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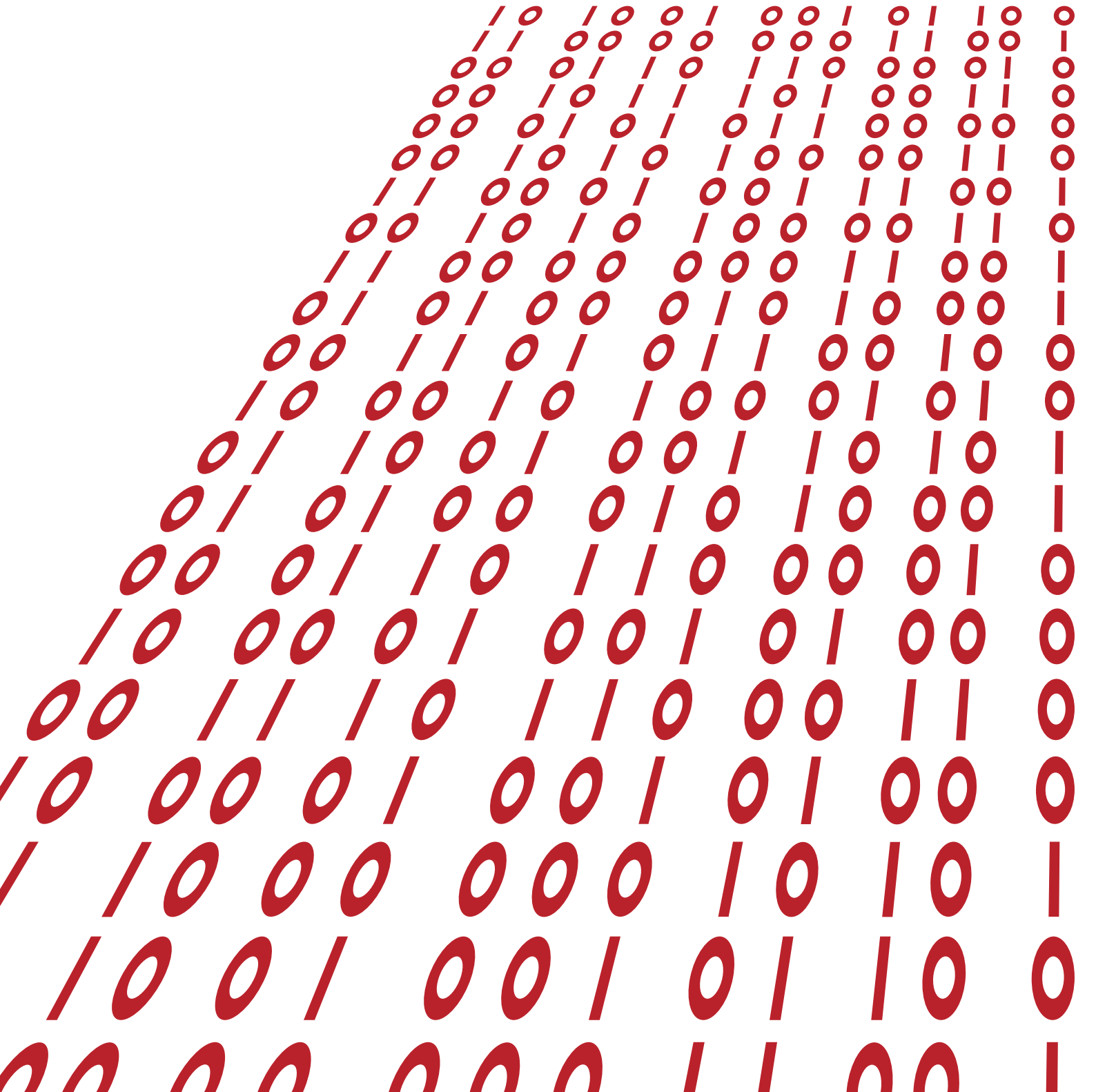
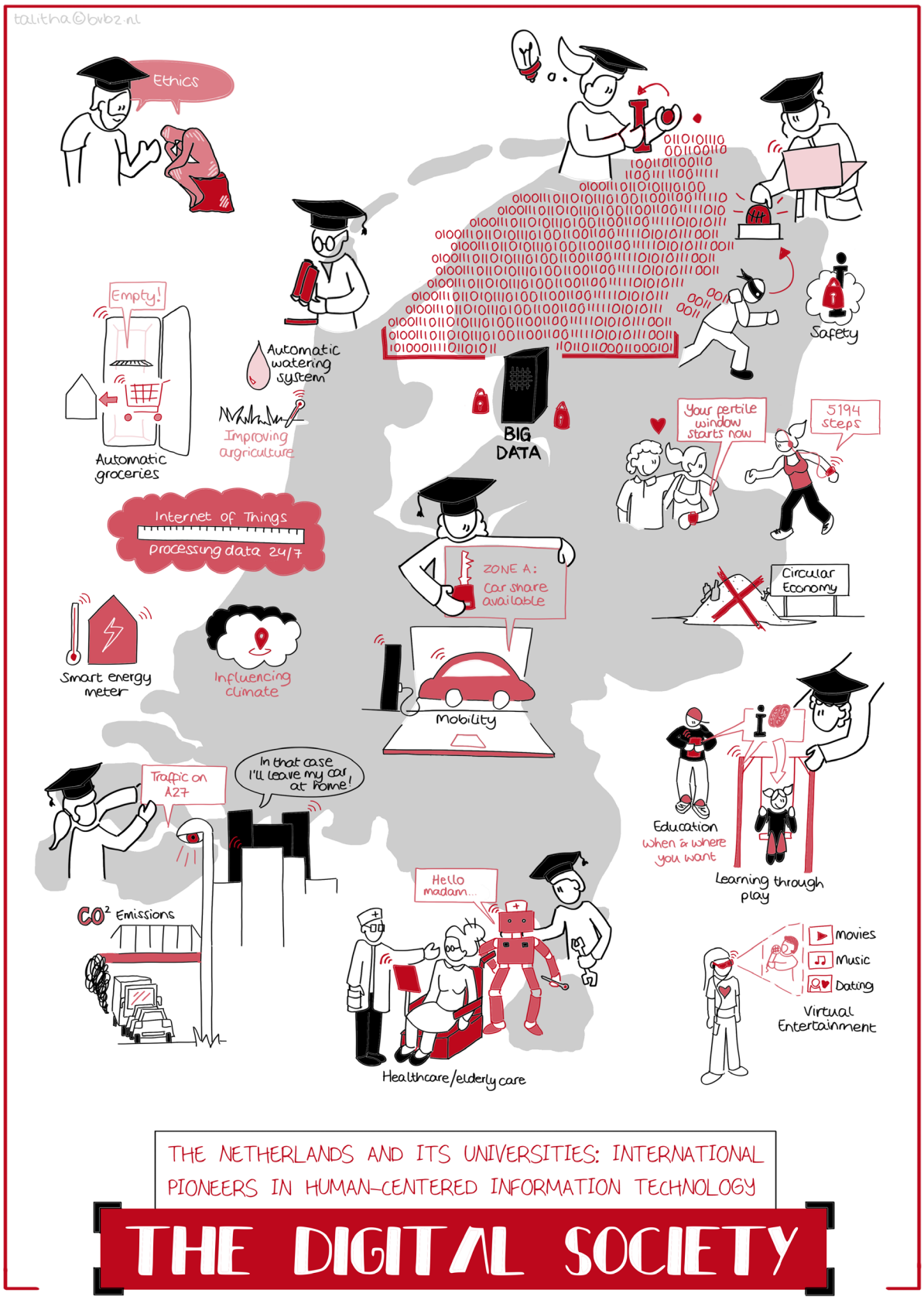
association of universities
THE NETHERLANDS

The Digital Society

The Netherlands and its universities:
international pioneers in human-centered information technology





Illustratie: Bureau voor Beeldzaken

Summary

Digital information technology is becoming ever more deeply and rapidly entrenched in our society. It won't be long before everyone is permanently connected to each other via the Internet. It has already become clear that extensive digitisation is set to radically change practically all aspects of society, not only in the Netherlands but throughout the world.

Digitisation will have major consequences for the way people live, work and learn, how we promote health and fight disease, how we deal with freedom and security, and for the role of information and knowledge, of industry, safety and mobility, of cultural identity and social equality, of consumption and sustainability, and of governance and democracy.

In all sectors, the tidal wave of digitisation will create significant dilemmas, challenges and opportunities for societies everywhere. Technological development can open paths to greater prosperity, health, welfare, security and sustainability, although only if we ensure that new technologies, people and societies and reinforce each other.

The Netherlands is a compact, highly developed, well-organised country with excellent physical and digital infrastructures. The academic research conducted at our universities is of high quality across the board: our country is a frontrunner not only in the field of information technology, but also in medical, social and natural sciences and humanities. Furthermore, our researchers are highly experienced in crossing the boundaries between disciplines and institutions.

This unique combination of characteristics creates an equally unique opportunity for the Netherlands: to lead the world in the creation of effective connections between digital technology, people and their societies. Our country can be a testing ground for and a trailblazer in the design, testing and application of human-centered information technology. This kind of internationally recognised focus will create huge social, academic and economic opportunities for our country.

In the years ahead, Dutch universities will work together towards this common goal. They will further combine the existing wealth of research in this field and focus it on a clear, common profile. As a corollary of the National Science Agenda, Dutch universities want to invest in cutting-edge research together with other knowledge institutions, the business sector and the government.

In ten years' time, this will make the Netherlands a global pioneer in human-centered information technology.

Background

1. Breathtaking pace of Digitisation

In the past 20 years, society has undergone digitisation at a breathtaking pace. Practically everyone in the Netherlands has a mobile phone that is permanently connected to the Internet. And in the next decade, the pace of this worldwide development is set to increase even further.

People around the world are already connected to each other via computers, tablets and smartphones. In the years ahead, billions of interconnected sensors, transmitters, cameras and other wireless communication devices and objects will be added.

> "Digitisation is the number one driver of earning power and progress. Together with universities in the Netherlands, the industrial sector wants to play a leading role in this development. Digitisation should be the top priority in the forthcoming government's term of office."
>
> **Ineke Dezentjé Hamming–Bluemink**
> *Chair of FME, the Employers' Organisation for the Technology Industry*

By 2025, we will have a global 'Internet of Things', the predecessors of which already surround us. Watches and phones monitor our body, energy meters influence the power grid, homes communicate with their residents or care providers, and street lights are constantly watching, listening, and even 'smelling' everything that goes on around them.

We find ourselves on the eve of a global digital revolution that will affect everyone. Technological advancement will see computers taking over many more jobs done by humans, including intelligent jobs. Smarter, more flexible, cheaper, simpler and 'more human' robots will become the norm not only in industry, government and service provision, but also in our homes and cars.

Billions of devices and sensors will generate vast amounts of data that will be stored, processed and analysed.

Digitisation will directly or indirectly affect practically every opportunity and challenge faced by all societies, including our own. From education to healthcare, from transport to housing, from service provision to media and entertainment, from agriculture to industry, and from infrastructure to the democratic rule of law, developments and opportunities that until recently would have seemed like science fiction are set to occur everywhere.

The challenge

2. Optimal fit focusing on People and Society

Digital technology does not exist in a vacuum. It is crucial that it optimally meets the needs and opportunities of people and societies.[1] And conversely, we need to optimally equip people and societies for the new technological opportunities.

To ensure effective connections between technology and society, new knowledge of technology and natural sciences must be properly integrated with knowledge of, for instance, economic, social science-related, psychological, cultural and political factors. Without this basis, technology will either be insufficiently or suboptimally utilised, or will cause an unnecessary level of serious negative side effects.

The following examples illustrate the importance of effective connections.

In the field of **climate and sustainability,** the effective application of digital technology can help to reduce CO_2 emissions by means of more sustainable buildings, more efficient sourcing of renewable energy and smart grids, in which centrally and decentralised energy generation is efficiently coordinated. However, a surge in energy consumption arising from the storage, transmission and processing of data must be avoided. In a century of higher peak rainfalls and rising sea levels, digital technology can also lead to **smart water management.**

"The opportunities created by the digitisation of education cannot be overestimated: children and students will finally be able to learn at their own level, own speed and at the moment they themselves choose."

Prof. dr. Harold Bekkering
Radboud University Nijmegen

By 2050, around 70% of the world's population will live in megacities, mainly in delta and coastal areas. Large urbanised regions will have to create a **circular economy** and sustainable water and energy sources with the aid of digital developments like precision agriculture and city farming.

Well-integrated technology should help meet the demand for **mobility** with fewer traffic jams, less air pollution, less energy consumption and fewer accident victims. 'Smart cities' should be able to grow while maintaining quality of life by listening and responding to the information generated by citizens and their behaviour.

Well-integrated digital technology offers opportunities for a smarter **manufacturing and transport** industry that optimises the entire production chain from raw materials to the finished product. It can also provide better and more flexible **products and services,** although some of these will turn existing business sectors upside down.

[1] P. Beijer, D. Greefhorst, R. Kruijk, M. Sasse and R. Slagter. Mens en organisatie in de 'perfect storm' van digitalisering' (People and Organisations in a Perfect Storm of Digitisation) Informatie, December 2014, p. 25-31.

Business models will change drastically and the average life expectancy of businesses will radically change.[2] Businesses and sectors that fail to adequately adjust will become prone to market disruptions, which will have major consequences for the job market and the economy. Digital technology must be used to understand customers and keep hold of them.
Workers that insufficiently innovate will also have difficulty. Can the **labour market** handle the rise of automation and increasingly intelligent robots? What consequences will new manufacturing methods, new types of service and disappearing businesses and business sectors have on job security, workload, retraining and pensions?

"New connections in big data, high quality technologies and infrastructures will result in a quicker realisation of preventive and tailored care for both patients and healthy citizens."

Prof. dr. Pancras Hoogendoorn
Dean and executive board member LUMC
Member of the steering group for the National Research Agenda, representing NFU

Quality of life, quality of society

Digital technology offers huge opportunities for the **healthcare** sector. Better registration, analysis and evaluation of medical procedures can result in better information, less risk, better health and greater quality of life for patients. Combining, analysing and applying large quantities of genetic and biomedical data can result in better diagnosis and **treatments** tailored to individual patients rather than to large patient groups. All manner of smart technology can help to make hospital and home care more effective and efficient, provided it ties in as closely as possible with the needs and opportunities of patients and care providers. At the same time, this care will have to remain collectively affordable.

Digitisation can help **healthy** people to remedy unhealthy habits and live a healthier lifestyle. With the aid of smart technology, **senior citizens** can live independently for longer. Analysis of digital data can help to diagnose illnesses earlier[3] and identify outbreaks of contagious diseases at an earlier stage.[4] Intelligent or humanoid robots can both activate patients and keep them company.

Digital technology will continue to have major consequences for **education.** Citizens of all ages must be able to continue their personal and professional development by means of effective, efficient and relevant forms of education. Digitisation will also create demand for new, data-related expertise, and therefore demand for this kind of training will rise.

[2] https://www.bcgperspectives.com/content/articles/strategic-planning-growth-die-another-day/
[3] Paparrizos J., White R.W., Horvitz E., 'Screening for Pancreatic Adenocarcinoma Using Signals From Web Search Logs: Feasibility Study and Results.' J Oncol Pract. 2016 Jun 7.
[4] http://datascienceseries.com/stories/predicting-the-next-pandemic

Digitisation also will present major challenges to the **rule of law** and **citizens' freedom of choice.** Fundamental rights such as privacy and 'the right to forget' will be challenged. Government bodies and businesses can collect, combine and analyse vast amounts of information about citizens and consumers and use this knowledge to entice, reward, influence or punish them.[5] Information has become a 'currency' for which the rules are still unclear.

Digital networks also influence citizens to change many aspects of their life, from their purchases, choice of partner and driving behaviour to their social interaction and self-image. Digitisation creates new opportunities for social networks, new forms of cultural experience and entertainment, and access to new stories and ideas that stimulate the imagination.
Citizens and societies must be made capable of simultaneously balancing the disadvantages of sharing information, such as the risk of abuse or the loss of privacy, with the benefits, such as better health or greater government protection.

"The Netherlands is a huge player in water technology, because it developed fundamental knowledge that can be applied everywhere. The digital society must also be based on a fundamental understanding of the interaction between information technology, people and society. A solid foundation of ICT education and science is essential in this regard."

Prof. dr. ir. Inald Lagendijk
Representative for the route 'Accessible and Responsible Value Creation from Big Data' within the National Research Agenda

On the one hand, the application of digital technology will increase **security** by means of cameras, robots, biometric sensors, e-mail monitoring or other types of screening. On the other hand, digital technology will create new risks and feelings of insecurity, such as data/identity theft or accidents due to driverless cars. Better protection of digital information is essential. Faster computers require encryption methods that are both secure and realistic.

Digitisation also presents major challenges to our physical and national security. **Conflicts** will more often be fought with robots - drones - and digital attacks on military and civil infrastructure, such as energy-production, water-management and payment networks. These networks must be prepared to defend themselves against these threats.

[5] For example, the website www.youarewhatyoulike.com, developed by Cambridge University, predicts Facebook users' character, sexual preference, level of happiness, intelligence, political persuasion and religion based on their 'Likes'.

Approach

3. A Theme that unites Disciplines, Universities and 'Routes'

Over the next ten years, as an extension of the National Science Agenda, the shared goal of Dutch universities, together with other knowledge partners and the private sector, is to give the Netherlands a new and appealing international profile: that of a leading nation in the field of digital technology oriented towards people and societies.

Our country can transform itself to a testing ground, enabling rapid discovery of how new technology can be optimally tailored to suit the needs of individual citizens and societies as a whole.

"The Digital Society clearly displays both the breadth of modern science and the shared challenges we face. A good example of how the National Research Agenda unites different scientific disciplines, business sectors and social organisations."

Prof. dr. Louise Gunning
Chair National Research Agenda

This kind of leadership position not only benefits the quality of Dutch society, it also creates huge economic opportunities. In the global economy, the Netherlands will largely depend on its competitive edge in areas such as knowledge, talent and innovative system solutions.

Making the Netherlands a testing ground for human-centered digital technology is a strategic investment in one of the biggest transitions in the modern era. It will greatly boost our international profile and competitive position, just as our system of dikes and polders made the Netherlands a world leader in the field of water management.

There are amazing opportunities for the Netherlands. We are a compact, highly developed and well-organised country, easily accessible geographically and equipped with an excellent physical, digital and social infrastructure. Our economy and public administration are strong, stable, flexible, internationally oriented and effectively organised.

"Researchers in the Netherlands stand out not only individually, but also by collaborating with each other at both the national and international levels. This is an excellent point of departure for becoming a world leader in the field of digitisation."

Prof. dr. Jos Engelen
Chair NWO

Our universities are of extremely high quality across the board. Our country is a leading nation in all relevant fields, such as technology, IT, humanities and medical, social and natural sciences, and fulfils pivotal roles in leading European alliances. Thanks to a national tradition of collaboration and relatively short distances between collaboration partners, Dutch researchers have proved particularly adept at transcending the boundaries between different universities and disciplines and tackling overarching themes.

"TNO cannot envisage a single solution for today's major social issues that does not involve the development of information and communication technology. The Dutch universities are important partners in our work. TNO therefore wholeheartedly supports efforts directed towards a digital society."

Prof. dr. ir. Jos Keurentjes
Chief Scientific Officer TNO

The Digital Society theme capitalises upon the strengths generated by bringing together multiple disciplines and universities. It requires coordinated knowledge development in a wide variety of disciplines, such as technology and natural sciences, as well as humanities and social/medical sciences. Knowledge is required that focuses on new applications, as well as fundamental knowledge of the principles and mechanisms underpinning effective connections between people, societies and information technology.

Of course, combining all parties' focus on human-centered information technology doesn't detract from other crucial research that the Netherlands conducts and will continue to conduct in the future. However, it is a theme that unites many individual issues and 'routes' from the recently formulated National Science Agenda.

"Good digital infrastructures are a necessary basis for digitisation of the economy and society."

Prof. dr. ir. Erik Fledderus
CEO SURF

Additional efforts

The Netherlands' ambition to become a pioneer in human-centered digital technology will require additional efforts, including from Dutch universities.

The universities are the most important supplier in all fields of science, and each institution has its own particular strengths and focus areas. They are already conducting a great deal of research into areas that are important for the realisation of a digital society. This research encompasses everything from fundamental natural sciences to applied technology and from mathematics and linguistics to economics, sociology and business administration.

Collectively, the universities will determine how to shape and mould the new ambition.

"The Netherlands should make use of the opportunities created by digitisation as an enabler of breakthrough technologies. If we build on our international leading position and focus on the increased application of digitale technology, the Netherlands can make a digital quantam leap, both economically and societally speaking."

Drs. Hans de Boer
President VNO-NCW

For example, specific and substantial incentives can create extra focus and scope for unifying science programmes. The universities can also stimulate the necessary increase in talent of all ages by investing in the training of specialised and multidisciplinary digital scientists. Relevant technological and laboratory infrastructure can be further expanded, such as through overarching players like SURF, the National Coordination Point for Research Data Management and the Netherlands eScience Centre. Testing grounds within universities can be used by the institutions to optimally prepare their education and research for the future themselves.

Making the Netherlands a testing ground for human-centered information technology will also give the Dutch business sector and labour market a better competitive position on the international stage.[6] It requires broad public and private investment as well as collaboration, coordination and management at the highest national level: recommendations that have already been made by employers' organisations.[7]

Additional public resources, together with the results of the National Science Agenda, can be linked to substantial investments from the private sector. In this regard, the proposition 'NL Next Level', devised by VNO-NCW (the Confederation of Netherlands Industry and Employers), MKB-Nederland (the Dutch Federation of Small and Medium-Sized Enterprises) and LTO-Nederland (the Dutch Federation of Agricultural and Horticultural Organisations) and which calls on the Dutch government to invest substantially in digitisation, is also an important stimulus for the universities.

[6] The Boston Consulting Group. 'Digitizing the Netherlands: How the Netherlands can drive and benefit from an accelerated digitized economy in Europe.' June, 2016.

[7] VNO-NCW, MKB Nederland, LTO Nederland. Investing in the transformation of the Netherlands. June, 2016.

The entire breadth of science

4. Examples of Knowledge Development

The development of digital technology oriented towards people and society requires new knowledge in nearly all fields, from technology to ethics, from robotics to medicine, from biophysics and biochemistry to economic studies and from ICT to law.

The transition to a smarter, more sustainable economy with renewable channels of **energy and raw materials** creates major opportunities for research in the fields of physics and chemistry. Fields such as economics, psychology, computer science and mathematics will be vital for the optimal design and integration of this research into energy systems that help save, generate and store decentrally generated energy. The same applies to the development of new technology for a smarter manufacturing industry both in the Netherlands and abroad.

The development of smaller and more powerful processing chips and new generations of 'learning' software will hugely accelerate the digital analysis of **language, speech, images** and other complex data. The development of smart materials that can communicate with and adapt to their environment will ensure the rapid growth of the Internet of Things. To safely and effectively implement all of these technologies, for instance into driverless cars, intelligent devices and humanoid robots, will require a great deal of knowledge from fields such as humanities, medical sciences, neurology, cognitive science, linguistics and philosophy.

"The design of human-centered information technology requires innovative forms of co-creation, interdisciplinary research and collaboration."

Prof. dr. Martin Paul
President Maastricht University

Every discipline in the field of **science** will have to develop, expand and maintain digital knowledge, skills, methods and infrastructure. This particularly applies to *data science:* a new, multidisciplinary field which, besides technology and IT, also involves disciplines such as social sciences, mathematics and physics.

The new subject focuses on the core of the digital society: the exponentially growing mountains of data from all corners of society, including the social data that citizens unknowingly yet constantly generate by participating in society. It involves fundamental research into the methods required to distil the multitude of data patterns and translate them into valuable insights and innovative products. In addition, it seeks a balance between what is possible and what is permitted with regard to aspects such as privacy, accessibility, security and the reliability of the data used, as well as the transparency of the methods utilised.

"Personal testimonies through letters, interviews, and social media show regional differences in the way people view their place in the world. As such, digitisation of information contributes to a better understanding of societal and cultural phenomena."

Prof. dr. Franciska de Jong
Utrecht University

Insights from data science will generate more and more applications within all fields of science, as well as in society (e.g. smart cities, personalised healthcare and all forms of safety and security).

The growing Internet and vast volumes of data also generate new questions about how to **handle and regulate** it. They necessitate research into the optimal adjustment of rules, processes and institutions. For example, how can biometrics, security systems and the Internet of Things be designed in such a way that they satisfy often contradictory requirements relating to aspects such as security, privacy and individual freedom? How could mass government supervision be compatible with such demands? Research can encompass all aspects, from the use of iris scanners at border crossings to the examination of global censorship and online extremism.

"Making mistakes is human. But are robots allowed to make mistakes as well? Through research, we can find out whether using robots dimishes the number of mistakes made. Do we, as a society, accept failure from robots in the same way that we do from humans?"

Prof. dr. ir. Pieter van Gelder
Delft University of Technology

The **Internet economy** provides a substantial source of research subjects. The development of intelligent hardware and software can facilitate new types of services. The rise of robots requires greater knowledge of the interaction between intelligent machines, people and societies. The transition from physical markets and institutions to the digital economy requires new, responsibly designed regulation and economic and social arrangements. This requires integrated knowledge of many fields, such as economics, social sciences, management sciences and law.

Politics and government are also becoming increasingly digitised. The Internet has transformed politics, from campaigns and voting behaviour to protest activities and revolutions. Political movements are getting increasingly turbulent and unpredictable. The government is becoming more and more dependent on complex networks of IT systems and often lags behind its citizens when it comes to online innovations such as social media and new applications. Digital innovation creates a wealth of opportunities to make policy more effective and efficient and to better tailor services to the needs of individual citizens. By working together, the government and academia can develop better policy and services.

Ethics and philosophy will be assigned a new meaning in a data-driven society. More insight is required into pressing ethical and philosophical questions in order to develop a suitable system of law and government for the digital society. This encompasses issues such as monitoring, control of the institutional memory (and forgetting) and the individual interest in a society that is becoming increasingly dependent on opaque algorithms and 'intelligent' machines. This requires regulation of the ethically responsible use of big data. This in turn requires an answer to be given to the question of citizens' responsibility with regard to online services, for example, if they are required to consent to data filtering or monitoring. The function of existing laws and rules in the event of regulation of cyber attacks must be tested, as must the ethics of invasive technologies: issues relating to the regulation and ethics of search engines, including the 'right to forget'.

"Digitisation is and will be immensely import for education. By finding the right way to integrate online lectures and new technologies, for instance, it can be a meaningful addition to education, in which personal contact will remain key."

Dr. Jet Bussemaker
Minister of Education, Culture and Science

Education, from primary school to research universities, will be drastically changed by the digitisation of both structure and content. Technology creates opportunities to better tailor education to suit the individual learning needs and styles of schoolchildren, students, and people who left school years ago. The role of teachers and lecturers must change for many reasons, e.g. because students can access online information and lectures from anywhere and at any time, giving them permanent access to high-quality education. Research will also focus on the fundamental position of education in a world in which circumstances and requirements are changing rapidly and radically, and in which people are permanently part of data networks. Attention will be paid to the psychological and social consequences of this factor, in particular for children, adolescents and people who are not or no longer willing or able to surf these new waves of data.

Will digitisation reduce social, economic and cultural inequality, or will it increase them? Will there be a shift in international inequality in areas such as the economy, freedom and democracy? These will also be important research questions.

Digital knowledge and culture influences all areas of society and science. How can we store, protect and capitalise upon our digitised culture and scientific heritage? How do we use it to increase citizen involvement? How will digitisation change the development of national, cultural, religious, political and ethnic identities and the social groups based on these factors? How will we use open public digital platforms to create new knowledge?

These are examples that make it clear how human-centered information technology can become an overarching, cross-sectional and distinctive theme in Dutch academia. The Dutch universities can take a running start on this theme as they are already active in all relevant fields.

A final thought

5. An Inspirational Idea

The decision to make the Netherlands a testing ground for human-centered information technology gives Dutch society and academia a clear and long-term vision of the future. It's a daring, appealing and inspirational idea that can inspire major collective efforts.

- It enables our country to take huge international strides in the development, application and commercialisation of knowledge.
- It ties in with the proven strengths of the Netherlands and its universities, including policy on the reinforcement of research priority areas.
- It offers a reference point for the necessary national investment in knowledge and knowledge development, as advocated by the 'knowledge coalition' of research, higher education and the business sector.[8]
- All people of the Netherlands have an interest in the execution of this theme: investors, jobseekers, the government, the business sector, consumers and knowledge institutions.
- *Last but not least:* It will enable the high-quality modernisation and sustainabilisation of Dutch society at a rapid pace.

In his book *Leesbaar Landschap,* the writer Willem van Toorn reminisces on his time travelling through the Netherlands with a Chinese poet who had never seen a dike. When Van Toorn explained how a dike works, there was a long silence. 'Eventually, he put his hand on my arm and admiringly said "That's a good idea!" ', writes Van Toorn.

"We must rapidly and thoroughly prepare ourselves for a drastic change in Dutch society, and we simply cannot do it soon enough."

Drs. Wim Kuijken
Delta Programme Commissioner

At that moment, Van Toorn realised that the Dutch landscape is an idea. 'If people hadn't come up with the idea of creating this land from beneath the waves, it never would have existed. Nearly everywhere you stand in the Dutch landscape, you are standing in someone's idea...'
Many generations worked together based on that single idea: to keep the water out using increasingly ingenious delta technology. Without that one inspirational idea, the Netherlands would never have become the compact, highly developed, prosperous delta metropolis that it is today.

Now, we can follow in our forefathers' footsteps and work towards a new vision: a radically different technological society in which quality of life is central and new generations will create more prosperity and welfare for all. Now is the perfect time for us as a country to collectively invest in fundamental and applied research into and education on human-centered information technology.

[8] VSNU, NWO, KNAW (Netherlands Academy of Arts and Sciences), NFU, TO2 (Federation of Applied Research Organisations), VNO-NCW, MKB Nederland, Vereniging Hogescholen (Netherlands Association of Universities of Applied Sciences)

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