production through technology.

Interest in and barriers to sustainable agriculture and food production

What are the interests and barriers in the "protein transition": the transition from animal to plant-based food? Is cultured meat a realistic option? How do we prevent zoonoses? Is circular agriculture the solution? Important questions for the Netherlands with its strong agricultural sector. Socially innovative concepts such as urban agriculture and local food production systems will be examined in connection with theme 4 ("Robust Science and Knowledge Ecosystems").

Building on our knowledge from the ammonia dialogues and the Potarei potato seed project, we will explore social aspects of the transition to a sustainable agri-food system. In dialogue with stakeholders, we are investigating ways of accelerating the agricultural transition on the basis of social values.

In the area of food production, we support democratic decision-making on climate and agricultural policy by undertaking research and dialogue with all the parties involved: "bio", farmers, industry and the public. Where necessary, we will develop new frameworks within which necessary transitions, such as the protein transition or the energy transition, can be achieved, such as in the European RECIPES project on risk assessment and legislation and regulations governing new technology. In this way we will be contributing, together with key stakeholders nationally and internationally, to the political and public debate on sustainable agriculture and food production.

3 Democratic information society

Acting Mayor Lokkers of Zoetermeer chairing an online council meeting due to the coronavirus crisis. Photograph: Frank de Roo/ANP

The Rathenau Instituut has been researching the role of knowledge in political decision-making and policy since the 1980s, and also has a great deal of experience in conducting social dialogue on disputed issues. This always involves more than scientific and technical insights; interests and values also play a role. Digital tools can engage the public in political decision-making. At the same time, the dominance of technology companies supplying these tools also poses a threat to democracy.

Democratic information society

The theme "Democratic Information Society" covers three key questions over the coming years:

1) **How can everyone participate in the technological society?**
2) **How can knowledge for policy lead to trusted and informed political decision-making?**
3) **How can democratic control over technology be strengthened?**

Trust in science, the media and democracy is relatively high in the Netherlands compared to other countries. The high degree of digitalisation of our society brings with it opportunities to reinforce this trust. At the same time, we are seeing the growing influence of the international information conflict, where geopolitical power blocs try to influence democratic processes. Targeted disinformation can fuel polarisation. The public debates surrounding the coronavirus crisis and climate change are prime examples of this. On the one hand, digital media are a source of information, leaving scope for a wide range of opinions. On the other hand, extreme opinions are more easily heard thanks to algorithms.

The current societal challenges show how important it is for research institutes to contribute to a trusted stock of knowledge which is needed to improve policy. And for them to make use of the knowledge and judgement of citizens and civil society organisations in research into societal challenges.

The interplay of shifts in geopolitical balances of power, the influence of information on society and the changing relationships between private tech companies and public actors require political responses. Our national security, prosperity and democracy are at stake. The public debate and the self-organising capacity of society need to be protected.

Over the coming years, we will be fuelling the debate with new research. What responsibilities and opportunities do different groups of individuals, government, science and industry have for strengthening democracy in the information society?

New research and dialogue

To explore the theme of "Democratic Information Society" we will be contributing to the following topics with new research and debate over the next two years.

Participating in the technological society

Being able to participate in a society permeated by technology is not something to be taken for granted. In recent years, we have observed that technological developments have given individuals more opportunities to acquire information and knowledge, but also that automated decision making, algorithms and AI are undermining individuals' critical ability to choose and direct their own lives.

Technological citizenship

Dutch people are digitally literate. However, our research in recent years has once again shown that it is not easy for everyone to participate online. What is more, all people, young and old alike, are running up against the limits of their individual abilities – no matter how media-savvy or technologically skilled they are. Over the coming years, we will further develop the concept of "technological citizenship". Much more is required than education alone. People need to be aware of how science and technology work. And they should be able to have their say about it. This is not just about educational level or age. Higher educated and younger people also lack the skills and alertness to come to grips with the high-tech society, such as being able to recognise fake news or protect one's own cyber security. We will explore technological citizenship and ways of representing society, to put the interests of all under the spotlight.

Trust in science and society

Every two years, the Rathenau Instituut conducts research that looks into trust in social institutions such as government, science, the media and public administration. We will be doing so again over the coming years. What factors influence people's trust in social institutions, in particular when controversial issues are at stake? We will expand these studies by forming focus groups comprised of people with different levels of education and backgrounds. We will come up with ideas about ways of strengthening society's engagement with science and vice versa.

Digital engagement with democracy

Digital technology enables people to engage in a much more intensive dialogue with each other and with government. This can strengthen the quality of democracy and support for it, if used properly. In recent years, we have been working on researching ways of strengthening democracy by digital means. We did so together with municipal councillors, as well as the Lower House of the Dutch Parliament, the European Commission and the European Parliament. We also studied practices in other countries. To this end we cooperated with our international sister organisations.

Over the coming years, we will continue to expand this line of research. We shall share our results with partners working at various levels of government. In particular, we shall explore what can be learned from recent experiences about involving individuals in democratic decision-making during a pandemic like the coronavirus crisis.

Trustworthy knowledge for policy and political decision-making

The relationship between knowledge and politics

Knowledge for policy is derived from numerous sources, including institutional memory, the in-house development of knowledge by ministries and politicians and the research of public and private research outlays. The stock of knowledge is growing, partly due to information from digital data. The changing role of government, the decentralisation of tasks, the desire to involve the public in government and the large amount of digital data raise questions about knowledge management. How can we ensure that all relevant knowledge is used in policy development in the right way? How do we make sure that normative issues and interests are balanced in a transparent manner? To what extent is policy development "technocratic"? When do politicians need to clarify choices and take responsibility? Over the coming years, we will be using our expertise to assist policymakers at various levels of government by providing course material, workshops and publications. At the same time, we want to learn from current cases about these developments. After the pandemic, we will evaluate experiences with partners, including by means of international comparisons.

Risks and uncertainty in the short and long term

The interests of future generations need to be considered in debates on a number of tricky issues, where long-term risks are uncertain. Examples include the disposal of radioactive waste or the safety of biotechnology.

It is precisely in these debates that both values and scientific results are often contested. This sometimes leads to juridification, rather than recognition of uncertainty, opening up the dialogue or inclusion of more stakeholders. Over the coming years, we intend to focus systematically on ways of considering the interests of future generations in decision-making.

We have already started projects on procedural equity in decision-making on radioactive waste and, in order to be able to make recommendations, we will be organising several research and dialogue projects. We will involve actors from society, government, industry and science. We are charting how the Netherlands and other European countries deal with radioactive waste and how they structure decision-making processes accordingly. To explore possible routes for decision-making about radioactive waste, we will be looking at the history of this issue, technical options and funding. We will also be considering principles such as "the polluter pays", the current legal frameworks, the functioning of the knowledge ecosystem with regard to radioactive waste and ways of involving society.

Over the coming years, we will also be working with a large number of European partners on current interpretations of the "precautionary principle" in the RECIPES project. As part of the T-TRIPP programme, we work with policymakers and researchers to ensure the safety of modern biotechnology. Over the coming years we will organise a Future Panel around the development of the synthetic cell and the significance of this technology for our thinking about creating "life" in future.

Contested science

We will contribute to public debates on a wide range of ongoing issues, where the role of science and knowledge is contested, such as in the case of ammonia emissions or climate change. Political decision-making requires careful consideration of risks and opportunities, focusing on who pays the bill and who benefits. It often concerns issues that require a great deal of scientific knowledge and specialist expertise, while at the same time there is great uncertainty and the risks to society are unevenly distributed. Experts will not be trusted if insufficient attention is paid to everyone's interests and to shared principles.

Decision-making then becomes difficult and the debate moves to other forums. The Rathenau Instituut has developed a number of methods for conducting dialogue to gain an insight into the decision-making mechanisms surrounding contested science.

Democratic control of technology

Society depends on technology for well-being and prosperity. A number of private parties supplying this technology have become global superpowers. They do not automatically serve public interests. Public and political support is growing for regulation to protect competition in the market and safeguard human rights and public values. Ways to solve this regulatory issue are fiercely debated. What is the desired division of responsibilities between public and private actors? What conditions will ensure that industry operates more in the public interest? Where should intervention take place, at what level, and what measures are effective? These questions also have a major geopolitical dimension. In particular, the US, China and the EU are increasingly competing openly for power over science and technology. After decades of moving towards open markets and more cooperation, Europe now strives for more strategic autonomy and digital sovereignty.

Political control of technology

Over the coming years, we will be supporting our own parliament and other decision-making forums. We are working with our sister organisations to think about ways of exerting democratic control over these developments. It involves understanding public and private actors, such as state actors, tech giants and online platforms. To allow governments to exert control over technology, it is necessary for industry to be accountable and transparent with regard to automated data processing and decision-making, as used in social media and by public authorities and executive agencies. We will therefore be monitoring national and international agreements and supervision of private parties and public authorities, the safeguarding of public values and the public interest.

Social responsibility of technology companies

What is the social responsibility of big tech companies? We support the social dialogue on the desired relations between government, industry and users. We are particularly involved in the debate about the dynamics of social media use and its effects on polarisation in the Netherlands, but also about the data of internet users and the influencing of their behaviour by algorithms. Dialogue is needed on the desirability of this influence. What type of data use do we consider to be permissible and what constitutes undesirable manipulation or surveillance? Important issues in the near future will be the EU proposals for a Digital Service Act Package and how these proposals relate to directives concerning corporate social responsibility. Can EU measures really address the problems? To contribute to these debates, we are conducting research into the revenue models of online platforms and social media and into harmful developments in society, including disinformation, cyberbullying, polarisation, poor working conditions and unfair competition. Do these revenue models and algorithms harm society?

4 Robust science and knowledge ecosystems

Launch of TU Delft Solar Boat.
Photograph: Bart Maat/ANP

Our society needs knowledge, knowledge developed by various organisations and experts, including the knowledge required to innovate or to underpin political choices. In recent years we have been able to sketch a better picture of the public knowledge infrastructure, including universities, universities of applied sciences, research institutes of the Royal Netherlands Academy of Arts and Sciences and the Netherlands Organisation for Scientific Research, TO2 institutes and public knowledge institutes, as well as their partners such as companies and municipalities. We introduced the concept of “knowledge ecosystems”. This concept indicates that knowledge for the present and the future is the result of dynamic interaction.

Robust science and knowledge ecosystems

As part of the theme of "Robust Science and Knowledge Ecosystems" we will be finding the answers to four key questions over the coming years:

1) **How can we use our innovative power to tackle societal challenges?**
2) **What shape should international cooperation take in times of geopolitical tension?**
3) **How do we ensure that science is inclusive?**
4) **How does differentiation and balance arise in science?**

Science and society are changing. Coronavirus exposes the extent to which we expect knowledge to contribute to societal challenges. And how important it is for knowledge organisations to collaborate with government and industry, while safeguarding their independence. Major challenges such as climate change and loss of biodiversity require long-term research agendas in which many parties cooperate and adjustments can be made in the interim. And where, in addition to fundamental knowledge, specific knowledge for the setting of societal challenges is developed.

While society has high expectations of science, it also appears that science and technology have strategic significance in light of geopolitics and the dominant positions of China and the US. Geopolitics affects the way we work with partners at home and abroad. Partly as a result of rapid digitalisation, society is changing socially and economically. The humanities and social sciences in the Netherlands are in the international top 5. They help us to understand mechanisms of inclusion and exclusion and to shape changes in the welfare state and society. But the question of diversity and inclusion is also topical within science itself. Who shares in the benefits of science? Who helps shape the development of science? Over the coming years, we will be working on research and dialogue to answer the above questions.

New research and dialogue

As part of the theme of "Robust Science and Knowledge Ecosystems" we will be working on the following subjects with new research and debate over the next two years.

Mobilising the power of innovation to meet societal challenges

How can science and innovation be better mobilised to meet the major societal challenges of our time, such as adapting to and combating climate change? This was a recurring question in our consultations for this work programme.

This question is also prompted by changing views on the role of government in guiding, mobilising and funding science and innovation. Society expects a more active and guiding role from government to ensure that public investment in research leads to knowledge and innovations in the service of sustainable development.

Mission-driven research

"Mission-driven" research is emerging in science and innovation policy, not only in the Netherlands but also internationally. We previously conducted research into the implications of a mission-driven approach for scientific research programming. We are now broadening our view. After all, linking a societal "mission" to science and innovation is just one of the ways in which society can use research to meet societal challenges. We will join forces with partners from the knowledge and policy communities, to develop tools that enhance the government's steering skills. We will be focusing on the government's ability to learn ways of upscaling small-scale experiments and a new intervention logic in policy: can a societal challenge be regarded not only as an economic opportunity for industry but also as an opportunity for social transitions? The government is part of the ecosystems for research and innovation, while being accountable as a public sector actor.

Innovation policy for regions and cities

Because societal challenges transcend policy domains and tiers of government, research and innovation for the benefit of these societal challenges are associated with coordination challenges, both between policy domains and between tiers of government. We can learn from the City Deals and Regional Deals, for example. We will be focusing on how to make better use of the innovative power of regions and cities. Innovations designed to meet societal challenges must be developed and implemented at local or regional level, while coherence between innovation and innovation policies is needed in regions and cities as well as at national level.

Evaluation and impact of innovation

New knowledge is needed if research and innovation policies are to meet society's expectations. We want to contribute to this. We will monitor the dynamics of ecosystems for research and innovation and use insights from "meta-science" (the way sciences can learn from each other about sharing knowledge). Methods for evaluating research and innovation policies must be updated. We will draw inspiration from the world of development cooperation. In this world, the question of the impact on society is key and there is a lot of experience of evaluation based on theory of change and impact narratives.

International cooperation under pressure
Changing geopolitical relations have serious implications for science and innovation. In recent years, our studies have shown that civil-military and public-private partnerships are blurring the boundaries. Civilian technology can be used for military purposes, for example. We also set out the extent of international and public-private cooperation in the Netherlands. This is relatively large compared with other countries, involving desirable and undesirable influences on research. Over the next two years we intend to answer a number of follow-up questions. To this end, we will track the developments in international and public-private cooperation in the Netherlands, under the influence of the shifting geopolitical relations and international and national policy.

Strategic European partnership
We want to gain an insight into how the Netherlands can relate to European science and innovation policy. How can the Netherlands regard Europe as more than an additional funding programme? How can the Netherlands develop strategic research policy for collaboration within a European Research Area? We will also monitor the effects of the new European framework programme on the position, collaboration and results of Dutch research organisations.

Intellectual property of knowledge and technology
We will examine how intellectual property regulations are interpreted and applied in the case of new technologies such as artificial intelligence, nanotechnology and biotechnology. What role does intellectual property play in international (power) relations? How can new agreements lead to fair and equitable distribution of the benefits of technology? How can a balance be struck between the benefits for innovation developers and the benefits for society?

Frameworks for international cooperation
Together with partners in the field, we intend to develop frameworks within which Dutch researchers and knowledge institutions can collaborate with international partners from the public and private sectors. In doing so, we will focus on the role of government as the party responsible for the science system in science and innovation policy.

Inclusive science
The input of various groups in society is necessary if science and innovation are to help find solutions for societal challenges, both to define the scientific challenges from various perspectives and to implement the approach. Diversity in science is also necessary to be able to train and use all the available talent.

Diversity in science
In recent years we have studied the position of men and women in science. We also examined the international mobility of researchers. We revealed that in the Netherlands the proportion of women engaged in research has lagged behind in industry and in senior posts (professors, senior lecturers, board members) at public research organisations in recent years, including when compared to other countries. The international mobility of researchers in the Netherlands is high and contributes to the scientific quality of publications. Over the next few years we will provide more details of employment and progression within science of men and women, students and employees with a (non-Western) migration background. We will do this as part of the monitoring of the National Action Plan on Diversity. We will be focusing in particular on the development of women and men in science at different job levels and in different fields of science, as well as the intake and through-flow of women and men, with and without a non-Western migration background, within various knowledge organisations. We also focus on engaging a diverse group of individuals in science, both well educated and less educated.

Open science

Our mission is to make science "open" to society. This is not just about access to results but also about how the ideas, views and interests of the public, civil society organisations and practitioners can be better involved in research. How can they play a structural role in knowledge ecosystems and their management in facing up to societal challenges? And how can we ensure - in the current geopolitical situation - that data, research results and facilities are shared responsibly between researchers and with public and private sector organisations? How has the openness of science in the Netherlands developed in recent years in comparison with other countries? These are the questions we will be focusing on over the next two years.

International cooperation

Over the coming years, we will work closely with our international partners, with the European Commission and the OECD, the national UNESCO Committee and UNESCO in Paris. We will be working on open science and other ways of promoting equity in science, taking account of non-Western knowledge and cooperation with the "global South". The coronavirus crisis has once again highlighted the need to share knowledge - in this case with regard to viruses and vaccines - in order to achieve a rapid response and lasting solutions to societal issues that do not respect borders.

Balancing science

Dutch science policy has three objectives: world-class science, seedbed for talent and impact on society. In addition to providing scope for independent and untethered research, this requires responsive scientific institutions. Institutions with a higher education mission and other knowledge institutions together constitute a diverse public knowledge infrastructure. In recent years we have seen that Dutch science performs well in the international arena, especially given the funding it receives from public and private sources. Trust in science is high, but so are society's expectations. Closer attention and therefore sufficient resources will be required to guarantee the independence of science. We have identified new research practices, such as living labs and public-public cooperation. These research practices need to be valued in a different way than is currently the case in science, to ensure that the knowledge gained will be useful to society.

State of Dutch science

Over the coming years, we will continue to monitor developments in various respects, such as money, personnel, cooperation, output and impact. Where possible, we will do so by making comparisons with other countries. We will again be monitoring the extent to which Dutch people's trust in science is affected. Could the coronavirus crisis have perpetuated that trust? We will present an overview of developments at universities of applied sciences - developments in policy and in applied research. We will be paying particular attention to the position of public knowledge organisations, also as a result of the coronavirus crisis.

The Rathenau Instituut's role is to provide information on and for science policy. We provide long-term and independent monitoring of developments in Dutch science, based on data concerning funding flows, researchers, research collaborations, output and impact. This also includes providing an insight into policy and the organisation and governance of science. We indicate long-term trends and make international comparisons. We systematically chart developments at knowledge organisations and in Dutch science.

Taking stock of science

How do we retain enough scope for "independent" research? What knowledge and innovation policy is needed to achieve this? What new roles do experts and knowledge organisations play in the knowledge and innovation agendas of industry and the public sector? Our studies have shown that more differentiation is needed in the structure, management and funding of the public knowledge infrastructure. This differentiation is needed to ensure that different types of knowledge institutions can better contribute to knowledge and innovations for society based on their own specific roles.

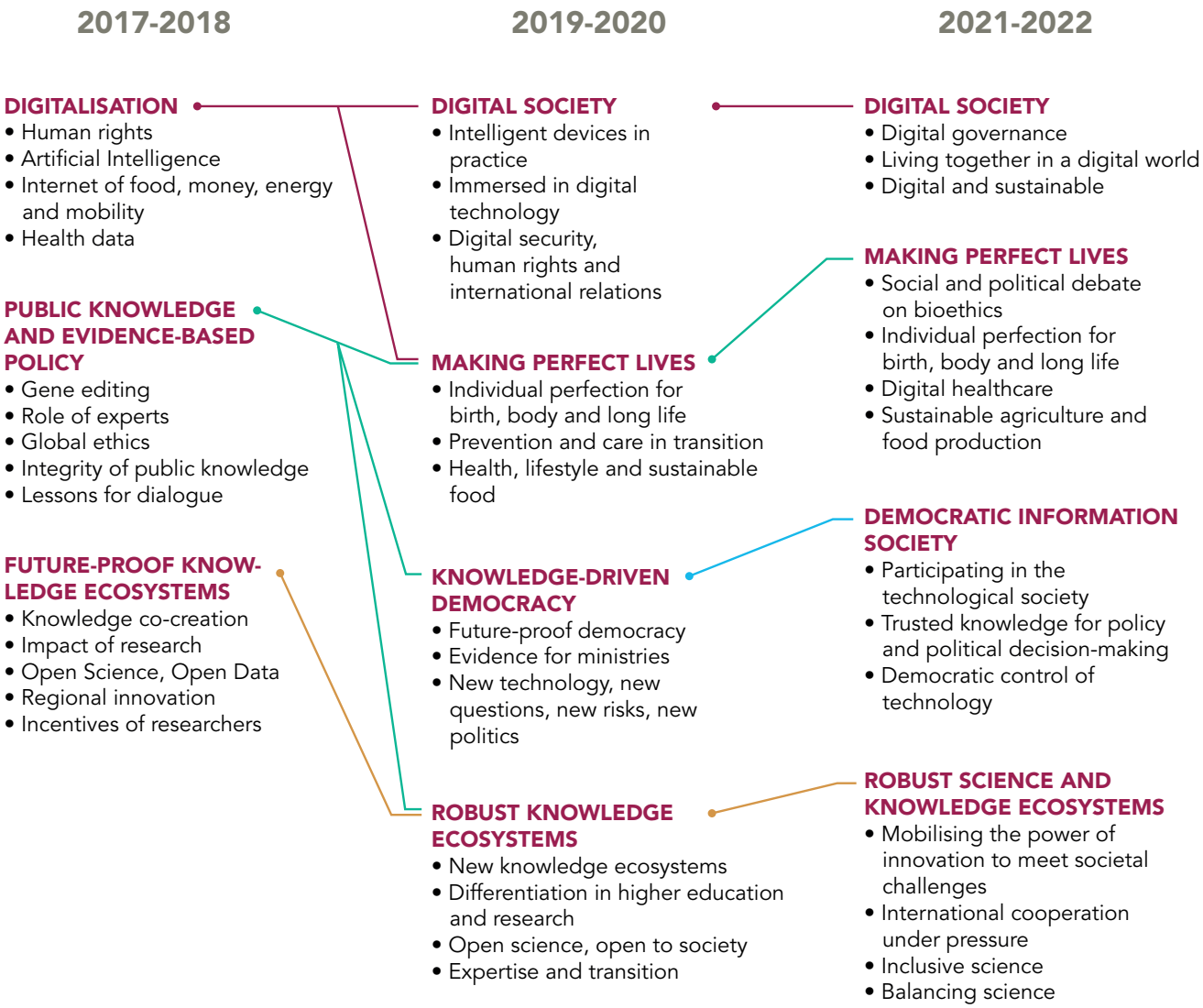
We will focus in particular on the interaction between education, research and impact within universities and colleges, for example the knowledge that has to be created across the boundaries of disciplines or so-called matching pressure, as a new form of co-creative education and research practice. Another example is differentiation in the management and funding of scientific education, research and innovation by the Dutch government. We will also call attention to possible shifts in scientific research funding as a result of COVID-19 in upcoming editions of Total Investment in Research and Innovation (TWIN). With our research, for example into the motivation of researchers, we will bring differentiation in talent and career development and evaluation of research back into focus.

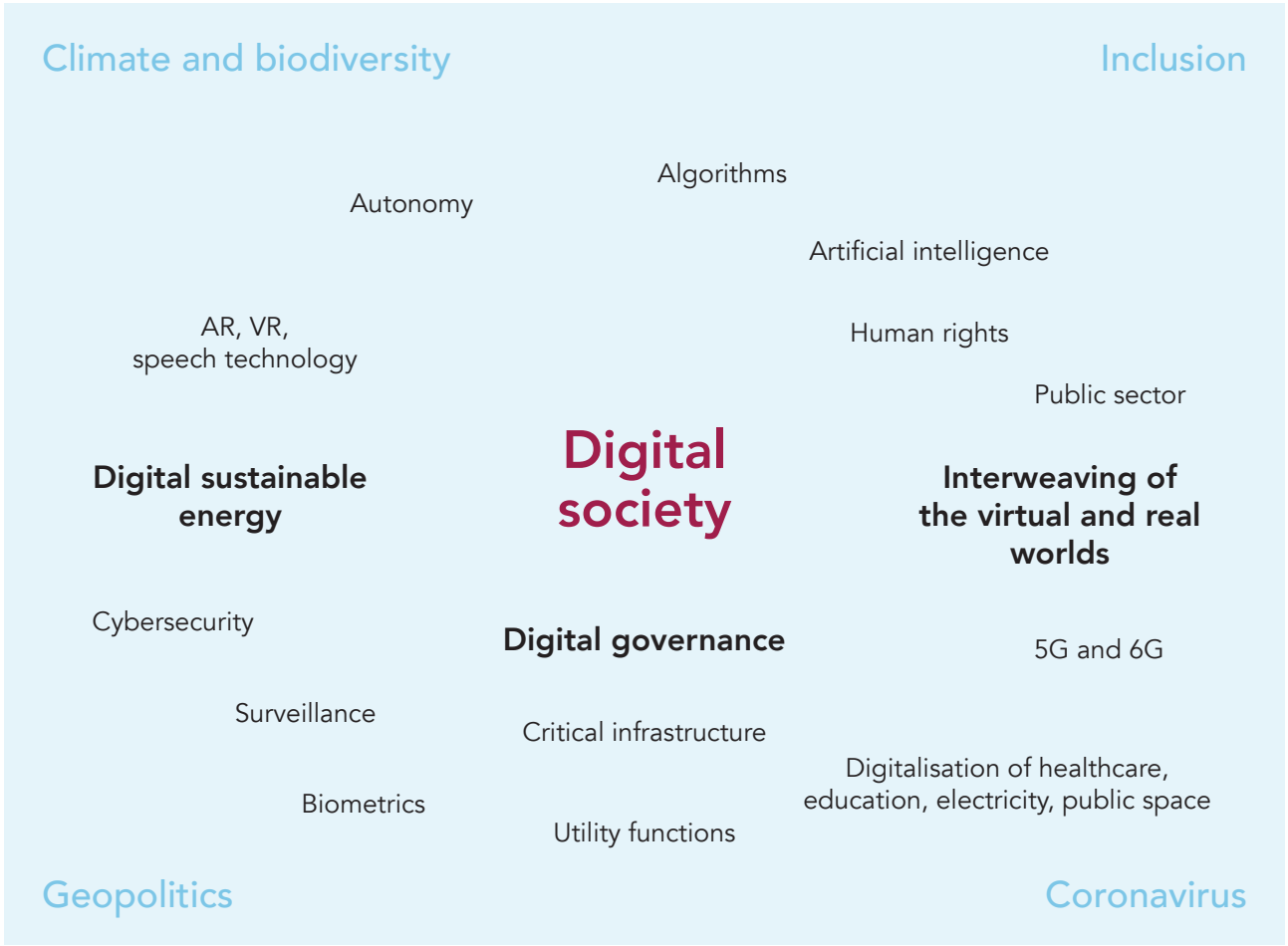
Part 3
Appendices

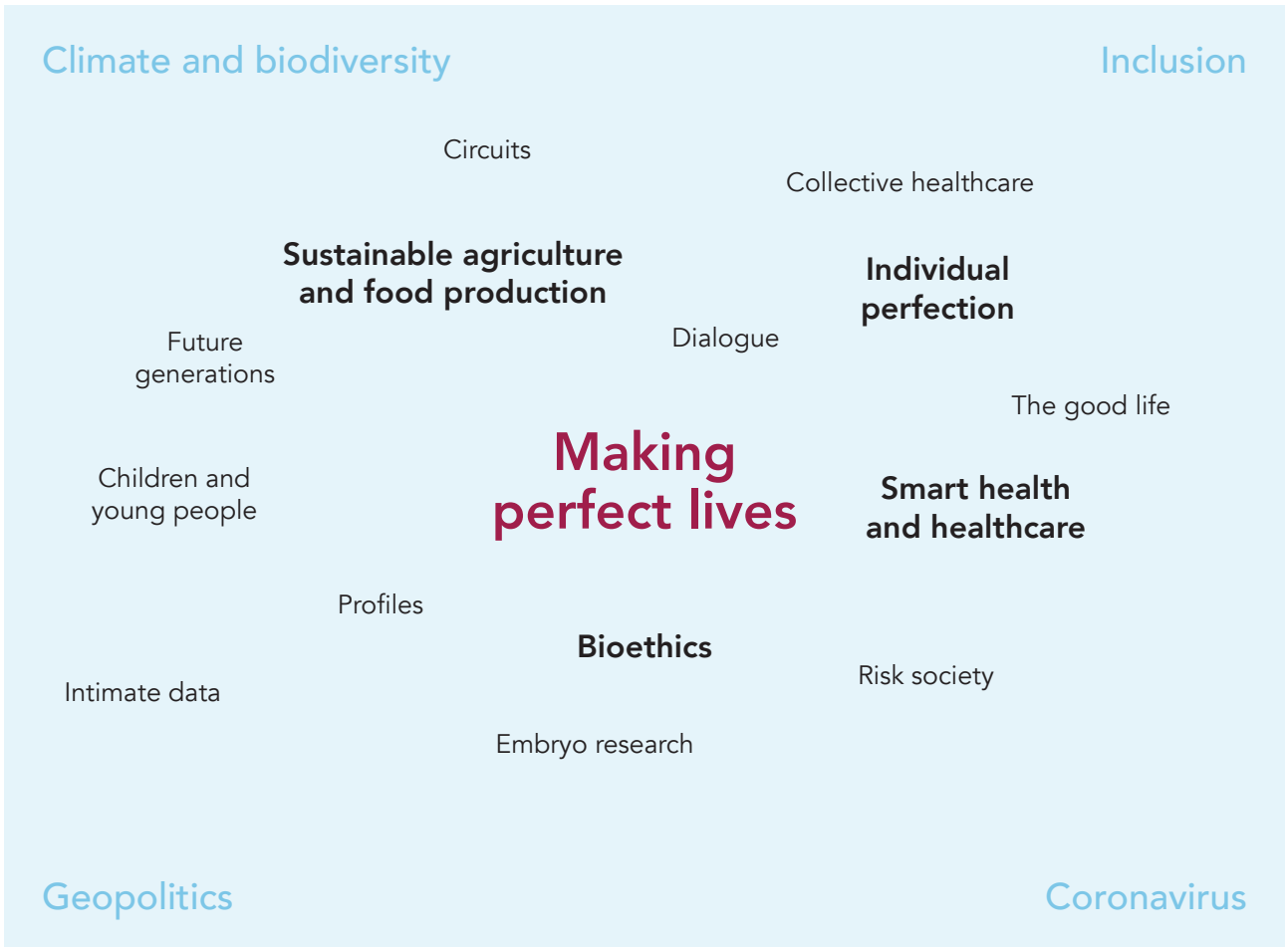
This part shows how the work programme builds on the previous work programmes and what the relevant topics and developments are within the themes. We also provide details of who is on the Board and on the Programme Panel.

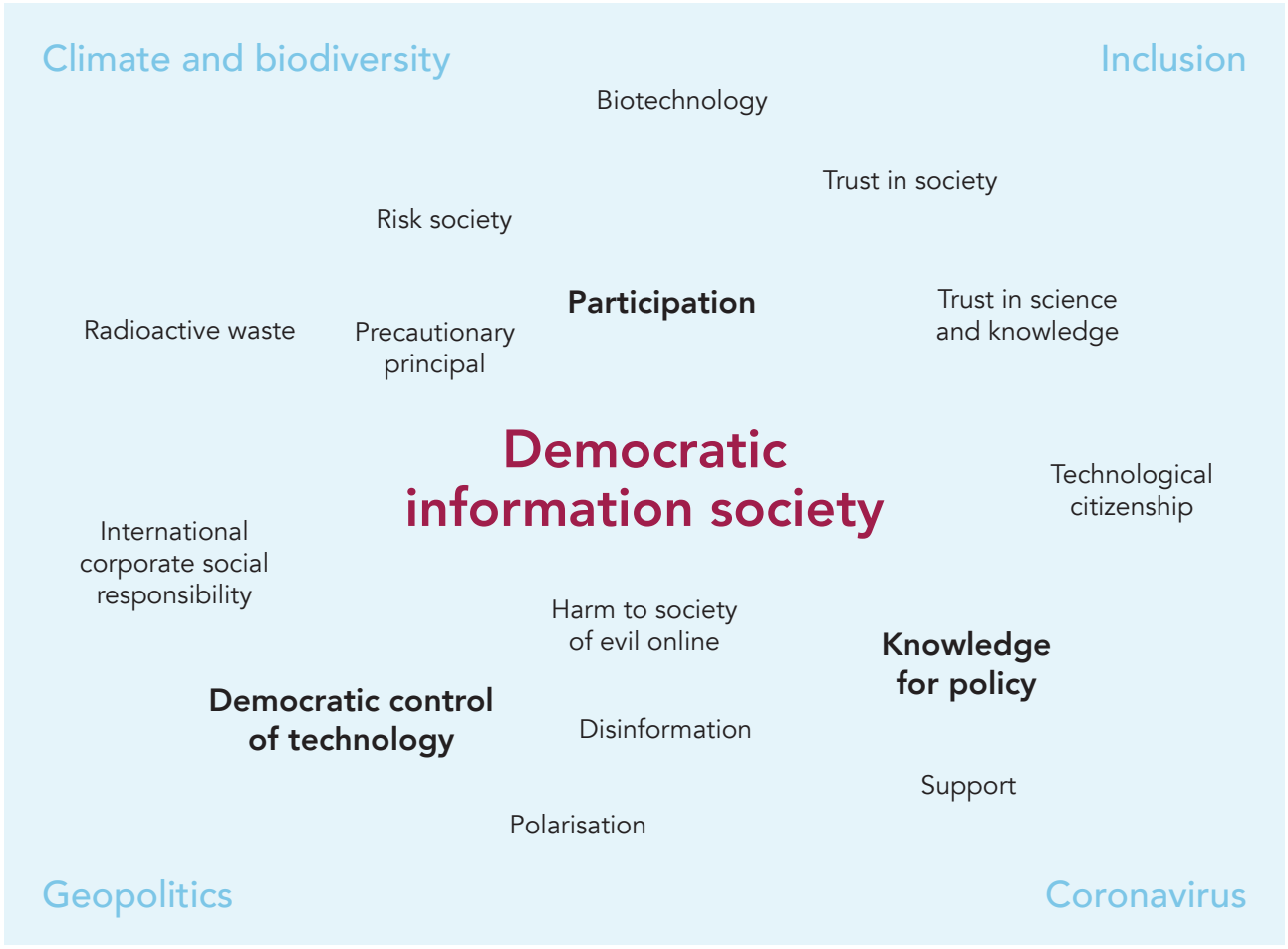
Visitors taste different types of lettuce and herbs at Urban Farmers, a company that grows vegetables and breeds fish in a reused office building in The Hague. Photograph: Joost Bataille/ANP

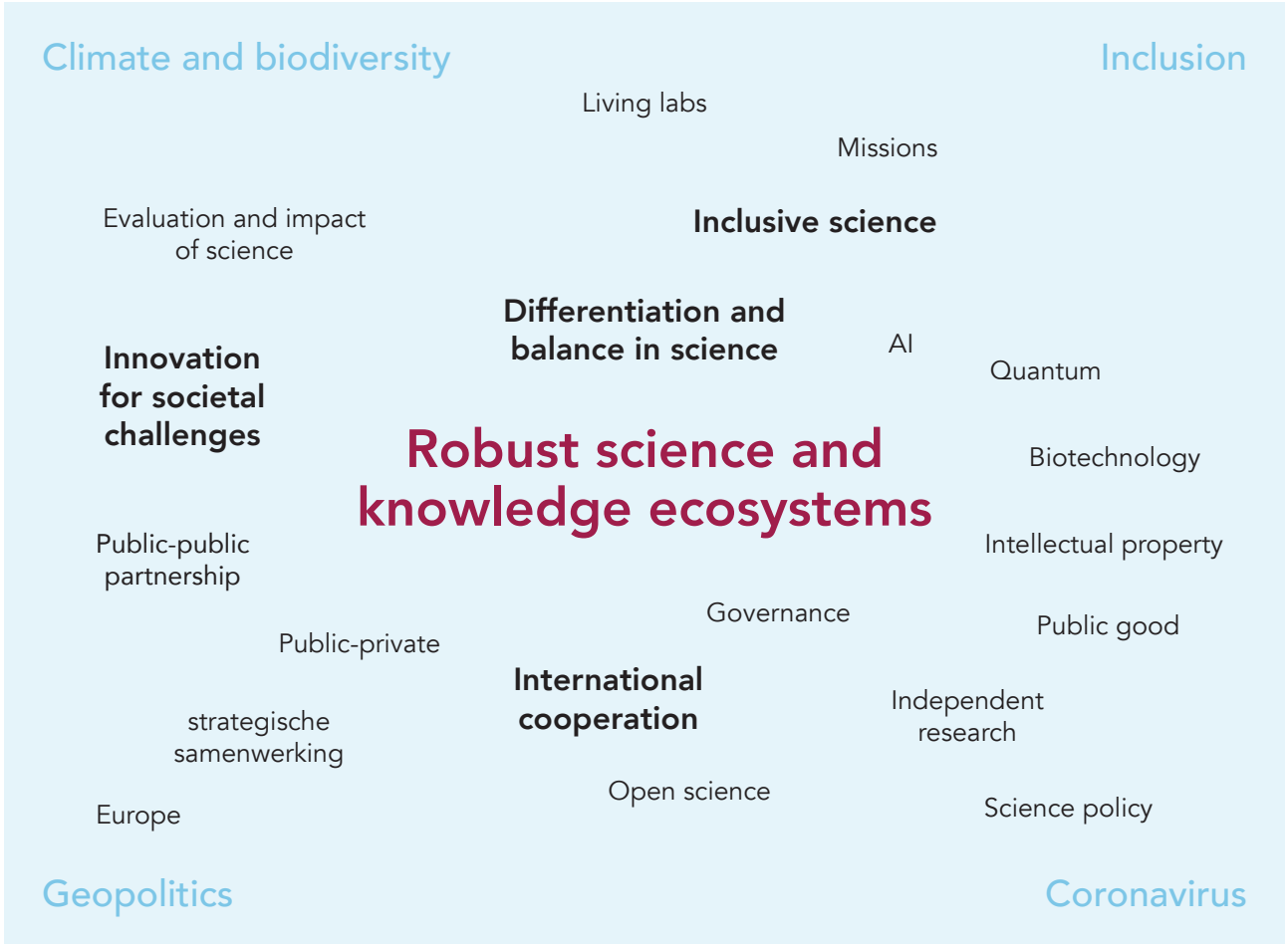
Relationship to previous work programmes




Climate and biodiversity
Inclusion
Algorithms
Autonomy
Artificial intelligence
AR, VR,
speech technology
Human rights
Public sector
Digital sustainable energy
Digital society
Interweaving of the virtual and real worlds
Cybersecurity
Digital governance
5G and 6G
Surveillance
Critical infrastructure
Digitalisation of healthcare, education, electricity, public space
Biometrics
Utility functions
Geopolitics
Coronavirus


Climate and biodiversity
Inclusion
Circuits
Collective healthcare
Sustainable agriculture and food production
Individual perfection
Future generations
Dialogue
The good life
Making perfect lives
Children and young people
Smart health and healthcare
Profiles
Bioethics
Risk society
Intimate data
Embryo research
Geopolitics
Coronavirus


Climate and biodiversity
Inclusion
Biotechnology
Trust in society
Risk society
Participation
Trust in science and knowledge
Radioactive waste
Precautionary principal
Democratic information society
Technological citizenship
International corporate social responsibility
Harm to society of evil online
Knowledge for policy
Democratic control of technology
Disinformation
Support
Polarisation
Geopolitics
Coronavirus


Climate and biodiversity
Inclusion
Living labs
Missions
Evaluation and impact of science
Inclusive science
Differentiation and balance in science
AI
Quantum
Innovation for societal challenges
Robust science and knowledge ecosystems
Biotechnology
Public-public partnership
Intellectual property
Governance
Public good
Public-private
International cooperation
Independent research
strategische samenwerking
Open science
Science policy
Europe
Geopolitics
Coronavirus

Board

The following individuals are members of the Rathenau Instituut Board:

Gerdi Verbeet (chair)

Gerdi Verbeet chairs the National 4 and 5 May Committee and is a supervisory director of charity organisation Novamedia.
Gerdi Verbeet (b. 1951) was president of the Dutch House of Representatives from 2006 to 2012. She now uses the experience she gained in national politics for the benefit of other organisations. Verbeet was a political advisor from 1996 to 2001 and and a member of the House of Representatives from 2001 to 2006, where she focused on sport, elderly policy and the national old-age pension. She chaired the Standing Parliamentary Committee for Justice and the Thematic Committee on Elderly Policy. She was elected president of the House of Representatives in 2006, only the second woman to hold this post. After two terms in the House (2006-2012), she took on a range of new roles, some of then board positions, including the chair of the Board of the Rathenau Instituut. Verbeet also chairs the Supervisory Board of Novamedia and is a supervisory director at Siemens and Unilever. On 1 June 2015, she was appointed chairperson of the National 4 and 5 May Committee.

Prof. M.N.C. Aarts

Noelle Aarts is director of the Institute for Science in Society (ISiS) at Radboud University.
Noelle Aarts (b. 1957) studied biology and cultural anthropology and obtained her PhD at Wageningen University in 1998 with a thesis on the communication between the government and farmers on controversial nature-related issues and nature policy in the Netherlands. Before being appointed Professor of Socio-Ecological Interactions at Radboud University in 2017, she was Professor of Communication and Change in Life Science Contexts at Wageningen University. She also holds a special chair in Strategic Communication at the University of Amsterdam. Noelle Aarts conducts research into the meaning of everyday conversations in complex processes of change around nature, human-animal relationships and land use.

Drs. Felix Cohen

Felix Cohen chairs the supervisory board of Regina Coeli.
During his career, Felix Cohen has held numerous management positions. He has always worked at the intersection between new technology and "ordinary people". He currently works as an energy coach, in which role, he advises consumers on energy saving. He also chairs the central board of clients of a health facility in The Hague and writes a blog on sailing and politics. During his career as a manager, Cohen has overseen change processes and reorganisations for numerous organisations He worked as a marketing manager for Philips Information Systems. As general manager of the Dutch consumers' association, he was committed to the development of the largest payment site in the Netherlands, with 80,000 paying members.

Dr Hans Dröge

Hans Dröge is a supervisory director for the Brabant Development Agency and the Dutch General Employers' Association.
Hans Dröge (b. 1956) worked at Unilever Netherlands until the end of 2013. He currently advises organisations, start-ups and other firms on technology, innovation and sustainability. Dröge is also a supervisory director for the Brabant Development Agency. He studied pharmacology. After graduating, Dröge began his career at the Unilever Research Laboratory, held various supply-chain positions and returned to R&D in 2009. He was responsible for Unilever's global R&D infrastructure and the operationalisation of its current R&D strategy. He was also in charge of Unilever's external relations with politicians, government and industry in the Netherlands.

Dr L.P.J.M. Guérin

Laurence Guérin is "lector" in World Citizenship at The Hague University of Applied Sciences and "practor" in Citizenship Education at Twente regional community college.
Laurence Guérin (b. 1971) studied Business Administration at the Ecole Supérieur de Commerce de Rennes in France. After working for ten years in the pharmaceutical industry in Basel (CH), including as a quality manager, she studied Pedagogy at Utrecht University. She holds a PhD in Citizenship (political and pedagogical justification of citizenship education and civic didactics). She has developed and led the "Beta citizenship" project and currently leads the NRO educational research workshop "Democratisation of critical thinking" in vocational education. The focus of the research in her practice and professorship is critical civic education in the context of vocational preparation, the promotion of youth participation and the impact of technology on social questions in a deliberative democracy.

Dr J.A. Hoekstra MSc

Janneke Hoekstra has chaired the Supervisory Board of welfare organisation Rijnstad since September 2019 and has her own consultancy firm.
Janneke Hoekstra (b. 1954) has devoted her career to forging links between knowledge institutions and society. Hoekstra studied biology and statistics and began her career as a statistician, first at research organisation TNO and then at public health agency RIVM. She contributed to research in the fields of agriculture, environment and nature and public health. In 2003 she became Director of Knowledge and Innovation at the Dutch Ministry of Agriculture, Nature and Food Quality. From 2011 to 2020 she was the director of the Faculty of Technology at the Arnhem and Nijmegen University of Applied Science. While in that post, she gave boosted cooperation with industry in the field of research and education, including as co-initiator of a Centre of Expertise for sustainable and reliable energy, SEECE. She also chaired the national advisory committee of the Association of Universities of Applied Sciences for all technical higher education programmes. She likes to share her experience with others, as a strategic advisor or interim manager.

Prof. Erwin Muller

Erwin Muller has been dean of the Faculty of Governance and Global Affairs (FGGA) at Leiden University and professor of Safety, Security and Law at the same university since 1 September 2018.
Erwin Muller (b. 1965) is editor-in-chief of the Kluwer Series *Handboeken Veiligheid* and *Tekst en Commentaar Openbare Orde en Veiligheid*. He is also chair of the Supervisory Board of Lucas Education, vice-chairman of the Supervisory Board of Avans University of Applied Sciences, and a member of the Supervisory Board of GGZ Noord-Holland-Noord. Before that, Muller was vice-chairman of the Dutch Safety Board and director of research for the Institute for Criminal Law and Criminology at Leiden University. He was also the director of the COT Institute for Security and Crisis Management, a member of the Dutch Council for Public Administration, the vice-dean of the Faculty of Law at Leiden University, the director of the Netherlands Police Academy and the director of the Netherlands School of Public Administration.

R. Rawal, MA

Rajash Rawal has been a member of the Board of Governors of The Hague University of Applied Sciences since 1 September 2018.
Rajash Rawal studied Government and Policy in Europe at the University of Teesside (United Kingdom). He obtained his master's degree in European Studies (specialising in Political Science) at the University of Amsterdam. Rawal has been associated with The Hague University of Applied Sciences for 25 years. Having arrived as an exchange student, he became lecturer/researcher in the European Studies programme (then called HEBO) and his roles included head of internationalisation and programme manager. He has been the Director of the Faculty of Management and Organisation Since September 2015. Currently, he is still teaching at The Hague University of Applied Sciences: the minor in Media and Politics.

Prof. Peter-Paul Verbeek

Peter-Paul Verbeek is Professor of Philosophy of Human-Technology Relations at the University of Twente and scientific co-director of the DesignLab at the University of Twente.
Peter-Paul Verbeek (b. 1970) is also honorary professor of Techno-Anthropology at the University of Aalborg, Denmark. Moreover, he is the chair of the UNESCO World Commission for the Ethics of Science and Technology, and member of The Royal Netherlands Academy of Arts and Sciences, and the Council of Supervision of research organisation TNO, the Commission for the Freedom of Science, the council of the Socially Responsible Innovation Programme of NWO, the NWO Division for Social Sciences and Humanities and the Dutch National UNESCO Committee. His research focuses on the relationship between humans, technology and society. He has written a number of widely read books, including What Things Do, Moralizing Technology and *De grens van de mens*.

Dr Melanie Peters (secretary)

Melanie Peters is the director of the Rathenau Instituut.
Melanie Peters (b. 1965) has been director of the Rathenau Instituut since 1 February 2015. Peters has a broad background in science, business and the public sector, combined with extensive experience in the Dutch and international political and social arena. She trained as a food engineer (Wageningen University) and toxicologist and obtained her PhD in biochemistry (Imperial College, London). Peters worked as an academic researcher at the University of Texas in Austin and headed a research group at the Shell Research and Technology Centre in Amsterdam. She has held various positions at the interface of science, policy, politics and society at the Ministry of Agriculture, the Dutch Consumers' Association and as director of Studium Generale programme at the University of Utrecht.

Programme Panel

The members of our Programme Panel represent different segments of society. The panel meets several times a year, discusses new trends and developments, and advises the Rathenau Instituut on its work programme. Gerdi Verbeet, chair of the Rathenau Instituut Board, also chairs the Programme Panel. Director Melanie Peters is the panel's official secretary. The members are listed below in alphabetical order.

Annet Aris, MBA
Annet Aris teaches digital strategy at INSEAD Business School in France and is a supervisory director of a number of companies.

Marien Baerveldt
Marien Baerveldt builds innovative learning communities at Utrecht University and is a team and process supervisor at Hosted Beings.

Dr Rob Bijl
Rob Bijl is former deputy director of the Netherlands Institute for Social Research (SCP).

Kris Douma
After a long period at FNV unions, Kris Douma was a member of the Dutch House of Representatives (for the PvdA) for a number of years (2003-2006), after which he worked in the field of responsible investment at asset manager MN, the UN Principles for Responsible Investment (in London), and now at Sustainalytics. He is also a supervisory director at the insurance company NV Schade and at Oxfam Novib.

Dr Linda Duits
Linda Duits is a researcher, publicist and lecturer in Media Studies and Gender Studies at Utrecht University.

Bas Eickhout
Bas Eickhout is a member of the European Parliament representing the Greens/EFA Group and leader of the GreenLeft Europe delegation.

Bert Fokkema
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.

Yuri van Geest
Yuri van Geest is co-author of the best-seller Exponential Organisations and co-founder of De Buitenboordmotor.

Peter Giesen
Peter Giesen is foreign editor and commentator for national newspaper de Volkskrant.

Prof. Rob J. Hamer
Prof. Rob J. Hamer is former Vice-President Agrifood External Affairs at Unilever NL N.V. and associate professor of Food Chemistry at Wageningen University & Research. He is currently director/owner of Hademar Holding B.V., a company that specialises in sustainable innovation.

Rob van Hattum
Rob van Hattum is a programme maker at Tegenlicht, science editor in chief for Dutch public broadcaster VPRO and Chief Technology Officer at NEMO.

Jos de Jonge
Jos de Jonge is former coordinator of the "Facts and Figures" group at the Rathenau Instituut. His motto: "Numbers don't say everything, but the lack of them hide a lot."

Yori Kamphuis
Yori Kamphuis is the co-founder of Coblue and Storro.

Dr Annette Klinkert
Annette Klinkert founded the firm of city2science.

Laurien Koster
Laurien Koster is the independent chairperson of the Children's Rights Collective and a supervisory director at Oxfam Novib.

Chris Kuijpers
Chris Kuijpers is Director-General for Governance and Housing at the Ministry of the Interior and Kingdom Relations.

Willem Lageweg
Willem Lageweg is governor of the Transition Coalition on Food and also holds management and supervisory positions at Triodos Bank, Max Havelaar, Louis Bolk and Institute Positive Health.

Joana Gomes Neto
Joana Gomes Neto is a student member and a Master's degree student in Molecular Biology & Biotechnology at the University of Groningen.

Dr René von Schomberg
René von Schomberg is a Doctor of Philosophy and specialist in science and technology studies. He works for the European Commission and is a guest professor at Darmstadt Technical University.

Dr Jeanine van de Wiel
Jeanine van de Wiel is Group Lead Global Regulatory Affairs at DSM Food Specialties.

David Winickoff
David Winickoff is senior policy analyst at the Organisation for Economic Co-operation and Development (OECD) and Professor of Law at Sciences Po Law School.

Lynn Zebeda
Lynn Zebeda is the co-founder of research & ideation agency Dr Monk, board member of Worldconnectors and supervisor at Fair Trade.

The **Rathenau Instituut** supports the formation of public and political opinion on the socially relevant aspects of science and technology. It conducts research and organises discussion of science, innovation, and new technologies.

www.rathenau.nl

Rathenau Instituut