



HORIZON SCAN 2050

STT 80

A different view of the future

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The Netherlands Study Centre for Technology Trends (STT)
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Horizon Scan 2050

The fusion of man and machine, programmable matter, artificial photosynthesis, the exocortex and the colonisation of space. These are all Signals for Change we will be facing in the future. They will impact the way in which we deal with today's Grand Challenges, such as climate change, global power shifts and new connectivity. This book by STT shows what the world may be like in 2050. And what that means for mankind.

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ABOUT STT

The Netherlands Study Centre for Technology Trends (STT) was established almost 45 years ago in 1968 by the Netherlands Royal Institute of Engineers (KIVI). STT is an **independent** non-profit foundation, funded by financial contributions from the Dutch government and industry and science. The **governing board** consists of more than 50 highlevel members from industry, science, society and government.

STT carries out **society-oriented technology foresight studies**. For that purpose STT facilitates a free space in which enthusiastic stakeholders, experts and creative minds from industry, society, science and government take part. There are often more than 100 participants per project. Young people from schools and universities are increasingly included in discussions. The participants create views on the future of technology in society.

And are stimulated to think 'out of the box', 20-30 years ahead, and to leave present principles and constraints behind. Through knowledge fusion new insights and ideas emerge as well as a willingness to explore new ways of cooperation between stakeholders. Topics are explored broadly (cross domains and interdisciplinary) and sub-topics are studied in-depth. The focus is on the interrelation between technological and societal developments.

The outcome of STT's projects serve as starting points for new initiatives, such as public-private cooperation, (system) innovation projects and applied research programmes. The basis is laid during the projects through the cooperation of the stakeholders involved. There is a long list of achievements resulting from the foresight projects in the past decades. Foresight and especially horizon scanning can also be used by STT board members and other stakeholders for risk assessment and risk management.



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PREFACE



— *Ir. J.H.J. Mengelers*

Chair of the STT Horizon Scan 2050 Steering Committee

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What will the Netherlands be like in 2050? We do not know. The future is uncertain, open but not void, as has recently been stressed by the Dutch Scientific Council for Government Policy (WRR¹). We do know, however, that our future will partly be determined by the Grand Challenges facing us. Scarcity, climate change, demographic change, longer life, global power shifts and new connectivity will all put their indelible mark on the future of the Netherlands. These Grand Challenges are in turn influenced by the so-called Signals for Change, such as future technological developments and great changes through robotics and interconnectivity.

Whatever happens, artificial intelligence will affect our lives. Robots hold the promise of making our life easier, but they will also bring about vast societal changes. In healthcare, industry, anywhere. These developments will change our lives and we do not know yet how. What if robots become smarter than us? Will they seize power?

We do know that man and technology will increasingly fuse together, as will the virtual worlds and the real world. In the future human existence will have new dimensions. For instance, from the moment we are born we will be permanently linked to others. The human brain will be extended by artificial memory, and we will be continually sharing experiences. We therefore also need to deal with new ethical and philosophical implications.

This book is the result of the STT Horizon Scan 2050 that was carried out in the Netherlands in 2012-2014 under project leader Jacintha Scheerder, supported by a steering committee and in collaboration with 300 experts and stakeholders from all domains and disciplines, from science, industry, society and government. The point of departure of this research was a free space, allowing participants to look far beyond the framework of the present state of affairs, while studying the influence and effects of a wide range of Signals for Change on the six Grand Challenges.

1 Dutch Scientific Council for Government Policy (2010), see http://www.wrr.nl/fileadmin/en/publicaties/PDF-samenvattingen/Exploring_Futures_for_Policymaking.pdf.

Together they produced a kaleidoscopic image of the Netherlands in 2050. These results have been catalogued in chapter 3 for each Grand Challenge in separate sections, including the blind spots, the issues of which we do not know that we don't know them, but which will have an influence on future developments. The resulting images of the future are aimed to inspire the reader to further reflection. The conclusions and recommendations in this book will be relevant to innovation, policy and research and can be used by stakeholders in science, industry, society and government.

The future is not simply happening to us. We can actually shape it ourselves along the way.

A handwritten signature in blue ink, appearing to be 'H. van der Meer', is centered on the page.

SUMMARY

The world is facing massive challenges, the so-called Grand Challenges (GCs). This book will address six of them. Ultimately we may see a future in which a growing population will no longer exhaust the **scarce natural resources**, for instance, because energy has become free of charge due to new power generation techniques. Maybe man will show less **climate-changing** behaviour in the future, because we will develop an economy based on renewable resources. And maybe we will see less **geopolitical conflicts**, because we have solved the problem of scarce resources. It will be a time in which we **become older** than ever before and the **world population** is growing enormously. A time in which **new connectivity**, brings together people from all over the world instead of leading to conflict. The Grand Challenges are, in turn, influenced by all kinds of developments that may — at present — still seem far away. Such as robotisation, the fusion of man and machine, programmable matter and lab-grown artificial food. We call these developments the Signals for Change (SfCs). This book confronts the six Grand Challenges with fifty-seven Signals for Change.

The STT Horizon Scan 2050 has four aims:

- **Inspiration.** This study reconfirms what the future Grand Challenges are and it adds the richness of the Signals for Change. In this manner our imagination is stretched to the very limits (the Unknown Unknowns or UUs). Together this offers crucial inspiration for research, policy studies, innovation and societal debate. It also helps us identify specific domains where major developments will occur. The Netherlands, as many other countries, needs the competencies to deal with these developments in order to survive the future global competition.
- **Vision.** The future is already in progress. Reflection on our society in 2050 allows us to create an image of future profitable business models. What will the developments identified in this book mean for our economy? Where will our future profits come from? And what will be the position of man in an economy dominated by robotics and interconnectivity? Do we have to pursue each and every technological possibility? There is an ethical issue involved here with far-reaching implications for our future social relationships. And what will all this mean for the Dutch so-called Top Sectors?²

² The Top Sectors are the nine sectors in which the Dutch Trade & Industry and the Dutch Cabinet aim to be leading. The nine sectors are Agri & Food, Chemicals, Creative Industry, Energy, High-Tech, Horticulture, Life Sciences & Health, Logistics, and Water. See <http://topsectoren.nl>.

How will entirely new innovation models alter these business sectors in ten years time? In many business sectors human labour will be affected by increased automation and the rise of robotics. This not only requires a vision on the way society will earn its income, but also on how it will deal with social issues, such as the distribution of labour and income.

- **Risk analysis.** The STT Horizon Scan 2050 links today's and tomorrow's Grand Challenges with the Signals for Change and potential Unknown Unknowns. This makes it an essential reference book for long-term risk analysis.
- **Innovation.** Expert input suggests that social and ethical factors may be more important than mere technological developments in the future. An interesting perspective. Who will be global leader in social innovation in 2050? Reflection on the various directions and shapes the future may take allows us to start a broad societal debate about the changes that are or are not desirable and inevitable. It gives us insight into the space we will have to manoeuvre and offers us a chance to prepare for these changes. The confrontation between the six Grand Challenges and the fifty-seven Signals for Change addressed in this book, however, also serves to inspire the reader to think further. Much further.

The perspectives sketched in this book first and foremost provide an overview of the conceivable visions and solutions for the six Grand Challenges, which are briefly described below:

Scarcity

There are three visions:

1. We solve scarcity through technology (new source of energy) or through a change in mentality and behaviour (consume less);
2. We solve the present scarcity, but there will be new scarcity (privatisation of resources, monopolies);
3. We cannot solve scarcity, which will have major consequences (geopolitical conflict).

Climate change

Three questions are important:

1. How many people can live under which conditions on earth in 2050?
2. How do we maintain earth as a place fit to live in for future generations?
3. Will human survival require us to search for new territories (other planets)?

The answers to these questions range from optimistic (technology, sustainability) to pessimistic (less biodiversity, inequality).

Demographic change

Five issues play a role:

1. How do we deal with a growing population?
2. What is the price for longer life?
3. Side effect on changes in the labour market (robotics will solve current labour market problems, but we are heading for a new economy in which there will, for instance, be a 24 hour working week including a totally new way of life, migration, working longer but differently, perhaps in the hospitality sector?)
4. Generation conflicts (balanced distribution of the burden)
5. What are the positive sides of an older population? Will an elderly society be a wiser society?

Longer life

Three visions:

1. Man will be immortal, needing new ethics (man-machine, digital man);
2. New, worse diseases (pandemics, the risks of genetic engineering and of food-printing);
3. A new quality of life (unaffordable healthcare, new lifestyle).

Global power shifts

In short: Who? Why? How?

1. What will be the future centre of power? The Western World or elsewhere? Will politics become superfluous?
2. Will scarcity generate conflicts?
3. How are we going to solve this together? Will common challenges lead to conflict or force humanity to find innovative solutions?

New connectivity

Three visions of the future:

1. A digital superorganism;
2. Machines seize power;
3. New etiquette. Tomorrow we will no longer be connected through the web but through our brain. Machines will become superior in any respect. Will they keep serving us or will we be serving them? Worldwide connectivity will lead to new ways to relate socially and towards a social-cultural revolution.

The STT Horizon Scan 2050 aims to provide a sound basis for out-of-the-box thinking about a future that is still far away. It is meant to stimulate the reader to form his own view of the future. To think much further than at this moment seems conceivable.

This broad scan across the various domains — including creative reflections on the visions it contains — aims to feed the debate with research institutes, strategists from sectors and industry, with science and the government, and invites them to think together about the next steps we should take. We know — or we think to know — what will be the crucial issues of the future, issues that now can be addressed, with an open eye for the ethical and social questions involved, by researchers, policymakers and product developers.



Robotics, IT and big data will change society. How we make decisions, how we travel, how we share information. Embedding robots into our lives, in healthcare and in our industry means that our role will change. Will tomorrow's smart systems be taking over our role? And who will be responsible for what? It is a potential Grand Challenge of the future necessitating an exploration of man's role in 2050.

How will society deal with the new technological possibilities? Man and his changing social relationships will determine which technologies will blossom and if we put our faith in them. In the future, technical developments become less important than the social and ethical factors that come along with them. Technological innovation will therefore have to go together with developments in social innovation.

The connection between the various domains and disciplines involved is complex. Anchoring the themes addressed by the STT Horizon Scan 2050 will therefore require stakeholders to strive for an integral and interdisciplinary approach across the domains. An approach that transcends within the present framework of politics, government, industry and society as a whole.

INTRODUCTION

'60% of the best jobs in the next ten years haven't been invented yet'
– Frey, 2012

We live in an age of scarcity, for example, scarcity of fossil resources, water and food. At the same time, for some it is also an era of abundance and prosperity, happiness and unsurpassed opportunities. An era of exponential growth in technological possibilities, with massive impact. This book aims to chart the *Signals for Change* (SfCs) — strong and weak — that may have an influence on the most (un)likely challenges facing us, the *Grand Challenges* (GCs).

This book wants to contribute to the societal debate on the future. The GCs, SfCs and stories in this book are meant to inspire. The STT Horizon Scan 2050 should not end with the publication of this book. In 2014-2015 STT intends to instigate the debate with representatives from industry, science and the government. What are the opportunities and threats that are in store for us? Where should we focus? What about tomorrow's jobs, what will they be like? Are we providing our labour force with the right skills and competencies? What will be man's future role?

In 2005 Thomas Friedman wrote in *The World is Flat*: 'Facebook didn't exist for most people, Twitter was still a sound, 4G was a parking space, and Skype was a typo.' The question is not whether the world is changing at breathtaking speed, but how to deal with it. The STT Horizon Scan 2050 provides input for the discussion on how we want to deal with the future. Because the future offers plenty opportunities.

2050 is still thirty-six years away, which is a relatively long period of time. Such a distance generally makes out-of-the-box thinking much easier. However, 2050 is also relatively close. Many of us will still be alive by then. By bringing this future closer and rendering the inconceivable conceivable we want to inform, inspire and stimulate the reader.

This book does not aim to be 'just' a collection of Grand Challenges and Signals for Change. That is why we had experts interpret these signals and stimulate cross-pollination between the GCs and SfCs and, subsequently, had them discuss a final analysis. After that, storytellers helped us to turn these interpretations into stories describing some possible future scenarios.



For whom?

This book wants to inspire as many people as possible. Futurists and researchers studying future developments will probably be mainly interested in our SfC survey and possibly elaborate on it. The survey can be used in workshops and master classes or for making future policies for businesses. The interested reader will perhaps be more comfortable with the images describing the confrontation between signals and challenges, thus creating visions of 2050. Policymakers, strategists and entrepreneurs will perhaps start with the synthesis and conclusions of the STT Horizon Scan 2050. Which developments demand our immediate focus? How do we deal with specific breakthroughs? And what do the results mean for the Netherlands and our national policy for business sectors?

1. PROCEDURE

This chapter describes the procedure for the STT Horizon Scan 2050.

Looking ahead, but how?

When H.G. Wells published ‘The Discovery of the Future’ in *Nature* in 1902 he laid the foundation for a systematic exploration of the future [Asselt, van, et al., 2010]. Much research on the future has been carried out since. We agree with the following definition of futures research:

‘The research of the future is the ability, the skill and the art to describe, explore, predict and interpret future developments, including their consequences for decisions and other actions in the present.’ — Duin, van der and Stavleu, 2006

This not only requires talent and creativity, but also a structured sequence of actions.

Companies, governments and research institutes study the future from the perspective of different disciplines and areas of research, using (semi-)scientific and non-technical sources and a number of methods. These include the Delphi method, trend analysis, the scenario method, quantitative trend extrapolation, technology assessment, back-casting, roadmapping and horizon scanning [Duin, van der, 2012]. Some methods focus on predictions, others clearly seek to explore. The STT Horizon Scan 2050 is obviously based on the horizon scanning method.

‘Horizon scanning is a technique for detecting early signs of potentially important developments through a systematic examination of potential threats and opportunities, with emphasis on new technology and its effects on the issue at hand.’ — OECD, 2007

‘Horizon scanning is the systematic examination of potential (future) problems, threats, opportunities and likely future developments, including those at the margins of current thinking and planning. Horizon scanning may explore novel and unexpected issues, as well as persistent problems, trends and weak signals. Overall, horizon scanning is intended

to improve the robustness of policies and to identify gaps in the knowledge agenda.
— Rij, van, 2010

'Horizon scanning is also: looking ahead, beyond usual timescales (as far as we can see) and across disciplinary and departmental borders (cutting across different policy domains), seeking out alternative sources of information and challenging implicit assumptions about the future that underlie today's decisions.'

— UK Government Office for Science, 2012

Horizon scanning seeks to determine what is permanent, what will change and what is continually changing. Horizon scanning is generally based on a literature study, consulting a wide range of sources, including official publications of ministries and other government agencies, NGOs, international organisations and companies, research institutes, and online and offline databases and publications. Horizon scanning may also be done by groups of experts focusing on a single area of interest, sharing their knowledge to see how new phenomena may influence the future. The STT Horizon Scan 2050 serves to support the design of strategies to deal with the future, or to assess trends or SfCs to be used in other research of the future, such as the scenario method. The first stage of the STT Horizon Scan 2050 consisted of a thorough study of the



literature on the research of the distant future in order to identify *Grand Challenges* (GCs) and *Signals for Change* (SfCs), using key words such as ‘breakthroughs’, ‘signals’, ‘seeds’ (for/of change), ‘significant developments.’

GC: Grand Challenges are challenges ‘of sufficient scale and scope to capture the public and political imagination, create widespread interest among scientific and business communities and NGOs and inspire younger people. They must be capable of acting as an important tool for percolating attention at all levels of society all the way down to civil society and the public at large.’ — European Commission, 2012

In plenary debates with members of the STT Horizon Scan 2050 Steering Committee — including representatives from science, government and industry — and through online questionnaires six Grand Challenges were identified as being the most relevant for the Netherlands. The GCs that were the subject of STT workshops are described in more detail in Chapter 3:

1. Scarcity
2. Climate change
3. Demographic change
4. Longer life
5. Global power shifts
6. New connectivity

The desk research also served to prepare an inventory of the Signals for Change based on the STEEP (Societal, Technological, Environmental, Economic and Political) model. The SfCs — expected or unexpected, rapid or slow, interacting or individually — determine, after all, the future of the GCs.

The GCs are taken as a starting point, with the SfCs acting as potentially positive or negative disruptions. The SfCs not only affect the GCs, but also society as a whole. The GCs are the challenges that are there for us to see, whereas the SfCs denote the potential change in the way we see these challenges. The signals may offer solutions (positive change), lead to new challenges, or even turn these challenges into disasters (negative change).

SfC: A high-impact event leading to a disruption of or change in a trend, influencing the Grand Challenges (GCs). A Signal for Change may be expected or unexpected, e.g. the emergence of new technologies in sustainable energy.’
— *European Foresight Platform, 2011*



An online survey was carried out in order to make sense of the c. 150 signals that were identified. 110 experts responded to our questionnaire. In the survey the experts were asked to rank the c. 150 signals on a seven-point scale. Respondents could also select *I Don't Know* if the signal or its impact was unknown. The signals were assessed for possibility, impact, and desirability of the signal actually occurring.

57 SFCs (see Chapter 2) were selected on the basis of this ranking. They fall within two categories. The first category consists of signals that were rated by the 110 experts as 'will probably develop further'. The second category includes the signals causing disagreement with the 110 experts about whether (and to what extent) they will develop further (see Appendix 2). The outcome is a list of 57 very likely as well as perhaps less probable signals. In order to address these 57 signals in workshops they were divided proportionally into three sets of 19 signals. This division was done at random, each set containing an equal distribution across the STEEP (Societal, Technological, Environmental, Economic and Political) domains.

The six GCs were also elaborated into narratives in creative workshops. In each of the workshops the groups of participants were asked to use a set of 19 (out of the 57) SFCs as the input for a brainstorm on the possible future of the GCs. The same three sets of 19 SFCs were used in each workshop.

Besides discussing the SfCs participants were also asked to reflect on the Unknown Unknowns, the developments of which we do not know that we do not know them, which makes them very difficult to identify or predict. Fortunately, not all people have the same blind spots, meaning that what is unknown to some may be clear to others. The Unknown Unknowns may have a huge impact on our future world.

To further extend our insight, apart from the six workshops devoted to the GCs various sessions were organised that were entirely dedicated to the UUs for 2050, or entirely to the technological SfCs.

The outcome of the workshops gave the input for the professional storytellers, who wrote eighteen stories describing the potential futures of the GCs. [These stories](#) aim to inspire the reader further. It appears that people expect much from — sometimes radical — technological SfCs to cope with the Grand Challenges in the future. For this reason we also invited three scientists to share their views on the technological developments in relation to social or societal changes.

'If men define things as real, they are real in their consequences.'

– W.I. Thomas; 1928

Characteristic for the STT Horizon Scan 2050 is its cross-pollination between the 57 SfCs and the GCs. Looking at the role the SfCs might play in facing one or more GCs allows us to sketch a broad vision of the future, cutting across the various domains involved. The first steps in this direction are taken in Chapter 4.

An exploration of the future teaches us what needs to be taken into account. However, by designing and co-creating together we also determine what this future may be like.

Procedure STT Horizon Scan 2050

1

Determining Grand Challenges and Signals for Change (literature review and expert interviews)					
Domains	Sociology	Technology & Science	Economy	Ecology	Politics & Policies
Signals for Change	20-25	50-55	20-25	20-25	20-25

2

Selection of SfCs through online questionnaires 110 researchers of the future and domain experts (narrow down 150 SfCs to 57 — see breakdown below)					
Signals for Change	10	17	10	10	10

Random distribution of 57 SfCs into three sets
(equal distribution according to STEEP)

3

SfC lists (STEEP)		
19	19	19
Participants use SfCs as input for vision of the future of GCs (workshops)		
One GC per workshop (using three SfC sets)		



4

Unknown Unknowns 4 x 57 SfCs					
Scarcity	Climate change	Demographic change	Longer life	Global power shifts	New connectivity
3 x 19 SfCs	3 x 19 SfCs	3 x 19 SfCs	3 x 19 SfCs	3 x 19 SfCs	3 x 19 SfCs

Storytellers write stories about 2050 based on workshop results

5

6 x 13 = 18 stories

2. SIGNALS FOR CHANGE

Before addressing the six Grand Challenges in more detail we first describe our selection of the 57 Signals for Change that were used in the workshops.

The SfCs have been categorised in line with the STEEP (Societal, Technological, Environmental, Economic and Political) model. The full list of 150 SfCs may be found in Appendix 2 (see also Chapter 1).

SOCIETAL SIGNALS

- 1 Reduced solidarity
- 2 Reduction of the welfare state in many (European) countries
- 3 Enriched reality
- 4 Decreasing difference between the virtual and real world
- 5 All use of information is controlled. A different approach to privacy
- 6 Rise of robots in daily life: robots will be better in daily tasks than humans
- 7 The advent of singularity: the moment that man and machine become one
- 8 Growth in economic importance of the creative sector
- 9 Extreme self-organisation and self-sufficiency
- 10 A behavioural change towards a more holistic approach in life
- 13 Emergence of a fourth-generation nuclear reactor (Travelling Wave Reactor) turning fertile material into fuel
- 14 Artificial photosynthesis: using sunlight to convert CO₂ (and water) into oxygen and carbohydrates (sugars)
- 15 Breakthrough in cold fusion
- 16 Possibilities of a new generation in IT
- 17 Growing potential of stem cells
- 18 Use of chips in the human body to monitor health or as identification
- 19 Hybrid-assisted limbs: an external skeleton enabling (previously) impossible movements
- 20 The exocortex: an artificial brain that is far more advanced than the human brain
- 21 Skin embedded touch-screens: means of communication and body monitor in one
- 22 Embodied avatars: remote-controlled physical avatars interacting with their environment
- 23 Prediction of human behaviour through big data analysis
- 24 Arcology: combining architecture and ecology
- 25 Drones: autonomously flying 'vehicles' on every driveway

TECHNOLOGICAL SIGNALS

- 11 New alternatives for oil in the manufacture of plastic, such as biomass and methane
- 12 Use of algae for the production of e.g. food, chemicals and fuel

- 26 Rise of programmable matter adapting autonomously or through user input
- 27 Utility fog: a 'nanomist' of tiny robots able to replicate a physical structure that continually adapts on its own

ENVIRONMENTAL SIGNALS

- 28 Widespread melting of Arctic and Antarctic Poles
- 29 Recovery of biodiversity e.g. to counter exhaustion of natural resources, with less or no damage to the environment
- 30 Desalination of water to meet increased demand for drinking water
- 31 CO₂ storage and trade in CO₂ emissions
- 32 Lab-grown artificial food such as artificial meat to (partly) replace consumption of natural meat
- 33 Extreme rise of sea levels
- 34 Collision of an asteroid, comet, or other celestial object with earth
- 35 Colonisation of Mars
- 36 Global mentality change to counter the effects of climate change
- 37 Global growth of prosperity with a focus on the environmental footprint



ECONOMIC SIGNALS

- 38 Risk of cyberterrorism endangering the stability of the economic system
- 39 Increased global inequality between poor and rich
- 40 The experience economy: goods become services
- 41 Decreased importance of cities
- 42 World economy disrupted by wars
- 43 The end of Moore's Law: the process of ever faster increasing computer capacity slows down
- 44 The limits of economic growth
- 45 Breakdown of the global economy and rise of barter
- 46 Dollar loses status of world reserve value
- 47 Changing global economy through digitisation and robotisation



POLITICAL SIGNALS

- 48 Changing global politics
- 49 Loss of trust in national politics and government: need for a new system
- 50 Energy crisis caused by geopolitical developments
- 51 Europe becomes a federation of national states
- 52 Changing political alliances
- 53 Increased risk of (world) war
- 54 Risk of regional wars
- 55 Threat of bioterrorism
- 56 Use of nuclear weapons: risk of human extinction
- 57 Nuclear disarmament

DESCRIPTION OF THE SFCS

A short explanation of the 57 SfCs below. The words marked in blue provide a weblink for more information.

Societal Signals

1 Reduced solidarity

Mutual solidarity has been waning for years and the current economic crisis does not stop this [development](#). The same may happen in future crises. For instance, people less often become members of trade unions and instead organise themselves ad hoc and problem-oriented through social media to deal with specific issues. As soon as the problem is solved they withdraw from the (temporary) collaboration. The way in which insurance companies now offer supplementary packages for each individual case shows how these organisations intend to adapt to these social changes. Formerly, people used to stick to a single insurance company for years, often without their policy ever changed. Nowadays they do an annual check and, depending on their individual situation, switch between companies and insurance packages.

2 Reduction of the welfare state in many (European) countries

The Dutch welfare state that was built up after World War II ceases to exist. This started with the decentralisation and privatisation policy in the mid-eighties. This diminishing of the welfare state combined with the aging population increases the pressure on healthcare and education, which will become more expensive for the average citizen. A growing number of tasks now falls to the responsibility of private organisations and companies. At the same time citizens appear to rely more and more on self-organisation, for example in collective [collaborations](#). It is likely that this development will continue in the near future. Citizens will increasingly organise things themselves, as individuals or as part of a collective. Government interference will therefore retire from executive tasks to regulating inequalities between specific population groups.



3 Enriched reality

Augmented reality adds digital information to visible and physical reality using, for example, glasses or contact lenses, as in the case of [Google glass](#).

4 Decreasing difference between the virtual worlds and real world

The STT future study on [superintelligent transport](#) (2013) suggests that virtual movements and meetings will in time become as real as physical movements and meetings. The rise of 3D television and Google glass is just a start, already work is being done on systems able to [mimick smells](#). Meanwhile virtual reality communities and games such as World of Warcraft have become well-known, with players forming social communities online and also meeting outside the game (although still mostly digitally).

5 All use of information is controlled. A different approach to privacy

Much information on our online behaviour — what we look at, what we respond to (or not), what we apply for (and how) and what we spend our money on — is available and for anyone easy to see. [Young people](#) today start surfing on the web at an early age, careless about giving their privacy any [thought](#). Who indeed has access to this information and personal data that are entered, and what can this data be used for? Experts warn that identity fraud and privacy violation are already a serious problem.

6 Rise of robots in daily life: robots will be better in daily tasks than humans

The Horizon Scan 2007 [COS, 2007] stated that robotics and interconnectivity will have a massive impact on both our well-being and our prosperity. The field of robotics is still progressing. Will robots and intelligent systems really take over human cognitive tasks, much the same way computers have taken over manual [tasks](#)? The rise of robotics will change the balance and configuration of the labour market. Experts predict that this development will cause people in the service sector to lose their jobs as well, because of robots taking over their tasks.



7 The advent of singularity: the moment that man and machine become one

According to futurologist Ray Kurzweil the [difference between human and artificial intelligence](#) will have become minute around 2030. He thinks by the year 2045 man will be able to upload his consciousness to a [computer](#), meaning that mankind has become de facto immortal. It is already possible to develop software that mimicks human character traits.

8 Growth in economic importance of the creative sector

We no longer live in an agrarian or industrial economy, but in a service economy. Which sector will be a moneymaker in our society by 2050? [Richard Florida](#) thinks the creative sector will be hugely important for the future succes of cities. Will creativity form the basis for our future economic [developments](#)? Will every human on earth be able to participate in the experience economy (SfC 40)?

9 Extreme self-organisation and self-sufficiency

Citizens are increasingly better able — and do more often choose — to unite themselves instead of depending on existing institutions or government arrangements. Social media enhance this development. The best example of the massive impact that social media can have is the [Arab Spring](#). In the same vein a concept such as [neoliberal](#)



communism (where the relationship with the government is strained and the focus is on self-organisation) indicates a changing attitude of citizens in society. The examples of durable energy and city farming demonstrate that civilian collectives are able to provide for all their needs without government interference.

10 A behavioural change towards a more holistic approach to life

Sociologists and trendwatchers are pointing out a mentality change towards a more holistic approach to life. In this concept the universum is seen as one inextricable entity, meaning that living, relaxation, learning, care and attention for each other are all fully intertwined. According to [Prabhu Kandachar](#) this phenomenon is becoming more popular. The holistic approach focuses on the connection between body, mind and **reason**. The aim is optimal well-being, with people accepting that they themselves are responsible for achieving and maintaining this state. Material well-being will make way for immaterial well-being.

Technological Signals

11 New alternatives for oil in the manufacture of plastic, such as biomass and methane

Exhaustion of natural resources is a large global problem, which is why people have started to look for new resources, e.g. in food, fuel and plastics. Small-scale tests are underway to find alternatives for oil. Chemical engineers developed a process to make plastic out of **biomass**. The American company [Mango Materials](#) is working on a process to transform methane — a greenhouse gas — into **plastic**.

12 Use of algae for the production of e.g. food, chemicals and fuel

Algae may also be one of our new resources, although growing them is still problematic. In the [Netherlands](#), but also abroad people are working hard to produce algae and to investigate their [potential](#).

13 Emergence of a fourth-generation nuclear reactor (Travelling Wave Reactor) turning fertile material into fuel

The Travelling Wave Reactor is a new form of nuclear energy, albeit more sustainable due to the use of waste uranium as fuel. In theory the Travelling Wave Reactor could provide enough energy to meet the [global demand](#). But this new form of nuclear energy may have implications for the environment and perhaps also our security. Will it, for instance, introduce the next generation of nuclear weapons?

14 Artificial photosynthesis: using sunlight to convert CO₂ (and water) into oxygen and carbohydrates (sugars)

Another interesting way to produce sufficient energy in the future (renewable hydrogen and [natural gas](#)) is artificial photosynthesis. This is an artificial energy transformer¹ that allows easy storage of energy, similar to the way this is done by green plants.

15 Breakthrough in cold fusion

Cold fusion has been a hotly debated issue ever since Martin Fleischmann and Stanley Pons in 1989 claimed that they had managed to bring about a sustained nuclear fusion reaction, or cold fusion as it became known. Their experiment, however, proved to be very difficult to duplicate, causing many scientists to turn away from it. Further research, e.g. by the U.S. Navy and Mitsubishi revealed many anomalous extreme results, which are now referred to as [LNER \(Low Nuclear Energy Reactions\)](#). In 2013 the U.S. Department of Energy finally opened a call for LNER researchers, suggesting that in the future cold fusion may perhaps result in useful power-generating applications.

16 Possibilities of a new generation in IT

The new developments in IT infrastructure are steadily moving forward at an incredible pace. This offers many opportunities for [innovation](#), such as internet connections that are 2,000 times [faster](#). New materials (e.g. graphene) are being developed that will make computers ever more flexible, [smaller and faster](#). In due time they may even become a seemingly invisible presence. But what may these developments taken together bring us? And what does the development of batteries that are ten times

¹ <http://technologygateway.nasa.gov/media/cc/lenr/lenr.html>



smaller and with the same **energy capacity** tell us about possible breakthroughs in the future storage of energy?

17 Growing potential of stem cells

Stem cell therapy is **hot**. Many diseases are caused by cells dying or functioning sub-optimally. If we can successfully replace these cells this may lead to recovery of the patient. Possible applications are bone marrow transplants, leukaemia, diabetes, Parkinson's disease, infarct (heart attack) and cartilage injury. At this moment the possibilities of stem cell therapy are being researched for Crohn's disease (chronical disease of the intestines), macular degeneration (age-related blindness) and **spinal chord injury**. Stem cells offer opportunities to do complex research on specific (terminal) diseases. They also allow easier testing of new medications and treatments.

18 Use of chips in the human body to monitor health or as identification

Chips in the human body offer many possibilities for technological applications, including **identification** and data storage. Any extension of potential applications in the near future will probably focus on data communication and storage, digital payments, ordering and buying, e-ticket identification, etc. In the future we will no longer need bank cards, key rings and identity badges, but wear a chip in our body instead. Medical applications are a possible next step, e.g. the neurological steering of **bodily**

functions, which may accelerate or even replace revalidation processes. Some mental diseases may also be cured without medication.

19 Hybrid-assisted limbs: an external skeleton enabling (previously) impossible movements

The **exoskeleton** is an external skeleton that is able to carry us, generating much more power than our own muscles can. It enhances, for example, the human capacity to lift things. The most logical application is in healthcare, to replace **muscle power**. The exoskeleton will allow people with missing limbs to re-enter the labour market.

20 The exocortex: an artificial brain that is far more advanced than the human brain

The exocortex consists of external memory modules, processors, hardware and software systems that enhance the human brain, while interacting with it. This is a direct brain-computer interface, meaning that these brain extensions become a functional part of the human brain.

This interface enables direct interaction between the computer (or digital system) and the human brain. There is no need for a screen, a keyboard, a mouse or a microphone, because the computer (or digital system) recognises and interprets the brain signals of the user. This means the user can interact with the computer or the system with his brain. This technology promises even faster and more efficient communication and use of computers and intelligent systems. There is some overlap with SfC 7



(Singularity: fusion of man and machine). The brain-computer interface does, however, carry the risk of cybercrime. The hardware and software used to detect the brain signals can be hacked without the user himself being aware of this. Could this lead to theft of thoughts and knowledge?

21 Skin embedded touch-screen: means of communication and body monitor in one

The future of mobile communication and [medical monitoring](#) is not just in our smartphones and tablets, but will also be applied on or under the [skin](#) as a personal [extension](#).

22 Embodied avatars: remote-controlled physical avatars interacting with their environment

The use of physical avatars that are indistinguishable from humans (partly also due to the development of the so-called [cyborg skin](#)) appears to become reality. The avatars are robots that are operated from a distance, allowing man to be in two places at the same time.





23 Prediction of human behaviour through big data analysis

Much personal information is online, for instance, the way we feel (status updates²), what kind of partner we are looking for (dating sites) and how we are doing financially (credit cards, stocks). The access to and analysis and interpretation of these data will — in combination with a brain-computer [interface](#) — lead to increasing predictability of (inter)human behaviour. Already people are using neuro-imaging to observe algorithms of brain activity. These algorithms may be deciphered, for example to identify the words in someone's mind. In theory this would make it possible to digitally read our mind. In the future the police may not be chasing facts, but anticipating them. In fact, predictive policing already exists, targeted patrolling based on the analysis of big data. The Amsterdam police and university researchers are already working on a system of advanced planning and forecasting methods to predict what will happen at a specific location and when. In the US a similar system is already operational (PredPol).

24 Arcology: combining architecture and ecology

Arcology is an architectural design concept designed by [Paolo Soleri](#) for large-scale living communities or habitats with extreme population densities. These habitats, including houses, businesses and agrarian facilities, infringe on the environment as little as possible and are economically [self-sufficient](#). Arcologies aim to limit the impact of mankind on his environment. The largest arcology project is Masdar City in Abu Dhabi. Many other cities, including Tokyo, Quebec and Chicago, are applying (some of) the principles of arcology.

25 Drones: autonomously flying 'vehicles' on every driveway

In January 2013 the Scientific American published a future scenario in which each house has a drone on its [driveway](#). A similar concept is now being developed at the

² Messages at social media

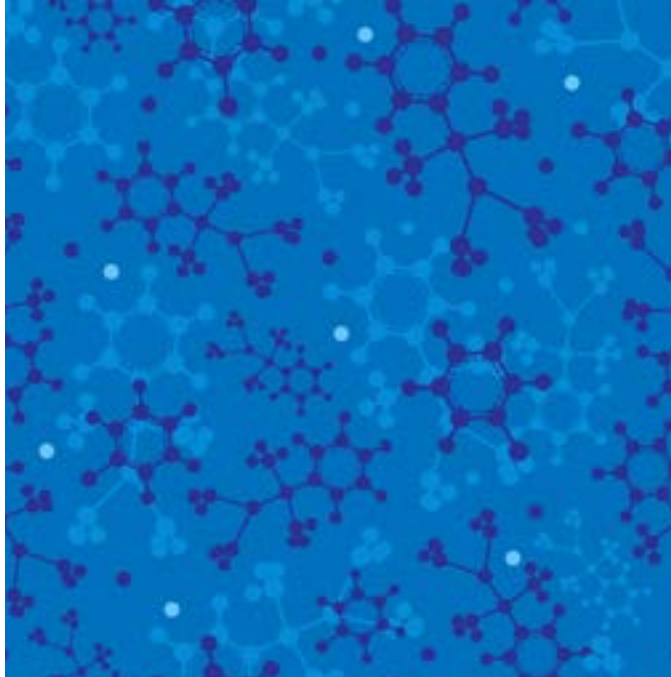
MIT. If the ‘flying car’ does indeed take off, this will have major consequences. It will drastically change traffic, especially commuter traffic. Do we then still want to be living as close to our work as possible or travel longer distances and enjoy more living comfort?

26 Rise of programmable matter adapting autonomously or through user input

Nanoparticles are able to link and form highly intricate structures, although it is still unclear how they do it. How do objects that are a million times smaller than a grain of sand configure themselves into usable material? The rise of reconfigurable minirobots and **self-folding paper** also contributes to the developments in programmable matter. Taken together with the internet of things, spectacular new perspectives loom up.

27 Utility fog: a ‘nanomist’ of tiny robots able to replicate a physical structure that continually adapts on its own

And what are the implications of the utility fog, a swarm of networked microscopic **robots**? If such a fog can take just about any shape, does this mean we can make do with far less production and limit the amount of waste?



28 Widespread melting of Arctic and Antarctic Poles

In 2013 it became public that China intends to open up a commercial [shipping route](#) through the Northern Ice Sea. This has now become possible in summer because of the melting of the North Pole. At the same time the average temperature on the [South Pole](#) has risen twice as fast in the last two decades as anywhere else in the world. How will this affect the climate and the sea level? In the tundra meanwhile the [permafrost](#) is melting, releasing carbon dioxide and methane. Will this reinforce the greenhouse effect so that it becomes irreversible?

29 Recovery of biodiversity to counter exhaustion of natural resources, with less or no damage to the environment

On a global scale biodiversity has decreased during the past forty years by [one quarter](#). The tropics are particularly affected. Future population growth and income growth — living, working and food production — put a permanent pressure on biodiversity. Less biodiversity in turn will threaten fishing and wood production. It will also threaten the self-regulating capacity of the climate and water cycles as well as the recuperative power of the soil and water systems. Especially in developing countries this almost directly leads to less means of livelihood such as clean drinking water and fertile soil. In 2002 it was agreed that the decrease in global biodiversity would be slowed down by 2010, and even come to a full stop in Europe. These targets were never met. For this reason it was agreed to postpone these the targets to 2020, adding partial repair of biodiversity to the agreement. The EU is also working on its own [agreement](#).

30 Desalination of water to meet increased demand for drinking water

The availability of clean drinking water is a large global problem. Desalination of seawater is a viable solution, but this is very expensive compared to conventional drinking water production. There are indications, however, that in the future (around [2030](#) and perhaps even [sooner](#)) desalination will be much cheaper, becoming a standard technology to produce [drinking water](#) [Reijnders et al., 2008].

31 CO₂ storage and trade in CO₂ emissions

Calculations show that the warming up of earth — most probably caused by the increasing amount of greenhouse gases such as carbon dioxide, methane and nitrogen dioxides — can only be stopped if we reduce the emission of these gases by 80% [Reijnders et al., 2008]. It is possible to (further) reduce greenhouse gas emissions, for example through CO₂ storage and trade in CO₂ emissions. The EU already has

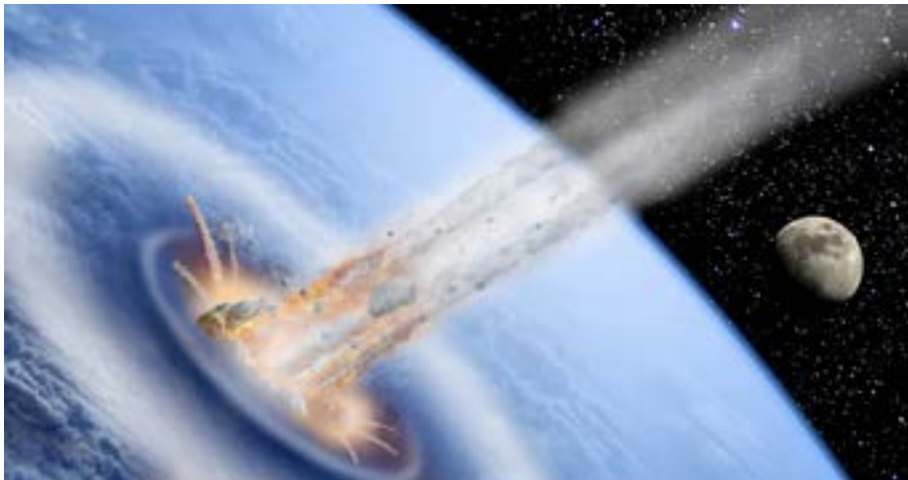
an extended programme for the [emission trade](#). Preventing gases from entering the atmosphere and subsequent storage would help to achieve a drastic reduction of these emissions. It is expected, however, that this ambition will not be realised before [2030](#).

32 Lab-grown artificial food such as artificial meat to (partly) replace consumption of natural meat

In 2013 the first hamburger made of lab-grown artificial meat was presented in [London](#). Scientists think that it may be in the supermarket in ten years time. The STT study on [food and medication](#) suggests that in the long term there may be pills containing sufficient nutrition for a perfectly normal and healthy diet.

33 Extreme rise of sea levels

Some believe that the [sea level](#) will rise much faster and higher — namely 60% — than the prediction by the UN. This has of course major impact for the Netherlands, and in more than one respect. It is not just water threatening our territory, it is also an opportunity. Dutch water expertise may become very much sought after.



34 Collision of an asteroid, comet, or other celestial object with earth

We will have to prepare for the impact of an asteroid on earth. The effects can be disastrous. In 1908 an asteroid hit Siberia, levelling a wooded area that was larger than London. The chance of an asteroid hitting earth is once every thousand years [Reijnders et al., 2008]. Larger asteroids may have an even greater impact, possibly costing hundreds of millions of casualties. Plans are in place to deflect (smaller) asteroids threatening to hit earth [COS, 2007].

35 Colonisation of Mars

With the imminent commercial space flights it seems that moving to another planet becomes more realistic. Elon Musk, who founded [SpaceX](#), advocates a self-sufficient community on Mars. China is working on growing vegetables on Mars and on the [moon](#). In view of recent proof that planets near [earth](#) contain both carbon dioxide and ice water, this should not be very difficult. This is an important development since the earth is becoming crowded, with the pressure on natural resources to match. This means that a Mars colony — if this can be economically done at a megascale — could become a solution.

36 Global mentality change to counter the effects of climate change

A change appears to be taking place in the view on climate change. For instance, president Obama decided to reinstall solar panels on the [White House after 27 years](#), which is seen as an important symbolic gesture. He also presented a new long-term climate policy, imposing for the first time in the US history CO₂ norms on power plants. To large investors the climate risk also causes [material risks](#). How will the way we look at climate change develop and what will be the effects?

37 Global growth of prosperity with a focus on the environmental footprint

Increased [prosperity](#) in our current way of living means an increased environmental footprint. It was estimated that in 2007 the entire environmental footprint of humanity equalled 1.5 times [planet earth](#). There is, however, no clear definition of 'environmental footprint'. Economic growth had, especially in the 20th century, a large impact on the environment. People at all levels of society work hard to lower this footprint. But will we be able to lower the environmental footprint in an economy that keeps growing?





Economic Signals

38 Risk of cyberterrorism endangering stability of the economic system

The economic system is increasingly dependent on IT and — for this reason — vulnerable to disruption (viruses, cyberterrorism, crime) of its digital **systems**. According to the FBI cyberterrorism will become the largest terrorist **threat**.³

39 Increased global inequality between poor and rich

The global inequality between poor and rich keeps **growing**. This effectively means that other **forms of inequality**, such as life expectancy, follow in their **wake**. This is a potential source of conflict between Third World countries and First World countries (possibly causing mass immigration from the Third World), but also within the Third World itself.

40 The experience economy: goods become services

The experience economy is the fastest growing sector in our economy. This means prosperity growth will increasingly come from a sector that provides immaterial products, the service economy. Retail may act as an example: the immense popularity of

³ other website pages to visit:

http://www.intgovforum.org/cms/workshops_08/IGF_dimensions_Marc-Goodman.pdf

<http://www.fbi.gov/about-us/investigate/cyber>

<http://www.fbi.gov/news/testimony/cybersecurity-responding-to-the-threat-of-cybercrime-and-terrorism>

online shopping means that real-life shopping has acquired a new meaning, namely how we experience [shopping](#).

41 Decreased importance of cities

Some authors in the past predicted that the importance of cities would decrease, for instance, due to the rise of virtual reality [Kaku, 2011]. So far these predictions have been wrong. In fact, judging from the ongoing global urbanisation [cities appear to become more important](#). According to Michio Kaku this is partly because people by nature value personal meetings. Virtual meetings are still not seen as equal to personal meetings. But what if future developments make virtual meetings perfectly [real](#)? Will this change the role of the city? Apart from virtual reality other factors may play a role, such as changing economic interests.

42 World economy disrupted by wars

Various political SfCs refer to the [risk of war](#). Wars are [extremely expensive](#) and have a large impact on the global economy. There have always been parties — and there always will be — benefitting from war, improving their own economic and political position through war. The EU report [The world in 2025](#) explicitly states that there is a real threat of war that will have economic consequences.



43 The end of Moore's Law: the process of ever faster increasing computer capacity slows down

Moore's Law is a computer term that was invented c. 1970. In its simplest form this law states that the total processing speed of computers doubles each two years. There are, however, signals that this exponential growth will decrease. Robert Colwell, the director of the American DARPA (Defense Advanced Research Projects Agency) microsystems group and former project manager at Intel, believes that this growth will have **stopped by 2020**. Since Moore's Law has driven our economy for the past fifty years, this will have major economic consequences [Kaku, 2011]. Others, including the well-known futurologist Ray Kurzweil, expect that by 2020 there will be **new technology** enabling continued exponential growth.

44 The limits of economic growth

Advanced statistical models have shown that the classic combination of labour and capital accounts for just 15% of economic growth and that a 3D function consisting of labour, capital and energy actually gives a better **prognosis**. Cheap energy turns out to be one of the crucial drivers of economic growth. Now that the available cheap sources of energy are decreasing, the question is whether we are reaching the limits of economic growth. One of the first to advocate this theory was the economist **Herman Daly**, who devised the model of the steady state economy: *'The closer the economy approaches the scale of the whole Earth, the more it will have to conform to the physical behaviour mode of the Earth. That behaviour is a **steady state** — a system that permits qualitative development, but not aggregate quantitative growth.'* So have we almost reached the limits of economic growth?

In the past decades the notion 'labour' has changed worldwide. The industrial industry that used to be the prerogative of the West has moved to the Third World, the West aiming for the service economy. There is also a shift in sources of energy. Forms of energy that are polluting the environment, such as coal, have — along with the industry — moved to the Third World, although in the former Eastern Block we still see large-scale use of lignite (brown coal). The West is focusing more and more on new, green forms of energy. May we assume that these trends will continue and that changes in labour and capital will continue to guarantee economic growth?

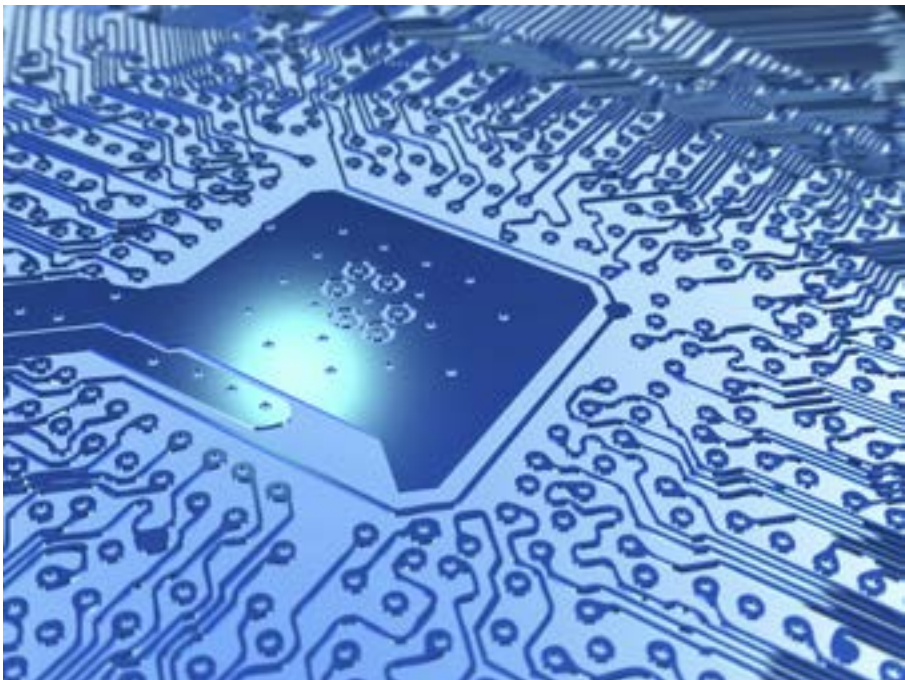
45 Breakdown of the global economy and rise of barter

Marc Faber, who foresaw both the 1987 crash of the stock market and the 2008 financial crisis, has a message to the West that is not very optimistic: *'The US Federal Reserve will destroy the world, many financial institutions will be crushed and especially poorer groups in society will be duped by mega-inflation. Also our pensions will be in great*

danger. Still he maintains that he is not even being [pessimistic](#). Faber thinks we have consumed too much for thirty years, creating a massive debt. Now it is time to even the score. According to him the global financial system will not be reset by central bankers, but by [imploding markets](#). In the past we have already seen that economic crises caused by banks have not led to any change in their mode of operation. Would such a collapse as described by Faber mean that the Third World will take over the role previously played by the First World or will we finally see a revolution in banking? Some even suggest we may fall back on a barter system.

46 Dollar loses status of world reserve value

There are various indications suggesting that the dollar will lose its position as world reserve value. In 2010 an important ex-Fed banker stated that partly due to the US monetary policy the dollar will irrevocably lose its status. At the same time the US appears to be losing its traditional role as global leader. Robert Zoelick, the former president of the World Bank, also advocated an alternative for the [dollar](#). The US of course intends to maintain this system as long as possible, because this allows them to endlessly finance trade [deficits](#), whereas it also creates additional power in world politics. Will the dollar lose its status as world reserve value and hand over this position to the Chinese yuan, or will nothing really change, as was suggested by the [Financial Times](#)? And would a change also mean world leadership for China?



47 Changing global economy through digitisation and robotisation

The virtual economy is on its way. Already in various places people can pay with [bit-coins](#), a new, virtual currency. This system of cryptomoney is still in its infancy, but it has the potential to become an important [currency](#). At the same time superfast robots are entering the financial markets. They may [disrupt these markets](#) because trade will go so fast then that human capacity can't anticipate events anymore. And what will the rise of bitcoins and robots at the stock exchange mean for the supremacy of the West?

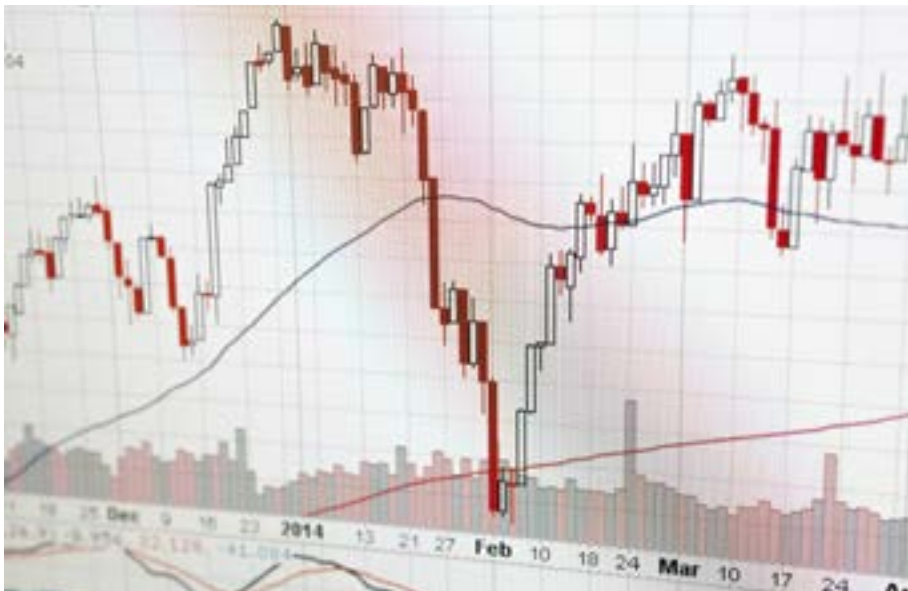
Political Signals

48 Changing global politics

The US appears to be losing its position as [world leader](#), with China, at least from an economic point of view, [taking over](#). But will this actually be the end result or will global power be shared among various nations? And how will the US deal with the new power [balance](#)? China is clearly accelerating its military build-up. Will a power shift take place peacefully or will we see a Third World War?

49 Loss of trust in national politics and government: need for a new system

The [Horizon Scan 2007](#) by the former COS stated that the loss of trust in national politics was an important future challenge. During the past six years this trend has continued. Only 6% of the Dutch citizens believe that politicians generally tell the [truth](#). Only 11% think that the political leaders and authorities in the [Netherlands](#)



are competent enough to solve major issues in society. There are **indications** that the **political system** is in need of profound change. Are we on the brink of **major changes in our political system**?

50 Energy crisis caused by geopolitical developments

Many important oil and gas fields are located in politically unstable **regions**. Also, ever since the eighties we use up more oil than we find. For the time being the world is still relying on fossil fuels. The **dependence on fossil fuels** in the Netherlands is 94%, importing much of this energy, as do many other **European countries**. An energy crisis caused by geopolitical issues (which is conceivable) would have far larger consequences than the present **debt crisis**. Does this mean that Russia — a large energy provider — will acquire political dominance in the EU?

51 Europe becomes a federation of national states

The agreements reached in 2013 on the European budget demonstrate that Europe is a patchwork of local cultures rather than a federation of **national states**. Negotiations between the various heads of government were mostly about financial consequences for their own **countries**, the countries paying most disagreeing with the countries receiving most. Will Europe ever be a federation of national states, in which citizens whilst first and foremost identifying with their own region, also see themselves as European citizens?

52 Changing political alliances

NGOs, networks, internet communities, etc. seem to become more important in the society of the **future**. They also generate more trust than the classic institutions such as the state or trade unions. These are neither trusted nor **supported**. What will this mean for society? Will we see new forms and levels of government?

53 Increased risk of (world) war

The EU report *The world in 2025* warns against a world war. There are many global tensions and conflicts that may escalate. But what would be the disruptive effects of such an escalation?

54 Risk of regional wars

Regional wars can have a massive impact on the entire world if existing relationships are turned upside down. For instance, there may be a war between China and Japan over the islands in the South China Sea. Or even a nuclear conflict between India and Pakistan or Israel and Iran.

55 Threat of bioterrorism

Besides cyberterrorism, bioterrorism is a new and major threat to the [world](#), perhaps even more dangerous than the nuclear [threat](#). It is conceivable that terrorists will increasingly be using these weapons, because they are no longer very difficult to produce. [Brett Giroir](#), former director of DARPA: ‘What took me three weeks in a sophisticated laboratory in a top-tier medical school 20 years ago, with millions of dollars in equipment, can now essentially be done by a relatively unsophisticated technician.’ Will bioterrorism become a threat similar to ‘the Bomb’ in the Cold War? And will we see a biological arms race?

56 Use of nuclear weapons: risk of human extinction

Some politicians and futurologists predict nuclear wars in the twenties of this century. Such wars will endanger human survival.⁴

57 Nuclear disarmament

Others expect nuclear disarmament between now and 2050, meaning that in the next decades it will be ‘just’ the threat of [nuclear war](#).



⁴ *Scientific American*, January 2013 – Ron Bosenbaum – author of ‘How the End Begins: The Road to a Nuclear World War III (2011).’

A small history

ELLEN DECKWITZ

38

Ellen Deckwitz is a poet, literary theorist and performance artist.

At ten in the evening it is still about thirty degrees, even on December 31. This is the first time I celebrate New Year below the equator. It is also the first time I celebrate New Year alone. I walk over to the showcase. During my career I collected many artefacts. I take out the small hand axe made of flint. I could never use it without skinning my knuckles. Tiny, tiny forefather. When Em died I wanted to start anew. With the help of my grandchildren I cleared out the house and took my things to the other side of the world.

The hand axe feels a bit greasy. It is made of stone that absorbs heat real quick. In the Stone Age people used enormous, roughly shaped pieces of flint to cover their graves. Maybe that is how they got the idea for this hand axe. So that their loved one would still be alive if they had used the stones as a weapon instead of covering graves with them. I carefully put the axe back. It is one of the earliest examples of the human use of technology, even if we have something different in mind when we think about technology these days. Exoskeletons. Stem cell implantation. Not the remains of the irrigation canals surrounding Pompeii or the invention or the windmill.

There is a skull next to the hand axe. The back of the head is small. And yet that is where it all started, in that wet and weak organ. We noticed how vulnerable our hands were, so we started to design tools. We made sure the world was perfectly adapted to the needs of our body — and our mind. We even managed to have machines do calculations that would cost a genius three years of his life. And thanks to these calculations we designed new machines that saved us many more years. Saved time, limited time.

And limited space, now that Earth is increasingly being flooded. Of course even back in the 18th century there were stories about emigration to Mars, but then this was called science fiction. Not allocation plans, like today. Or as a destination for backpacking as it is now, for the rich. Em would have loved to visit Mars once. But she did not make it. There are still warzones. Still places that are marked for death. Still, we manage to adapt. In my lectures I always like to tell people that make-up was the first form of bionics. The first way to use tools to adapt our bodies to the requirements of the outside world.

Just think about it, it all fits. We built machines because our arms were not wings and our legs

were not paddles. Up to today, with plugs in our heads to connect to the virtual world. To learn to feel what it is like to be hacked. At least, that is what Em would have said. She had a talent to explain these kinds of things. When we married at the beginning of '97 she had to laugh when the registrar asked her if we wanted to stay together till death would part us. 'As long as we marry on equal terms,' she joked. Even my parents found it funny. I was still ill back then. We did not know how long I was going to live. We also did not know that 2016 would see a revolution in the treatment of cystic fibrosis.

Suddenly the sky brightens. I hear people jubilating and shouting in the street: 'Happy 2050!' and it is all around me. Corks popping. Hysterical children. Happy 2050. I look at the hand axe. It must be possible to make ourselves even less vulnerable. Our children, our grandchildren. So that in the end our memories of days long gone are the only scars we have. Like the way she laughed. The way she smelled.



Peter Frühmann is the founder of Storybag. He has a BA in Fine Arts and a BSc in Psychology. Peter has worked as art director, copywriter and creative director at various national and international agencies.

Kokumo is sixteen. He sneaks through the ruins of the gigantic building that one time had been supposed to become a hospital. He knows that somewhere in the basement the rebels have their communication room. Guarded. On the way he had had to hide in ditches by the road a number of times for patrols chasing by. In the end he had come across the desolate, pock-marked road to the hospital. A typical inheritance of the colonists: a lot of promises, but in the end nothing but useless buildings and roads going nowhere. Africa has become a collection of lawless regions without a government. National borders only exist on paper... Kokumo (the name means 'This one will not die') finds the entrance he was looking for and cautiously walks downstairs.

At the same time Andre is moving just as cautiously through his beloved Norwegian wilderness. He senses and smells the freshness of a waterfall nearby. Birds are twittering, but this is a deceptive idyll. The forest is teeming with enemies. Trolls are the least of his problems. They smell horrible and if the wind comes from the right direction it is to your advantage. In

this virtual 4D multiplayer world everything is real. You need quick reflexes. It is 2038 and Andre is 96. Thanks to the successful stem cell research during the last decades he has become immune to incurable diseases. What his muscles — exercised in games — cannot do his exo skeleton will. Andre, a neuroscientist, had been one of the developers of the exoskeleton. He can run faster and jump higher than ever before. But he is already starting to dislike the multiplayer environment. He had retired only a few months ago and had expected that he would enjoy his fourth youth. Yes, it had been exciting for a while, but was there any meaning to it? No. The real world seems more and more remote to him.

There is a stale smell in the dusty hallways of the hospital. Kokumo thinks of his teacher. Schools in Africa are now small-scale initiatives and not very popular with the warlords. Only a few days ago the school in his own village had been destroyed. The teacher had disappeared... He had told the children about the world outside Africa using old-fashioned Prezi presentations. He had spoken about the federations outside

Afric. How the people there had invented alternative ways to create energy and how to store it. Cooperation was the secret. Their food shortages were almost gone, thanks to algae farms and lab-grown artificial food. The pupils had been listening mouths agape, although their teacher was not able to tell them how current his information really was. A thought crosses Kokumo's mind: 'It is not just the food that is scarce, knowledge is too'.

He hears voices of people arguing and moves cautiously in the direction of the sound. It comes from behind a door with a code. This must be it. Next to the door there is a dark side-passage, like a black hole. He hides and waits.

Andre dodges the fireball thrown by a troll and then throws his spear. He listens to the troll gurgling pathetically and sniffs sarcastically. Better a troll than a hacker, because they exist in real life and are far more dangerous. Lately, they have been entering the game world increasingly easier and more often, disguised as virtual opponents... Andre knows the stories about inexperienced gamers whose memories were hacked. After downloading their private and financial data their memory was literally and figuratively erased. Identity murder. The unlucky ones without a back-up were nothing more but zombies needing a new identity with the help of family and friends. But most people did have a back-up of their brain and could simply be reset. From the corner of his eyes he sees a blue leopard with orange dots waiting between the trees. Andre relaxes. The retro-avatar of his great granddaughter Susan... Members of her community who enter the virtual world appear as fantasy animals.

'Good thing I found you. I need some help quickly,' the leopard says.

Andre switches to safe stand-by.

Kokumo's teacher had also told them about a network of young people in the federations, a community called Wishbone. Anyone with a question — young or old — could ask them. But how to reach them? The teacher had explained that as well. It was dangerous, but Kokumo had immediately decided to try. His teacher had told him where to look and gave him some final instructions. After his teacher had disappeared Kokumo had made his plans.

The door opens and three men in camouflage overalls walk to the stairs, still arguing. They are too busy to detect the shadow sliding through the door before it locks again. Much to his relief the room is empty. He sees a communication console and a keyboard. Just like his teacher told him he types a letter. A large 'Y' appears above him: 'Wishbone — For Vital Questions'. Kokumo touches the symbol and sees hundreds of faces appearing on the screen. He touches a random face and there she is, projected in 3D in front of him, a young woman with a blue and orange headscarf.

'What is your question?'

He tells her about his village, about the school and his teacher, and asks his question: 'We want to be able to learn more, maybe then we will have a future. Can you help?'

'Where do you live?'

'In Isolo, next to the ruins of our school.'

'I will do what I can. Give me a few days. Wait at home and watch whatever will be flying through your window. You will recognise it. Trust me. But you must leave now, I see movement near

your coordinates.'

'What is your name? In case I have to find you again at 'Y'.

'Blue Sue.' The projection is gone.

'Take a break from the game, Andre,' the leopard says.

He presses a sensor and is back in his living room, facing Susans hologram. This is the first time she has asked him for help and he feels glad to get a chance to be of significance again, to someone, to a cause. His mind races.

'We could make a teacher of this boy through direct knowledge transfer. From brain to brain. Some of my former students have turned this into an application based on a universal e-brain language. If we instruct him well your new friend can take over the programme and pass

on his knowledge to others without any schools being destroyed. Just give his coordinates and I will send him my first instructions with a mini-drone — they are now smaller than a fly. Then he will receive the technology that he needs one step at a time.'

'And after that,' he hesitated, '...I could do more for you...' It almost sounds like a question.

Susan smiles. 'Maybe, yes.'

Kokumo has left the building and sneaks into the night. There is a half moon above him and twinkling stars, more than enough light to find the way home. He smiles, for the first time in a long while. Finally somebody has heard his question and answered him. He is starting to believe in a future again.



The Eurogazette Online: *Utopia started in Greece*

MIEKE BOUMA

43

Mieke Bouma is a storycoach, dramatist and scriptwriter working for theatre, film and television. She worked as a teacher at the Theaterschool Amsterdam and is founder of the Storytelling Academy.

Silver Juno (65) wrote *Utopia started in Greece* about the 2002-2020 crisis, the era in which humanity reinvented itself. Our correspondent visited her on the Greek island that has been her residence for the past thirty years.

Why

We left the Netherlands in the summer of 2015 in an old van. The banking system had crashed and no-one was able to get access to his money. Half the country had been flooded and people were boating the streets.

Our destination, our dream was Greece. Fascinating things were happening there. People were working together in small cooperations using new, local money and barter systems. The crisis had started in Greece, but it was also the first place to see the crisis end.

Stress

The rat race we were in at the time nearly killed us. Everything had to be bigger, faster, better and more. With hindsight we can say we weren't ready for the 21st century. We were caught in the old industrial concept: fight or flight, win or lose. We were thinking in opposites, were

terrified of any shortfall. We were running around like madmen, dead tired and exhausted.

Disasters

I wrote this book for my grandchildren to explain how this madness nearly destroyed Earth.

The maelstrom of disasters that hit us! Environmental, social, political and economic disasters. Tropical storms, earthquakes, poisoned oceans, polluted atmosphere, welfare diseases. And nobody taking responsibility. Nobody standing up to say that we were doing this ourselves. Looking back you may well ask yourself why we allowed a small but powerful elite to control our money, energy, food, water and information.

Start

The beginning was tough going. There was no money, so we offered our services in return for a roof over our heads, or a few tomatoes. We were just wandering around.

Energy, internet, media and telecom were all down. On the entire planet. We had no contact with family or friends.

We did hear about the wave of plunder that hit Western Europe, and about the climate derailing

and getting very cold. That is when my parents fled as well. They simply abandoned their home and came to live on a nearby island. They're very, very old but still healthy and happy. Dad had his one hundredth anniversary last week and he still swims in the sea each day.

Keep it simple

We started our Solar Project. Solar power for hot water, cooking, baking, drying, conserving and electricity. Fully natural and sustainable and as local as can be. Keep it simple. The smaller and simpler the better.

We were part of an interdisciplinary team. Technicians, ecofarmers, designers, physicians, psychologists and spiritual teachers. Our technical innovations were matched by sustainable farming, smart water management, great

architecture, health, communication and personal growth. An exciting time. As if we were inventing things anew.

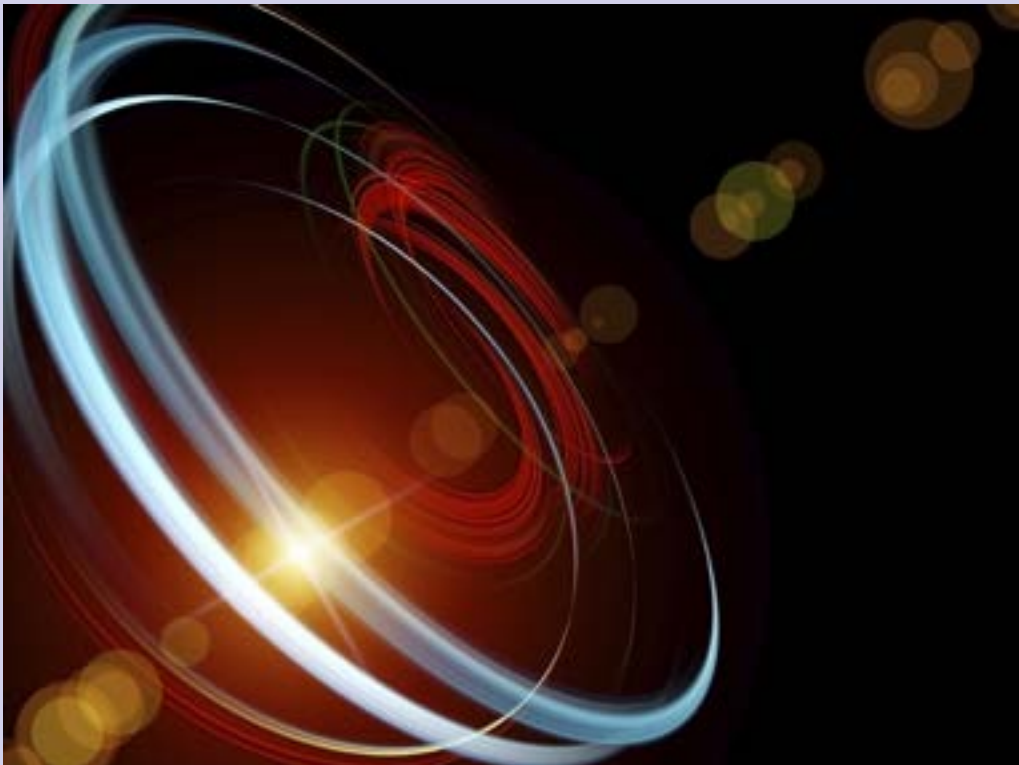
Mind and body

Look, I am sitting here on my terrace at the sea. Do you hear these waves battering the shore? Such a soothing sound. It reminds me that I am part of the bigger whole.

Those of us born in the eighties and nineties of the last century are the quantum generation. Our development concurred with the demise of the basic fundamentals of physics.

We learned that everything is connected, that we are part of a bigger whole.

We found out that the universe is a web of relationships. That our mindset and personal well-being influence the state of the world, the state



of mankind. If I feel good this will resonate, sending out a very strong positive vibe.

Evolutionary leap

We can make this world a better place if we take full responsibility for honest food, energy, care and education. And for our own inspiration. The solutions are inside us, not outside. Everything is already there. We have no lack of money, love or energy.

We found out that we could enhance our vibration through meditation and yoga, and that we have the capacity for telepathy.

The fact that you and I can harmonise together without any effort wasn't that obvious back then. The realisation that from an energetic perspective we are all one became the tipping point, and that saved the world. Mankind had made an evolutionary leap from adolescent egotism to responsible maturity.

Solar cooking

See that disc ten metres up there? That is our Solomon Mirror. It concentrates all sunlight on a single spot by turning with the sun, keeping

the focus stable. Perfect for a sun-cooked meal. You can actually cook tons of fruits and vegetables. We have already prepared our winter stock of jams and tomatoes. Is this paradise or what?

Living experiment

We do all this without exploiting nature, using only the simplest technology. It's fun! All we do is part of the living experiment. Everyone follows his own inspiration. Everyone has fun. It does not feel like work. We do it all together, creating friendship and trust. Of course there is still pain and misery. People get ill and die. We do have our conflicts, but we no longer run away from our experiences, we no longer resist

Solutions are never found outside ourselves, but inside us. It is all there.

them. This way the barriers and gaps between what is and what should be disappear by themselves. And that is what I want to explain to my grandchildren.

Red Hair, Grey Eyes

ELLEN DECKWITZ

46

Ellen Deckwitz is a poet, literary theorist and performance artist.

'We have just received a report that the authorities have started negotiations with the hostage-takers in the hospital. We now take you to...'

The balaclavas switch off the news. One of the hostages raises her hand. Sophie, the haematologist of dept. 23-C. Jolan had actually dated her once when they found out they shared a great-grandfather.

'Sorry?' Sophie is shaking a little. No response.

'Sorry?' She speaks slightly louder this time.

The fat hostage-taker turns his head.

'Yes?'

'I have to use the bathroom.'

The fat one sighs and points to the plastic wastepaper basket they have been using for the past twelve hours. It still smells only of urine in the room, but this may not be for long.

Sophie is shaking.

'But I have, I'm having...my period.'

Emmy snaps at her, telling her to get a hold of herself. Sophie moves to the corner face down. Most of the people in the room turn away their heads, except the fat one. They can hear her sobbing. Then it is silent for a long time. The sound of a trickle hitting a plastic bag.

Jolan is trying to figure out who these hostage-takers are. Religious fanatics, that seems obvious. Some of these fanatics have already carried out attacks on stem cell clinics. A Catholic

group from Ireland even claimed such an attack in a video that ended with a clear statement: 'No tear shed for the inbred'.

Jolan thinks of all the parties where he had to explain himself. It is not inbreeding. This is enhancing, the way they do with roses. That is why the Dutch are increasingly starting to look alike. Red hair, light brown skin and grey eyes.

Genetically speaking even the term 'inbreeding' is wrong. Ok, the forefathers of this new type of humans all came from Schokland, a tiny fisherman's village with a relatively limited genetic diversity. Many inhabitants were gingers, most had grey-blue eyes. Still, research had shown that there was much genetic diversity after all. But they all shared one characteristic trait.

'Right.' The tall hostage-taker enters the room.

'You,' he says, pointing at Alma Barefoot.

Muffled cries. The old Barefoot is probably the foremost genetic expert in the whole world. People had been developing stem cell chips for ages, but these were always rejected by the body, like a donor organ that doesn't fit. Genetic specialists didn't know where to look next.

It was Barefoot who discovered that the Schokland people all shared a common ancestor. This man had passed on to them a small genetic defect of the immune system. So their bodies did not reject the stem cell chips, simply

because they did not produce sufficient antibodies.

Jolan's parents had been part of the first test generation. And even though they had already been sixty by that time the chips were an instant hit. The same happened with thirty other test persons sharing this one ancestor. The effects had been impressive. The Schokland people wearing the stem cell chips could work longer, needed less sleep and were generally healthier than others.

This new generation of stem cell chippers was trained, displaying a unique way of thinking. Which was as accurate as the networks controlling their chips. Yet they remained creative human beings. These chips were issued by the government and chippers had to pay a large lease sum for use of the chips. The Netherlands suddenly became very rich. Very rich. Much richer than the rest of the Federation. We came to own a share in Qatar, the oil state. Barefoot received the Nobel Prize for this. And now someone is holding a gun to her head. The tall one sounds irritated.

'They are not listening to our demands, so we will take you up to the roof.'

He pushes her towards the emergency exit.

Jolan hasn't got a clue what the demands are. Most terrorists want the stem cell technology for themselves, to use it for their own people. This would finally enable them to compete with the Netherlands. So far the Dutch government has refused to share this technology with the world. Our country now presides over the G5, developing its own nuclear programme. Just in case.

The Dutch government refuses to share stem cell chip technology with the world.

As if she had read his mind. He hears Alma shouting from the roof:

'You simply can't stand the fact that we...'

She screams. Something falls past the window. The hostage-takers beckon Jolan. You just wait, he thinks. It won't stop with us. Pretty soon everybody will be ginger. Have a light brown skin. And grey, very grey eyes.

His turn to go up to the roof.



Men go to Venus, women to Mars

SABINE DE WAL

48

Sabine de Wal studied art history and works in graphic design studio Frederik de Wal. Besides that she writes articles and stories.

'I don't want to go to Mars,' Charlotte was carping, putting her arms around her legs and curling up in the far corner of her bed.

'Stop acting like a spoiled brat. This is a great opportunity and it would be dreadful if you didn't take it,' Emma said, making a dismissive gesture with her hands.

'Please adjust your smartedge and confirm at GBCom Board, otherwise they will not be collecting you.'

'But...,' Charlotte went again, changing a few codes on the touch-screen with her finger.

'Come on Charlotte, it has already been explained to you. A Grand Tour has always been a must for young people who have finished school. This is really special. Half a year on a different planet, each day a little history of mother Earth and an endless stream of parties to go to. There is also a space ferry between Mars and Venus and that will probably suffice to explore some other fields.'

Emma raised her eyebrows. The girl was silently shaking her head, looking anxious, with questioning eyes. Emma sat down on the bed, deciding to display some motherly calm. Maybe that would help to end this charade a little quicker.

'Dear Charlotte,' she spoke softly, 'already in the 18th century young adolescents from the British elite were expected to make a tour. This was an obligatory part of their education. In those days you were expected to discover the classic arts, so they would visit museums, musical performances and plays in the theatre. Since they did not have their own visuals system they would bring live visits to Rome, Paris, Milan and Vienna...' Emma was smiling inadvertently, but the little girl remained adamant. 'There was even a good chance you would have a sexual adventure, being free as a bird. Very exciting of course, but in passing you were actually being prepared for marriage. The Grand Tour was the best opportunity to escape from the restrictions of home. Go wild for a while. Wonderful!'

There was a brief moment of silence.

'That was four hundred years ago. No reason why I should be doing something like that now.' It came from behind Charlotte's arms and legs. She sounded angry. 'Those cities are no longer there and I am not interested in sex. It is childish.'

'Three,' Emma corrected her, 'three hundred years ago and no, of course you don't have to,

but it is so much fun! Less than a hundred years ago they still made these tours, only much further away. You cannot imagine this, but people still travelled on land. Hundreds of thousands of young people from Europe and the US would travel through Turkey and Persia to Pakistan, India and Nepal, and sometimes even to Australia. It was called the Hippie Trail. Sexual freedom was important, as was independence, making your own choices and sharing with your friends. I can say this for them, they sure were adventurous, young lady!

She looked at the girl on the bed with slight contempt, but Charlotte did not budge. Emma was getting impatient. It looked as if this would take some more time, but she did not want to miss the high-speed 18.12 tube.

‘But Emma, it is impossible. There is almost no water and really nothing to eat there.’ She sounded really upset, fearing this would happen to her. A young girl such as Charlotte could not imagine that people would go to a region as inhospitable, merciless and rough as Asia Corporated out of their own free will. Emma sighed. Cyber attacks were very frequent in Asia, knocking out 3D food printers. It was true, a trip there was not as attractive as it had been a hundred years ago. The peace-loving, naive hippies that wanted to make the world a better place would not even survive the trip. It actually ended already after the Afghan War of 1979. That had been the tipping point. Now the region was empty and barren. Only robots got through. The megacities had surveillance



eyes to monitor the ground from the air, and the smallest suspicious movement in between the power zones would lead to the next mini-war, the umptieth useless conflict, a cyber war that got people hurt. Food printers being out of order for a few hours or days meant no food and no water. She looked at Charlotte who was staring meditatively from the window at two young men in puffins zipping past in the air. The girl simply did not realise how great this opportunity was, a trip to Mars. How she would love the peace and serenity on this planet that knew no wars, power games between cities or the constant threat of total annihilation. Mars was there for a human reset, to escape the hectic pace of daily life and — provided their parents had the money — for young people to make their 21st century Grand Tour.

Emma knew she had to do something now if she wanted Charlotte's suitcase packed in time and the girl ready at stage 35 departure lounge B117, at 18.12 sharp, to start her voyage to personal growth. She put a light blue dress in the suitcase, starting with 'Sports & Tactics' from the packing list.

'So,' she asked, 'What sports will you be doing? quidditch, sterling ultraracing and maybe some good old-fashioned horseriding?'

'Horses still cannot live on Mars,' Charlotte retorted, 'so just quidditch and virtual tracks

hunting, but...'

She swept her thin legs over the edge of the bed, stood up and snatched the light blue dress from the suitcase. '... I am not taking that one. It is dull.' She threw a black flimsy dress into the suitcase, followed by her satellite dock and two hubs. 'There you go, my iMaster too. Hurry up Emma, otherwise we will be late.' Various items were thrown in Emma's general direction. She picked them up, smiling. Whatever had happened in that pretty little head of hers she did not know, but all of a sudden this young lady was very keen to travel.

Cyber attacks were very frequent in Asia, knocking out 3D food printers.

'Dearest, just one more thing,' she said while they were waiting in B117 for the spaceship. 'Please let me know once in a while how you are doing. You know, log in at GBCom Transics, stage 4 female 6008.' Charlotte nodded and embraced Emma fiercely. 'Oh yes, and once you have boarded please inform your parents that all went well and that you are on your way.'

Charlotte nodded again, wiping her nose and the corner of her eye with her sleeve.

'And please tell your mother that you have accidentally taken her new shoes to Mars, so that she will not be looking for them everywhere.'

A small drop

ELLEN DECKWITZ

51

Ellen Deckwitz is a poet, literary theorist and performance artist.

Dear dad,

I hope you will want to read this letter once you see that it comes from me. It was very difficult to find out where you are living now. Ever since you fled the Federal Union with the others who refused the DNA obligation I have heard very little from you. I hope this is the right address.

In my mind I see you living off the land. Maybe even hunting. Ironic really, that a confused technician such as you has ultimately chosen to live in the Stone Age.

I also don't know if you have already become ill. Whether the dreadful Parkinson is already affecting your thoughts. It was exactly this family disease that made me choose a career in healthcare. I think about you increasingly often. You always said that health is the most important requirement for freedom. Lately, however, it seems that the opposite applies.

Just as you suspected the Federal Union passed the law on obligatory DNA. It seemed so futile, just a tiny drop of blood. A tiny particle containing all data on each citizen, a minute passport of our genetic composition, unique and

all-encompassing, just like a fingerprint. The Union seemed to offer the solution for all problems.

I was already working at Mondi-Health at the time. The Union offered us the opportunity to develop the Chip, which at that time only existed on paper. Based on the individual DNA the Chip affects and stimulates the production of enzymes, meaning that hereditary diseases but also viral and bacterial infections are now countered directly by the body itself. The DNA Centre is used by the Federal Union to send new information to the chip on a weekly basis. The Chip then puts the body to work, sending back information. Twice a year these data are used for a personal stem cell injection. These are controlled by the Chip. A healthy humanity. For all eternity. And all that in exchange for a single drop of blood.

After fifteen years the Chip was there and as far as I can see we have done what we promised. The government pays for its manufacture, the plants and the hardware. And me. You always said that the person who pays also makes the decisions. And those who do not decide pay even more.

It all started when the Federal Union introduced the Health Credits system. People receive points on the basis of good behaviour as it were. It looks like driving without accidents, but the system behind it is really dangerous, because these credits are only given as long as people listen to the Federal Union.

Initially, if people worked thirty hours per week until they were seventy, they earned a full Chip. But in recent years we have seen a steady increase in additional requirements. People working less receive less Health Credits, so a limited Chip. Some time ago they even passed a law saying that Health Credits will now also be based on the amount of tax people pay. Those paying more than others will be the first to have a full Chip. By coincidence the people making the most money are already members of the board of the Federal Union. The people with less money are becoming the working horses of society. And that is not all.

Last week the Union approved a new legislative proposal. They plan to build in a kind of tracking device in the Chip so that they will always know where you are. It already has a mini-mike and if the Federal Union decides that you are a risk to society the law allows them to tap you. So the state knows where you are and what you do. People saying something bad about the state in the streets lose Health Credits.

In daily life this means that people listening to the Federal Union will lead a healthy life. People allowing the state to monitor them 24/7 will never be ill. Open your mouth and suddenly you will get a cold. Or the flu. Or one of those problems that come with age.

Health was once our most prized possession. But now our health is used against us. The Federal Union uses a disease-free life as the carrot, but before we knew it we were used for their own interests. Saying and thinking what is good for the Union.

Of course there is a lot of protest. There are hackers trying to get through to the DNA database to stop the government from blackmailing us with our health. But the database has an impregnable defence.

Dear dad, I would rather live in freedom and face the chance of Parkinson than contribute to a totalitarian state. Health is not the most important requirement for freedom. It is just the other way around. That tiny drop of blood we had to give them is much bigger than we could ever have imagined.

If that's the way life should be, I'd rather choose to live less years in the time bomb that is my body, but with you near me. I hope this letter reaches you. Please tell me that I can come and live with you.

Warmest greetings, Anna



The virtual breeding ground

SHELLEY VAN DIJK AND TIM MURCK

53

Shelley van Dijk is a dramatist who also works in online communication and copywriting. Tim Murck of Spektor Storytelling is an actor, writer, invited speaker and director.

The buzzer. Nathan wakes up with a jolt. A new assignment! Let's hope that this time he can stay in right till the end. In previous projects he kept getting pushed to a sidetrack by more experienced specialists. He walks to his desk chair, wondering what this assignment might be. He has applied for several projects. He is lucky that so much is happening in climate change these days. People need his expertise. Still, it is a lottery and people do have to invite him to a project first. Nathan logs in from his chair, opening the virtual breeding ground. He sees the project is about heat turned into energy. Good, his specialisation. The mind images thought up by his colleagues start appearing on the walls around him. Nathan absorbs the images, trying to find relations with his own vision.

Only five years since these virtual workspaces were introduced. Most people loved them, because travel to work became a thing of the past. Prototypes are now directly available in virtual space, allowing mutual consultation. It is also cheaper, because it enables people to work together without effort and wherever they are. It also enables people to create new plans and visions very quickly. International projects can

now be realised in extremely short timeslots. Virtually anyone working in teams is using this system. The only people not using it are actually the manual labourers. But the big disadvantage is that people get fired relatively easy. Project managers are quick to note whether your contribution has any value. If not, he puts another in your place.

The virtual space is getting crowded and Nathan sees the first ideas take shape on the walls. People are discussing, adapting ideas if necessary. The central brain, the project manager, assesses the ideas, deciding whether they can be used for the project. Some ideas are shelved, and may come in useful at a later stage. Other ideas simply disappear along with their owners, whose contribution was evidently insufficient.

After a few hours of debate, consulting and thinking, Nathan has had enough for the moment. He logs out and leaves the virtual space. Back to anonymity for a while. Everybody can see what he thinks online, but offline he can move into his own little world. A world without constant monitoring, where people cannot see



what he thinks and no high-quality performance is needed.

A few weeks later the project is done. A sigh of relief for Nathan. He has been there during the entire project. This not only means he will get paid for these weeks, but it is also a new project in his portfolio, his passport to future projects bringing long-term financial security within reach. Ever since the labour market shifted to total self-reliance the gap between poor and rich has become more visible than ever before. Not just on a regional or national scale, but global. Now that the only available work is project-based the economy has shrunk, destroying many lives. One moment you're top dog, the next you are sleeping in the street.

That is why there are so many workaholics, people working 24/7, afraid to log out for fear of losing their assignment. They hang out in virtual space for days on end. Others haven chosen to just lead a fully virtual life. Junkies, who forget and neglect the world around them.

For the time being Nathan is ok. He now has some financial back-up and more chance of landing the next project, although in each new project he will have to prove himself again. And again. Until one day he will be the centre of the circle, the brain of the project. One day he will be king of the circle.

The man who said no

ELLEN DECKWITZ

55

Ellen Deckwitz is a poet, literary theorist and performance artist.

It is about 7.30 when I arrive at the Charles Wertheim estate. Today it is one year ago that he became the prime minister of the European Union, only to resign the next day, being the last PM in our history. The moment I ask him about this he starts to laugh. Wertheim looks relaxed. Next month he will be 95, but he looks more energetic than ever. He leads me into his spacious living room. On the walls there are pictures showing highlights from his career.

His early days, halfway through the nineties, when he was a member of the municipal council for the liberals in the city of Groningen, and later even an alderman. His role in the Rutte cabinets.

Above the fireplace his finest hour, winner of the 2027 elections as the leader of Green '26.

He chuckles when he notices me looking. 'Yes, just like a young god.' Wertheim pours me a coffee and takes a seat. 'Ask me anything you want.'

'Right. You have been politically active for years. And the moment you were elected as our PM you suddenly resigned.'

'To explain this I will have to tell you something about my previous history first. When I entered politics in the nineties it was still a real trade. People would start young, mostly after studying sociology or law, and all the rest you learned

in daily practice. You had to. Democracy was a political system in which the people elected its representatives because they knew something about governing a country. And then suddenly some morons thought it was a good idea to undermine the power of these chosen representatives. They thought: Hey, we've got computers. We can use these to ask the people the same questions within a very short timespan, and directly show the results in a diagram. Wham! There we had a referendum. We were allowed to vote whether Europe should or should not have a constitution.'

'We celebrated the 45th anniversary of the first national referendum only last month.'

'Of course, because it became the natural start of our present government system. But we liberals hated it. Years of hard political work to learn to govern on behalf of the people who elected you, and then this.'

'So you are saying that citizens are unable to make the right decision when they vote in a referendum?'

'Of course not. They just think oh God, this European constitution will give these weird Poles the same rights that I have, so I will vote against. They do not have the capacity for thinking in



the long term. And that is how democracy was destroyed, even though people thought they were making the best possible use of their democratic right.'

'Churchill referred to democracy as the least bad form of government. Today most people would disagree.'

'Not me. Look, what really is a ballot box these days? A mandatory daily questionnaire. Do you want more trade with China? Should the Mediterranean become greener? Literally hundreds of questions that citizens have to muddle through in half an hour just to get rid of it. The results are processed day in day out in vast databases and that is what governs the Union. Clearly that is rubbish? Who has ever said that plans backed by the majority are always the best plans?'

'Well, that was actually the system people used when you were elected.'

'All of a sudden I had become the leading candidate for the post of PM. Nobody asked me. Nobody asked the citizens. Better candidates than me did not make it to the list. It was a simple choice between me and two other candidates. People were allowed to vote, but not allowed to vote from a whole list of candidates. Nobody was able to explain to me why I had become the leading candidate, and not others who were better qualified than me.'

'People know you from your opposition against the Wisdom of the Crowd.'

'Because I come from a system in which governing is left to people who have learned to do this [laughs]? Wisdom of the Crowd, and I am simplifying things here, starts from the assumption that the opinion of the majority is also the truth. That is ridiculous. In that case we would still think today that the earth was flat.'

'Some people would say that your decision was in essence the end to democracy.'

'When I was made the foremost candidate for the post of PM, against my own will, I knew that democracy was dead. Individuals no longer have freedom of choice. But I still had the right to refuse.'

'Your choice has not effected any change.'

'Really? So why are you here? I detected a maze in the law. If democracy was effectively dead, then let's go out with a bang. That is exactly why I made this show of my resignation the next day. Fireworks and all. Farewell democracy. I have never been as drunk that evening as ever before in my life.'

'Will we ever return to democracy?'

'Yes, [big laugh] but it will require an awful lot of referendums.'

The Westland in 2050

MAX REMERIE

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The posh and mundane Westland in the city state of RotterHague¹ has now become the residence of wine producers and affluent citizens. Due to the climate change and a change in the sea current that led to an inflow of warm water from the Canary Islands, the temperature has risen significantly. This has turned the coast from Rotterdam up to and including Scheveningen into the new European Riviera. Nowadays, Monster — a former greenhouse horticulture town — is the place to be seen walking on the boulevard and dining in exclusive restaurants. It is very agreeable here. Thanks to the constant breeze from the southwest, the air is clean. This is of course also the result of the 21st century Clean Air Initiative, which led to the Rotterdam industries now only emitting pure air. By that time greenhouse horticulture had already been moved to the high north. In 2020 European subsidies had enabled the government to carry out their plan to support such economically weak regions such as Groningen.

The greater RotterHague metropolitan area now has three million inhabitants. It is not the largest city state in Europe, but it is one of the most powerful and influential. Due to its neutral location between East and West and the decreased importance of the European economy on the global market, the Netherlands has become the centre of the world, just like Brussels was for Europe.

The twenties also saw the establishment of the International Cyber Tribunal in The Hague. This had become a priority due to new cyber terrorist cells that had formed in mainly Greece and Spain, consisting of jobless youngsters who time and again were able to disrupt international web traffic. They were becoming a serious threat to world peace. Fortunately the US, Turkey and Russia managed to convince China and India that nothing would go without the International Cyber Tribunal, thus firmly establishing The Hague as the City of Peace, Justice and Security in an increasingly global world inhabited by new powers.

¹ *RotterHague is a fictional fusion between the Dutch cities Rotterdam and The Hague*

Its strategic location has once again turned Turkey into a formidable player on the global stage. Its active role in the Middle East finally brought peace to the region. The local economies had all been disrupted by the Arab Spring, and people were turning on each other. With the support of NATO, Turkish troops had restored the power balance. Notably absent was the US. They had kept aloof after having given up their battle against Al Qaeda in the Middle-East, withdrawing all their troops. The Turkish economy flourished due to the reconstruction work needed on harbours, airports and roads in countries such as Egypt and Syria, but also in Russia and other countries formerly belonging to the Soviet Union, such as Ukraine.

In the city state of RotterHague, the natural, evolutionary result of what once had been the Rotterdam-The Hague metropolitan area, the citizens had successfully dissociated themselves from the European and Dutch governments. Of course they still pay a sizable share of their income to the EU and Dutch tax authorities, but they have managed to create a certain degree of freedom. Citizens have successfully united through social media, using their own resources to create a local pension plan. After all, the old age pension paid by the state has become a joke. All the money goes to other European regions, to people who really need it.

People are healthy these days. It is clear that the vast investments in the Medical Delta have paid off: [Aspirin is something that you put on your sandwich](#) and although the anti-obesitas pill was very expensive, it was also a great success. But the difference between poor and rich

is clearly visible in RotterHague. The burqa has made a comeback. It is now used to hide in.

Shiploads of these miracle pills were exported to the East and the West, sometimes being traded against rare earth elements and other natural resources. The further developments of the digidrug meant that people could take a mental break at any moment, without any side effects. It is also cheap. Hard drugs are still prohibited, and although the authorities do not come down hard on users of soft drugs, the use of digidrugs is actively promoted, with the support of both employers and the government. Especially the DDA — Digital DrugApp — had been a striking success. Fancy the Caribbean for half an hour? Just press 'C'. Want to be the best soccer player in the world, if only for five minutes? Press 'S'. Hooked on cocaine? You no longer need it. The touch-screen provides virtual satisfaction without any harmful side effects. An additional great advantage is that people are finally able again to relax and to communicate with each other without constantly checking incoming messages. That had actually been a big problem in the twenties and thirties. The DDA had also been instrumental in wiping out ADHD.

The breakthrough in cold fusion meant that people were now self-sufficient in energy. When the authorities decided to create a local internet environment, RotterHague became much less vulnerable to the cyber attacks from the south of Europa, the Philippines and Thailand. Especially in the latter two nations politics have become totally unreliable through corruption and repression. The Chinese and Indian authorities were confronted by a revolution instigated



by the strong middle class, but they successfully averted disaster through their willingness to listen and communicate.

The people living in and around the Westland are also happy. Self-sufficient, autonomous and still part of the bigger whole. There is always a power supply, that is, if the own sources are operational. If not, there is always the permanent connection with Harwich, a smart cable railway and power line in one. If the locals produce too much power it is exported to England where it is used to pump up water in retaining reservoirs. In case of potential shortages in RotterHague this water is used to rotate the turbines, and the power is then fed back to Rotterdam through the same cable. The idea to combine this system with a cable railway means

that the crossing to England is now really easy, and a very good alternative to travelling by Thalys and Eurostar. London has never been this close since the Fyra disaster.

High water is also no longer a threat. There are now vast inflatable dikes that fill when the flood comes and empty themselves at ebb tide. The expected braindrain of knowledge and expertise when the elderly started moving to Africa was, with hindsight, not as bad as had been expected, although that was not entirely our own merit... The Anti-Christian fractions in Africa ran amok against the tsunami of European refugees, fearing the Europisation of Afric. Especially the elderly were not welcome. There were so many of them now that stem cell transplantation had become normal. Stem cells have

rendered people virtually immune to disease. People get older and older, although as age progresses the mind becomes weaker. Alzheimer is now public enemy no. 1. It was therefore no surprise that the ships carrying mostly elderly people with the disease were sent back through Madeira to their places of origin. The authorities had used the luxury resorts on the island to house these refugees and when they returned to the Netherlands, a programme was set up to teach them knitting and crocheting. Making glass fibre clothing turned out to be a huge success, eliminating child labour in Bangladesh. Granny's Finest Ltd. became a big hit.

In the end it was the revolt against the banks in the arrogant city of Amsterdam that really united the people of Rotterdam. After four bank crises in two decades people had had enough. Bankers were smeared with tar and feather and then sent back to their main offices in Amsterdam. Their houses and luxury cars were impounded, their 3D printers taken away. At the same time a DDOS attack by an insider at the bank knocked out all traffic of payments, meaning that no-one had access to his money anymore. The shortages in the shops lasted for weeks, leading to the final crisis. But hunger and plunder ultimately brought the people together. Politics were brushed aside and, led by a committee of the wise and youngsters connected through social media, people started to collaborate with each other. They started accumulating savings, foreign currencies, bitcoins, anything and founded the Rotterdam Cooperative Bank. Investments were focused on an independent Rotterdam infrastructure. Independent of European policy, but still connected. With

governments in China, India, Russia, the US and Turkey this is the new Byzantine Empire. The regional major and aldermen introduced a 'four eyes policy' to check each investment for its financial consequences and feasibility. Budget deficits were prohibited by decree. The occasional financial windfalls and the huge income from the tax on the anti-obesity pills were set aside for the future, for innovation. A regional development fund to boost employment was started.

And now that the Medical Delta, the Clean Tech Delta and The Hague Security Delta are in place it is time we think about a new delta... a delta of wine, and tourism. A delta with an international reputation and with autonomy. A unique city state. The US had its Texas Lonestar State, South-Germany its Freistaat Bayern, but we have Rotterdam, the beautiful city state behind the dunes, an international centre of Peace, Justice and Security. A main port that still fills the original inhabitants of Rotterdam with pride... the Westland with Monster as its mundane bathing resort with a casino that even people from Paris love to visit. Not too cold, but very agreeable till the late hours.

And of course ADO-Feijenoord has won the World Cup. For the third time in a row.

People are healthy these days. It is clear that the vast investments in the Medical Delta have paid off.

3. GRAND CHALLENGES & SIGNALS FOR CHANGE

In 2009 the EU presented the Lund Declaration, calling for a common approach to the major issues of today, the Grand Challenges.

Grand Challenges 'are of sufficient scale and scope to capture the public and political imagination, create widespread interest among scientific and business communities and NGOs and inspire younger people. They must be capable of acting as an important tool for percolating attention at all levels of society all the way down to civil society and the public at large.'
– European Commission, 2012

According to the EU European research should investigate today's Grand Challenges in a way that goes beyond the present rigid theme-oriented approaches. In our search for the Signals for Change (SfCs) and the Unknown Unknowns (UUs), the Grand Challenges (GCs) were used as the point of departure in order to clarify the implications of the signals. This chapter describes the confrontation between the GCs and the SfCs.

The STT Horizon Scan 2050 focuses on six GCs. These are interacting with the relevant SfCs and UUs, the Unknown Unknowns being events or developments of which we do not know that we do not know them, making it difficult to anticipate them. The full list of SfCs, including a concise description, can be found in Chapter 2.

These are the six Grand Challenges:

- 1 Scarcity
- 2 Climate change
- 3 Demographic change
- 4 Longer life
- 5 Global power shifts
- 6 New connectivity

In this chapter we will provide a brief description of each Grand Challenge, which is mainly based on *Global Europe 2050*, the report by the European Commission. With each Grand Challenge we will also list the Signals for Change that according to the participants in our [workshops](#) are most likely to be relevant for or have impact on the GC involved. Mentioning these, however, is not to be taken as an indication of the likelihood or desirability of these signals.

The Unknown Unknowns ('What if ...?') listed in this chapter are also the product of our workshops. They aim to stimulate the reader to think further, by which we mean much further. This is difficult, since it implies having to define the impact on the six GC by events or developments of which we do not know that we do not know them.

Each GC also includes a description of the themes, issues and scenarios that were brought up during the workshops. Storytellers were invited to give their own rendering of the interaction between the Grand Challenges and the Signals for Change. Their stories, included in this book, help to create a vision of what the future may bring. It is of course fiction, but a fiction that may become reality one day.

When reflecting on the interaction between the GCs and the SfCs it is very important to take into account the rebound effect, meaning that technologies offering a solution for future challenges (such as biodiesel) may in turn lead to new challenges. We can see this happening around us. For instance, it was generally believed that digital photography would save us time, only to see people becoming increasingly engrossed in recording their own lives. There are, however, still just 24 hours to a day. No more.

3.1 Scarcity

Economic growth means the use of scarce natural resources. If people become richer they will use up more energy, water and food, and create more waste. Technological advances often also lead to increased consumption, as well as to new challenges (rebound effect). The much acclaimed introduction of biodiesel, for instance, led to an undesired decrease in farmland used for food production.

Growing demand

There is an end to our natural resources. Many of these resources are found in areas that are politically unstable. The rise of the BRIC¹ and MINT² countries (and probably other nations in the future as well) and the corresponding growing prosperity have increased the demand for natural resources considerably, creating an additional problem for countries consuming the most.

The solution?

A transition to renewable resources, as is done in a biobased economy, may be the solution. In a biobased economy non-renewable fuels are replaced by biomass. Still, even renewable resources may be exhausted, for instance through overfishing. Also a transition to renewable resources may create new problems. Recently, for instance, the EU limited the production of biodiesel, because, apart from causing accelerated deforestation it drove up food prices. Furthermore, it will take a number of decades and vast investments to adapt the existing infrastructure for the distribution of natural resources (such as pipelines and harbours) to the transition to renewable resources.

Renewable and non-renewable natural resources are not distributed evenly across the globe. That is why for centuries they have played an important role in global relationships. The GC Scarcity therefore has a strong link with the GC Global power shifts.

According to the participants in our workshops the following SfCs are likely to have a large impact on the Grand Challenge Scarcity:

- Decreasing difference between the virtual and real world.
- Artificial photosynthesis: using sunlight to convert CO₂ (and water) into oxygen and carbohydrates (sugars).
- Rise of programmable matter adapting autonomously or through user input.

1 BRICS countries: nations seeing an economic boom after 2000: Brasilia, Russia, India, China and South-Africa.

2 MINT countries: nations currently (2014) having a large potential for economic growth: Mexico, Indonesia, Nigeria and Turkey.

- Use of algae for the production of e.g. food, chemicals and fuel.
- Extreme self-organisation and self-sufficiency.

UNKNOWN UNKNOWNNS FOR FURTHER REFLECTION

What if...

- *In 2050 energy is free for all?*
 - *There is no more scarcity?*
 - *Artificial photosynthesis solves all energy storage problems?*
 - *Cold fusion becomes reality?*
 - *The transport of electricity becomes wireless, making us independent of old infrastructures?*
 - *It becomes a national sport to keep our environmental footprint as small as possible?*
 - *Waste becomes so expensive we can no longer afford it?*
 - *Scarcity is simply the result of information scarcity?*
 - *There are new forms of transport, we no longer drive cars but drones (autonomously 'flying vehicles')?*
-

Towards 2050

The workshop on the GC Scarcity produced three visions of the future:

1. We solve scarcity through technology or a change in attitude and behaviour.
2. We solve the present scarcity, but there will be new scarcity.
3. We cannot solve scarcity, which will have major consequences.

We solve scarcity through technology or a change in attitude and behaviour

- A. *Technological breakthroughs will solve scarcity in one or even various domains.* Examples: energy storage, a new way to generate energy, desalination of seawater. Seawater may also be used for cooling greenhouses or in sustainable production. A real opportunity for the Netherlands.
- B. *We change our lives and consume less.* The issue of scarcity is solved by limiting waste, as is done in the Cradle2Cradle concept. Or we move from an organic food chain to a chemical chain. Maybe in the future we will all be eating pills, or rely on biological, locally produced food. Or genetically manipulated food and lab-grown artificial meat.

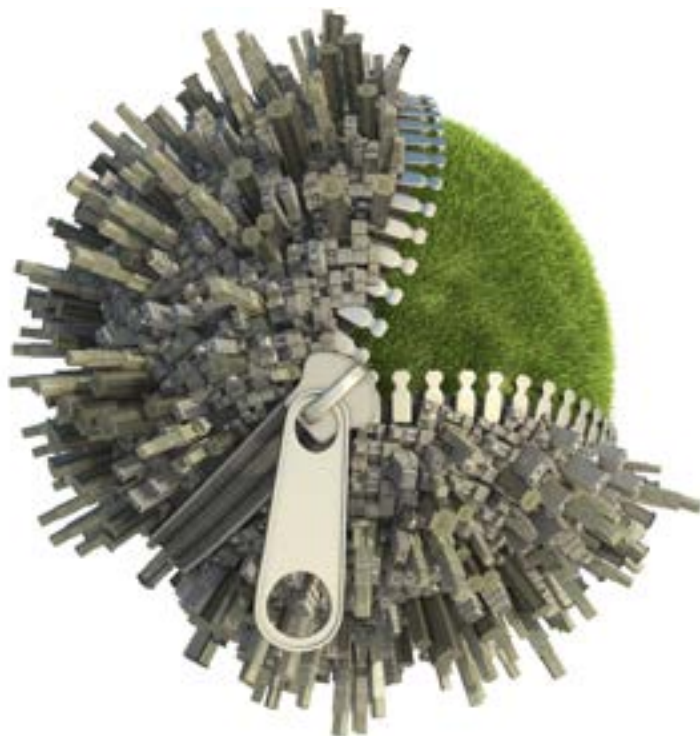
- C. *Common natural resources are privatised on a global scale.* Market prices will regulate access to these sources. Large stakeholders will control the strategic assets in other parts of the world (the way China does now in Africa).
- D. *Global management of natural resources allows sustainable consumption and access for all.* All nations should accept a common responsibility to maintain a minimal level of social security, in which each citizen has the right to a specific amount of food as well as primary education. This solution has a link with the GC Climate change.

We solve the present scarcity, but there will be new scarcity

The transition from non-renewable resources to renewable resources may lead to new non-renewable resources or new scarcity. For example scarcity of land. Or maybe there will no longer be scarcity of material items such as natural resources, but only a scarcity of immaterial items such as privacy, time and attention for each other.

We cannot solve scarcity, which will have major consequences

We will exhaust the earth. Increasing scarcity will lead to less prosperity for future generations, and to large geopolitical conflicts.



3.2 Climate change

Man's relation to earth is complex. Earth and nature determine the fate of mankind, but in turn mankind determines the fate of earth (nature) through technological advances and the extraction of natural resources, for instance, through large-scale deforestation, leading to less biodiversity and, consequently, desertification and erosion of the soil. Or through dumping plastic in the ocean (the infamous plastic soup). Ever since the seventies of the 20th century there has been a global debate on the limits of growth. Will tomorrow's population be so large that it will exhaust the earth?

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Greenhouse effect

Experts believe that climate change (through the greenhouse effect and global warming) will render specific regions on earth uninhabitable [Knox and Marston, 2011]. Weather conditions may become more unstable and more extreme. This will, for instance, increase the risk of large hurricanes and disastrous floods. Extreme heat and lack of water may turn specific parts of the world into deserts. Cities lying on the coast may disappear into the ocean.



Is the changing climate caused by mankind or simply the result of a natural climate change (take for example the Milankovic cycles [Sciencecourseware.org, 2014] or the Gaia theory [Gaiatheory.org, 2014])? Human actions seem to have an influence on climate change, but more important: climate change has large implications for human life. The challenge is to maintain its sustainability on behalf of future generations.

The Solution?

The European Commission advocates a paradigm shift in the global economy, especially in efficiency of manufacturing and energy-saving solutions for cities. Chances are that in the future natural resources will be more scarce (see GC Scarcity). The climate change and scarcity will of course bring about innovation, but there is a real need for governance of this innovation [EC, 2012].

According to the participants in our workshops the following SfCs are likely to have a large impact on the GC Climate change:

- Breakthrough in cold fusion.
- Emergence of a fourth-generation nuclear reactor (Travelling Wave Reactor) turning fertile material into fuel.
- New alternatives for oil in the manufacture of plastic, such as biomass and methane.
- Arcology: combining architecture and ecology.
- Loss of trust in national politics and government: need for a new system.
- Changing global politics.

UNKNOWN UNKNOWNNS FOR FURTHER REFLECTION

What if...

- *We discover an underwater paradise?*
 - *Society forces businesses and organisations to be more conscious of their environmental footprint?*
 - *Seeds and microbes from the permafrost become a global pest?*
 - *The bee becomes extinct, with huge consequences for food production?*
 - *We will see more natural disasters due to the climate change?*
 - *We move to other planets to colonise them or to extract their natural resources?*
-

Towards 2050

The workshop on the GC Climate change led to three questions:

1. How many people can inhabit the earth in 2050 and under which conditions?
2. How do we sustain earth on behalf of future generations?
3. Will mankind have to look for new territories (other planets) in order to survive?

The answers to these questions are either optimistic or pessimistic. There may be technological breakthroughs and sustainable production and consumption. Or less biodiversity, global inequality and the potential extinction of mankind.

Optimistic views

- There will be a breakthrough in sustainable forms of production and consumption (circular economy).
- Eco-innovation and green technologies become the basis for a sixth Kondratieff wave or third industrial revolution.
- IT allows us to calculate exactly how we can exploit ecosystems without destroying them.
- New green production systems for specific needs, doubling agrarian productivity and reducing waste by 33%.
- Scarcity and war boost solidarity. Apparently we need wars.
- Who will benefit from climate change?

Pessimistic views

- The unequal distribution of climate change effects will increase further, Third World countries suffering more than the West.
- Less biodiversity and new diseases are a great danger.
- How do we balance between measures to influence the climate in a positive way (e.g. the use of desalinated seawater for greener deserts) and the loss of ecosystems?
- Tensions create new tensions: disease-scarcity-war.
- System Earth will survive without people. It's our choice, however, to (be able to) stay.
- Prevention is no longer enough. People, animals and plants will die by the millions and the challenge will be to deal with the consequences.

3.3 Demographic change

During the next decades improved healthcare, more access to education and higher living standards will lead to a population increase. According to the UN and OESO the world population will increase to 9 billion people in 2050, with a peak of 9.2 billion in 2075. An additional two billion people in forty years. In other words, increased competition over scarce resources (see GC Scarcity).

What will old age mean in the future?

The average life expectancy for each region differs, but on a global scale it will rise. As of 2030 a life expectancy of 106 will no longer be surprising. The notion 'old age' will have to be redefined. In many developed economies 55 years old is middle-aged now. If the global trend of people migrating to cities continues, more people will be living in cities than ever before (urbanisation). These cities can only be viable places if they are sustainable, smart and resilient.

At present we see decelerating economic growth and decreased productivity, whereas government expenditure continues to rise, especially in healthcare. In the long term In the long term, staff shortages are expected in Dutch employment sectors such as IT, healthcare and technical professions [CBS, 2014a]. Massive ageing may also prove to



be a time bomb for healthcare, pensions, taxes and social dynamics in general. If people would continue to work after becoming 65 this would, according to experts, solve many problems that are connected with ageing. In 2040, the Dutch *old age dependency ratio* (ratio working force and people over 65) will be over 40%. There will be a new social mapping between the young (working) generations and older (no longer working) generations.

Migration

The biggest uncertainty factor in demography is migration. Some countries and regions are experiencing a brain drain of young, highly educated people looking for work elsewhere. Other countries are literally flooded by (labour) migrants. This may be a solution for the ageing problem, but it may also create tension between populations.

According to the participants in our workshops the following SfCs are likely to have a large impact on the GC Demographic change:

- The limits of economic growth.
- Drones: autonomously flying 'vehicles' on every driveway.
- Possibilities of a new generation in IT.
- Prediction of human behaviour through big data analysis.
- Rise of robots in daily life: robots will be better in daily tasks than humans.
- Reduction of the welfare state in many (European) countries.
- Increased global inequality between poor and rich.

UNKNOWN UNKNOWNNS FOR FURTHER REFLECTION

What if...

- *There will be mega-migration flows?*
- *Solving the GCs will lead to a global population of 20 billion people or more?*
- *The birth rate in the West will rise?*
- *It becomes possible to live or produce on the bottom of the ocean? Or on Mars?*
- *A large epidemic, a pandemic, a natural disaster or some insect infestation annihilates large parts of the global population?*
- *People become immortal?*
- *The advantages of the city become less attractive due to autonomous transport?*

- *People are born with debt as the result of the debt crisis?*
 - *There will be new money systems?*
 - *The virtual world counts more people than the global population itself and age is not an issue there?*
-

Towards 2050

The workshop on the GC Demographic change led to five questions:

1. How do we deal with a growing population?
2. What will be the price of ageing?
3. How do we solve the shortages on the labour market?
4. What are potential conflicts and what is fair?
5. What are the positive sides of ageing?

How do we deal with a growing population?

The issue of the growing population is not just about the number of people, but also about balance and distribution of the population. And about the gap between poor and rich. How do we distribute resources that will be increasingly scarce over a larger population? In the future there may be geopolitical conflicts about water. Also, population growth and scarcity will lead to increased self-sufficiency.

What will be the price of ageing?

How will we maintain our social security and healthcare, with so many elderly people and a relatively small labour force? This is a problem throughout Europe. And what will it mean for the position of Europe if the rest of the world has a young and productive labour force?

How do we solve the shortages on the labour market?

The solutions for shortages on the labour market range from job automation (robotics) to migration. Also, there appears to be a mismatch between the available jobs and education. Working longer after becoming 65 — a possible solution — is already a visible trend. A higher birth rate would have the same effect.

What are potential conflicts and what is fair?

Will the younger generation be able to cope with the high healthcare cost of the older generations? Or even accept this? It is, after all, the younger generation that will have to make the money. Working longer will partly solve the pressure of the ageing population, but also keep job positions occupied.

What are the positive sides of ageing?

Population growth and a changing population structure may cause problems, but an elderly society may also have its positive sides. For instance, the elderly have more time for voluntary work and more money to spend (silver economy). They generally are also more aware of the impact of moral issues and human relationships.



3.4 Longer life

The average life expectancy in the West has risen extremely fast. In combination with a falling birth rate this leads to ageing of the population, and — consequently — turns care of the elderly into a challenge. Especially, when it comes to informal (family) care for women. The growing demand for healthcare is also felt on the labour market. Almost 75% of the primary caregivers is female, and more than 30% of the people caring for a family member also has a job [EC, 2012]. Work and informal caregiving are in each other's way.

New values

There are indications that increasing prosperity leads to changing values and ambitions, also in the emerging economies. A higher life expectancy and more prosperity make people look different at the quality of life. The living standard in the various regions is still measured in Gross Domestic Product (GDP) per capita. But this may change. Think, for instance, of the so-called Happiness Index. In more prosperous societies materialism and consumerism are gradually losing their attraction. In the future people will probably mainly want to measure the quality of life.

New threats

There are also new threats. The extreme mobility of people and goods means that a lethal virus from Africa may be here within hours. The resistance against antibiotics among bacteria may also become a big problem. Finally, the capacity of mental healthcare may be strained in the future because of an increasing number of patients suffering from dementia and/or Alzheimer.

The solution?

It is expected that the demand for healthcare will rise faster than the supply from the labour population. Perhaps the solution lies in technology. Robots may become the new nurses, and domotics will allow people to live at home longer by themselves. In the future technology may even be inside our bodies (for example nanotech), meaning that man and machine will increasingly fuse together.

According to the participants in our workshops the following SfCs are likely to have a large impact on the GC Longer life:

- Growing potential of stem cells.
- Hybrid-assisted limbs: an external skeleton enabling (previously) impossible movements.
- Skin embedded touch-screens: means of communication and body monitor in one.
- Use of chips in the human body to monitor health or as identification.
- The advent of singularity: the moment that man and machine become one.
- Enriched reality.
- Global growth of prosperity with a focus on the environmental footprint.

UNKNOWN UNKNOWNNS FOR FURTHER REFLECTION

What if...

- *Genetic manipulation allows us to create the perfect human being? Who determines what perfection is?*
 - *In 2050 stem cells have eradicated all diseases?*
 - *Our psychological capabilities (telekinesis, telepathy) develop so fast that we can no longer control them?*
 - *A virus damages or destroys the world food supply?*
 - *People decide to just not die any longer and this can be done?*
 - *Through technology or mutual solidarity a care surplus occurs?*
 - *People can be hacked?*
-

Towards 2050

The workshop on the GC Longer life led to three visions of the future:

1. People become immortal, leading to new ethics.
2. New and more serious diseases.
3. New vision on the quality of life.

People become immortal, leading to new ethics

Many visions of the future of healthcare predict that technology will render mankind immortal, for instance through new medicine, stem cells or programmed DNA. Or because people become one with the machine and body parts will be easy to replace. Or because a digital human being will arise whose personality and memories will be stored on a chip. The idea of a longer life or immortality leads to many ethical questions. Is living longer something we really should want? If so, under which conditions? Not everybody will allow the implantation of technology in their bodies.

New and more serious diseases

Future diseases may become worse. The globalisation renders us vulnerable to pandemics and the spread of new viruses. Even technological solutions such as genetic manipulation, printed food and lab-grown artificial meat may carry a risk. In places where there is no scarcity of food people suffer from welfare diseases such as obesity and diabetes. And concerning future mental afflictions, think of the crowded cities populated by overstimulated, depressed or anxious people.



New vision on the quality of life

Ageing leads to questions about the quality of life. If we live longer, this does not automatically imply a longer quality of life period. Maybe in the future healthcare becomes too expensive, meaning that we have to change our way of life. By working less, for instance, and taking more care of family members. Maybe in the future we will care less about our material well-being and more about immaterial matters such as spirituality and the care for others. A scenario in which health will primarily be one's own responsibility is conceivable.

3.5 Global power shifts

State borders and geopolitical relationships resulted from centuries of voyages of discovery, from colonisation, decolonisation, wars and the Cold War. Much of the political unrest in the world is caused by the globalisation of the economy [Knox and Marston, 2011]. In addition, a global power shift is taking place. Asia is becoming more powerful. During the past ten years Asian countries have accounted for half of the global growth of the Gross National Product (GNP). All indications are that within the next ten years Asia will dominate Europe and the US. The fast rise of India and China will lead to a multi-polar world in which the US is no longer supreme.

The world is not becoming any safer

By definition political developments are unpredictable, although the strategic visions of the most important international players do provide some insight into the future of the international political constellation. Political stability in the West is likely to remain, but does this also apply to the Third World? Ethnic rivalry (South-Sudan) and regional conflicts (Middle-East) will not cease overnight. An increasing number of weak states may become the playground for drug cartels (South-America) and terrorists (e.g. Afghanistan). Bioterrorism, cyber attacks and attacks with nuclear material will remain a structural threat in the future. In 2050 the world will most probably not be much safer.

According to the participants in our workshops the following SfCs are likely to have a large impact on the GC Global power shifts:

- Utility fog: a 'nanomist' of tiny robots able to replicate a physical structure.
- Changing global politics.
- All use of information is controlled. A different approach to privacy.
- The experience economy: goods become services.
- Widespread melting of Arctic and Antarctic Poles.

UNKNOWN UNKNOWNNS FOR FURTHER REFLECTION

What if...

- *Africa is the most innovative continent and world leader in 2050?*
- *Government loses its legitimacy?*
- *Companies or governments control our lives through artificial intelligence or singularity (fusion of man and machine)?*
- *There is a free trade zone between Europe and the US?*
- *Sensitivity becomes a downloadable app; will this lead to less conflict between cultures or nations?*
- *People no longer want to work harder and harder for money that has decreased in value?*
- *We will be living on another planet such as Mars? Will this be a colony or an independent state? Who determines who will be allowed to live there?*
- *The polar ice caps melt, leading to geophysical changes? Will Leuven be the largest seaport in Europe? What are the implications of geophysical changes for geopolitical relationships?*
- *Google Translate is so advanced that there are no language barriers anymore?*
- *Networks will govern worldwide, rendering governments obsolete?*

Towards 2050

The workshop on the GC Global power shifts led to three questions: Where? Why? How?

Where and with whom will power be concentrated?

Political and economic power will shift from nation states to supranational power blocks and cities or mega-regions, for instance, the axis London-Tokyo-New York. Cities will continue to grow and become self-sufficient. Other potential powers are the large multinationals, the crowd and intelligent computers and robots. The lack of faith in governments and authorities increases. A power shift towards supranational organisations (such as the EU and the UN) — a global government with a global currency — will not automatically lead to more peace and harmony.



Why conflicts?

The distribution of resources — the competition over oil and natural gas — is one of the main causes of geopolitical conflicts. In the future this may also include access to water and rare earth elements. Even the new multi-polar constellation may lead to conflict. The emerging powers have their own vision of the world, and this may differ from ours. The West will find it difficult to maintain its influence.

How are we going to solve this together?

This is a tricky question, because the solution for problem A or party B may be a problem for Party C and create new conflicts. A multi-polar world essentially means that there will be more visions existing side by side, so that it will become difficult to act together in complex systemic issues such as poverty and the environment. This will, for instance, require a redefinition of economic success and global progress, with a focus on crucial factors such as ecological sustainability and social cohesion [EC, 2012].

3.6 New connectivity

An increasing number of obligations and networks exists outside the family context. This leads to less cohesion in families and households, influenced by technological developments in mobile communication, social media and computers. Our social tissue appears to change from 'blood relationships' to 'chosen relationships'. Relationships are increasingly driven by (temporary) affiliations and interests.

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Generations and changes

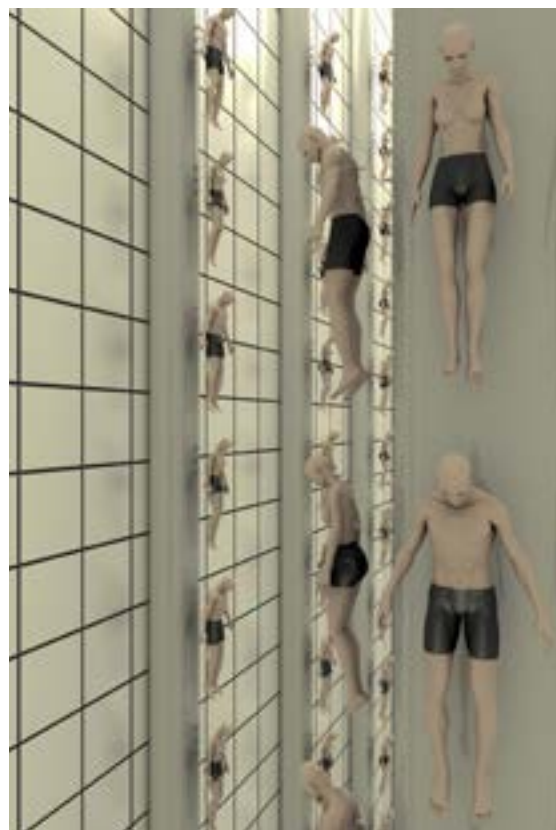
The next generation, also called digital natives, will change the rules of the game. This generation will be a dominating power in the ageing West, even if economic growth is zero. Shortages on the labour market will force employers to be flexible or move away. The younger generation will demand more flexible and attractive labour conditions in line with their own ambitions. This generation will also be 'hyperconnected'. Virtual online collaborative communities will be the best way to get things done.

Global connectivity

Increased connectivity will change the way people live, work and think. Mobile hardware in particular is the key technology for access to the web. At this moment, on a global scale approximately two billion people have access to the internet. 2.5 billion people use a mobile phone. 13% of the global population are living outside the country of origin these days. In 2020 the majority of the population in development countries will gain mobile access to the web. Most new users will come from China and India. Sharing ideas on a global scale will become increasingly easier.

Man and machine

In time computers may become smarter than human beings. This is a potential dilemma. If machines are more intelligent than their makers, what would stop them from seizing power? Machines first took over repetitious manual jobs, but it will not stop there. Maybe many more people will become superfluous because their jobs can now be done by computers.



The convergence of computers with robotics and nanotech may lead to a number of disruptive technologies. Nanotech will affect the entire industry, including air and space, energy, transport and medicine. The market will see products we cannot imagine yet.

We may see a radical change in representative democracy (the current Dutch system), the crowd becoming the dominant power. Social media and online action have the potential to change the future policy landscape. It allows an increasing number of citizens of any age or background to participate in policy debates, exchange ideas, organise support (sometimes with lightning speed) and propose measures, simply circumventing traditional politics. Online shared intelligence enables people to force breakthroughs in any societal domain. For instance using [co-creation](#) [STT, 2012].

According to the participants in our workshops the following SfCs are likely to have a large impact on the GC New connectivity:

- Risk of cyberterrorism endangering stability of the economic system.
- Changing global economy through digitisation and robotisation.
- Prediction of human behaviour through big data analysis.
- The exocortex: an artificial brain that is far more advanced than the human brain.
- Embodied avatars: remote-controlled physical avatars interacting with their environment.
- Loss of trust in national politics and government: need for a new system.

UNKNOWN UNKNOWNNS FOR FURTHER REFLECTION

What if...

- *All information becomes available to anyone, anytime and anywhere? And what if it can be downloaded into the brain in a millisecond? Will information still have any value?*
- *Every home has a 3D printer capable of printing anything. What will this mean for transport and distribution? What resources will we require?*
- *Hypertransport (e.g. teleportation) allows us to travel the world in five minutes?*
- *A quantum computer can hack any security system?*
- *The virtual world becomes more important than the real world, and there are no more schools and hospitals?*
- *It becomes possible to read and send thoughts?*

- *Human behaviour is controlled by big data?*
- *Machines are not just quicker and more precise, but also more creative than people?*

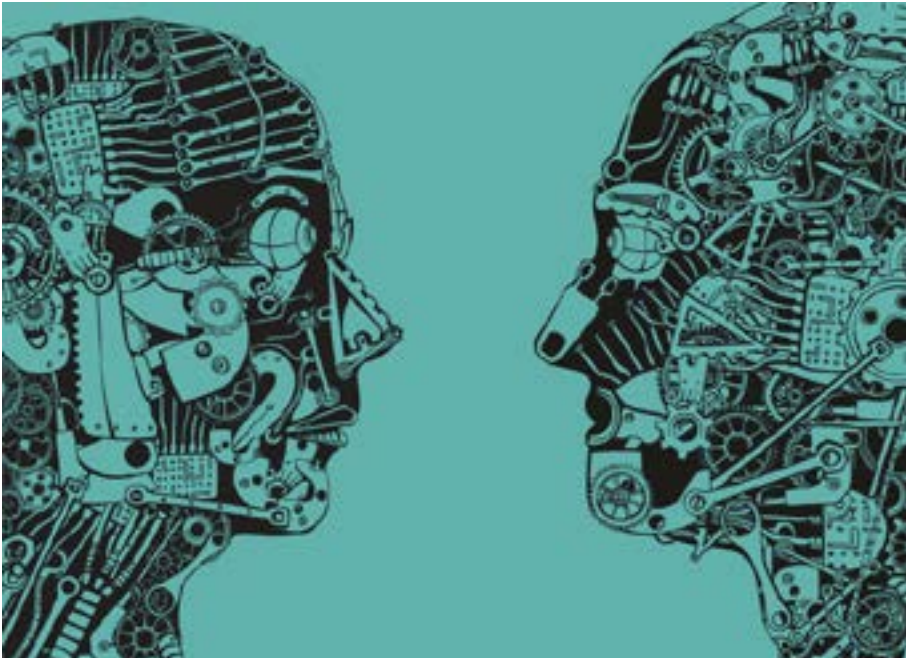
Towards 2050

The workshop on the GC New connectivity led to three visions of the future:

1. Everybody will be digitally connected.
2. Machines in power.
3. New etiquette.

Everybody will be digitally connected: a superorganism?

It appears that in due time everybody will be connected with others worldwide, initially through the web. The hardware needed will, however, become increasingly smaller and may ultimately become part of the human body itself. There are also indications that in the future we may be linked through our brain, becoming a kind of superorganism. This in turn may lead to a new global spiritual consciousness. Or to a fair distribution of resources. The downside is probably loss of privacy, private property and personal identity. Cyber attacks and brain manipulation (brainwashing) at a global level will be a serious threat.



Machines in power

If computers and robots carry out an increasing number of human tasks and turn out to be better in specifically human characteristics such as creativity, spirituality and justice, they will become our equals and maybe even smarter than their makers. This will have large consequences. Maybe man will not have to work at all any longer, his only worry being the quality of life. Maybe the machines will seize power, man becoming slave to the machine.

New etiquette

Global connectivity will lead to a new etiquette and — possibly — also to a social and cultural revolution. If everybody is connected and able to participate in decision-making the role of traditional politics will change or even disappear, especially if *crowd-funding* will become more important than the government budget. But who will, in that case, guard the unpopular (but necessary) interests? Will people in Africa have a say in European politics? Not everybody can or wants to be part of the crowd. New connectivity may lead to new boosts for increased geopolitical stability. Or to social and cultural conflict.



4. SYNTHESIS

In the previous chapter we addressed possible relationships between the Grand Challenges (GCs) and the Signals for Change (SfCs). In this chapter we will make choices and explain which SfCs we think are relevant. And what visions of the future we have for all six GCs. In short, what are the implications of the interaction between the most relevant signals and the GCs for the future?

The aim of this book, however, is to inspire the reader and to stimulate him to form his own image of the future, which is, of course, different for all of us.

Trend bureaus and foresight organisations have published various overviews of trends and signals³ that will determine our lives in the next decades, often mentioning the development of the city state or metropolis, 3D printing, the internet of things, the return to ancient wisdom, cyborg marketing, the medialisation of society, collective intelligence, the resistance of bacteria, the colonisation of space, etc.

Many of these trends are also described in the STT Horizon Scan 2050, albeit that in our workshops there was a tendency to stress the social signals (see the table below). Why? Is it perhaps because we sense the inevitability of the technological, environmental, economic and political signals, and the only thing left to get a grip on is our interaction with those signals and with each other? Or is it because we see the technological signals as a means rather than a target, forcing us to focus on the social signals?

Table 1: Average mentions of signals per workshop

Domain SfC	Average mentions per workshop
Social/societal	2,8
Technological	1,7
Environmental	1,4
Economic	2,0
Political	1,9

³ E.g. Sparks & Honey (New York), Trendbureau Overijssel, Strategieeraad Rijksbreed, the European Commission and the World Economic Forum.

During the workshops a *creative leap* was performed in order to uncover the most relevant signals. The top 10 of [Signals for Change that were mentioned most](#):

1. Extreme self-organisation and self-sufficiency.
2. Increased risk of (world) war.
3. The experience economy: goods become services.
4. Decreasing difference between the virtual and real world.
5. Global growth of prosperity with a focus on the environmental footprint.
6. Risk of cyberterrorism endangering the stability of the economic system.
7. Increased global inequality between poor and rich.
8. Loss of faith in national politics and government: need for a new system.
9. Growth in economic importance of the creative sector.
10. Prediction of human behaviour through big data analysis.

Whether these SfCs will indeed play a large role in the future depends on many factors, including the speed and desirability of technological developments.

The dilemmas encountered can all be connected with six areas of tension. It may be useful to keep these in mind when reading this chapter, because with each SfC — and also with the interaction between the SfCs and GCs — there is always a tension between:

1. Fascination and fear
2. Autarky and globalisation
3. Bottom-up and top-down movements
4. Levelling and dislevelling effects
5. Freedom and control
6. Incremental and revolutionary development

The whole is more than the sum of its parts

The challenges are clear. The global population is growing. It will need an increasing amount of scarce natural resources, thus putting more pressure on the ecological and climate systems. There is the threat of geopolitical conflicts and unbalanced composition of the population. How are we going to distribute prosperity? Who stands to benefit from the fruits of innovation in healthcare and living environment? And finally, how do we deal with the new connectivity in a world of different political beliefs, religions and cultures? While trying to answer these questions we have to remember that solutions for problems connected with a specific GC may have negative effects on other GCs. This means solutions must come from an integral approach.



The STT Horizon Scan 2050 mainly focused on the potential role of the interacting SfCs in changes within GCs, and which implications this may have for government, industry and education. In the next paragraph we will look at the widely shared interpretations of the most popular SfCs per GC.

Scarcity

In the future scarcity may no longer be a problem. It is expected that developments in alternative power generation (e.g. solar technology and artificial photosynthesis) will progress at a rapid pace. The (production) costs will go down and the implementation of energy supply may take place without political interference. Cheap — or even free — abundant energy may become one of the crucial drivers of growth, and solve geopolitical conflicts in the process. If desalination of seawater becomes affordable, water will also no longer be a source of conflict. This will bring future self-sufficient communities closer or, seen from the other end, self-sufficiency may be an indirect solution for scarcity. The fusion of the virtual worlds and the real world and programmable matter may also reduce scarcity issues. Finally, also a new economy — from linear to circular and sharing — may point the way towards a new consciousness: from *having* to *being*, from *owning* to *sharing*.

Climate change

People these days predict large but still invisible effects of climate change, which will be worse than changing local weather conditions and the rise of the sea level. Entire ecosystems will disappear, rendering plants and animals more vulnerable to diseases, leading to new but unknown challenges. In the future the more visible effects of climate change may trigger us to finally do something about CO₂ and methane emissions and the exhaustion of planet Earth. Climate change is therefore directly linked to scarcity, but also to the potential solution. This will not be found in social or societal change, but in technology, in the sense that technological genius will allow man to act in a more environmentally friendly way. Artificial photosynthesis may, for instance, become the foundation for an economy based on renewable resources which is in harmony with nature, just like the giant arcological structures of Paolo Soleri are.

Such an arcological structure, called ecopolis, with an extreme dense population (50,000 inhabitants) will include homes, businesses and agricultural facilities. It provokes as little damage to the environment as possible. The adaptive system will protect us against the rise of the sea level. The transition to such a sustainable, resilient society will be complex. Mankind and global politics will play a decisive role here. The EU will either become world leader in durable energy or — if it falls apart — slow this development down. It is expected that national politics will have become irrelevant by this time.





Demographic change

New labour distribution and labour innovation may help to create a better demographic balance. Apart from the pensioned people boom (at its height c. 2035) more people will become older towards 2050, due to brain and body technology. This requires more people to work and a fair distribution of available jobs. A working week of 24 hours at the most means that everybody will have a job. The healthy elderly will be working longer, maybe till they are 80 or 85 (by 2050). A steady and probably uncontrollable flow of climate refugees and labour migrants towards the more prosperous countries will also increase the labour force. Robots will change our lives. Much of the work currently done by man will be taken over by them. But just like in earlier automation waves, further robotisation will also create new employment. People will have more time off to busy themselves with self-realisation (the upper tier of Maslov's Pyramid), although there is some fear that people will become bored (to death). In 2050 the grudges against the destructive nature of (economic) growth have reduced the combined power of politics and companies to zero. Citizens are in power now, united in civilian networks meeting in real life and in the virtual world. These networks are small, independent and self-regulating mini-organisations partaking in larger networks.

Longer life

In the blackest scenario the gap between poor and rich cannot be bridged. Healthcare is only available to the rich, who can afford it. This situation will change if new technological developments that allow people to prolong a high-quality life become available for a DIY budget. This development — partly thanks to 3D printing — fits within the trend of the breakdown of our welfare state. Citizens will have to rely on themselves and their own open or closed (protected) network. The perspectives offered by

singularity and life in the virtual world are literally limitless. Chips will monitor our body, while providing an entirely new healthcare experience. 4D printers will produce a hand that is able to touch and feel. Deep brain stimulation will counter the effects of dementia. But there will also be new challenges. People may become disconnected, anxious and depressed by the extremely fast developments they cannot control.

Global power shifts

The climate problem will increase tensions. Conflicts about responsibilities and fear of uncontrollable situations will most probably be settled at the highest levels. Take, for example, conflicts about deadly CO₂ and methane emissions caused by the melting permafrost or about the rights to climate change tourists who want to visit melting South Pole. The battle over scarce resources will aggravate international relations, especially between East and West. The monopoly on (rare) earth elements will become a power tool for new leaders on the global stage, who will strive to impose their own rules. For this reason people will be looking for alternatives, such as algae for durable food production, chemicals and fuel, or new ways to generate power. These alternatives will be large-scale developments that lead to less dependence and less conflict. We may see a dividing into self-organising, resilient and autonomous regions across borders, ignoring traditional politics. Constantly monitored online life and the growing threat of bioterrorism and cyberterrorism force people to organise themselves in closed (protected) offline and online networks. Ultimately man will move in the direction of a new economy of experiencing and sharing. An economy of earning a living together, taking responsibility together in daily life.



New connectivity

A new form of living together. We will see an increase in interaction between offline and online experiences, a world in which real and virtual have melted together. This development may be reinforced by brain to brain interaction. People who are completely paralysed will be able to move again because another brain will pick up their wishes and act upon them. Global cyber attacks and terror attacks are a problem, because any computer-based action may be hacked. Governments respond as usual too late. The stability of the economic system is under pressure. Less faith in national politics may lead to a new economic system (e.g. circular or biobased economy). The shift from top-down to bottom-up becomes an irreversible trend.



TECHNOLOGY + PHILOSOPHY

When it comes to major social issues, science and technology — even on the horizon of 2050 — appear to play a key role. We asked a futurist and two philosophers about their views on technological developments and their promise for the distant future.



Martijntje Smits p. 90-94



Paul Rademaker p. 95-96



Peter-Paul Verbeek p. 97-99

A magic cave for the knowledge agenda

MARTIJNTJE SMITS

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How do you prepare for a worrisome, highly uncertain future? This is the theme of *Melancholia*, a film by Lars von Trier (2011). It deals with the most apocalyptic picture of the future imaginable. As the result of a collision with the much larger planet Melancholia, looming at the horizon, Earth is threatened with instant destruction. Each of the characters of the film responds very differently to the catastrophe at hand. John, who likes to be in control, is studying the orbit of the planet using his advanced telescope. Despite the visible and undeniable encroaching of the planet he still puts his faith in the scientific reports and tells the others that in the worst-case scenario it will only pass close to Earth.

His counterpart, John's sister-in-law Justine, suffers from fears and is very downcast, which gets on John's nerves all the time. Now that the despair around her reaches new heights Justine becomes ever quieter and ready to accept what is about to happen. John, however, panicks

when he realises he can no longer deny the fatal ending and kills himself. Then John's frightened son Leo tells Justine that, as his father told him, there is no place to hide if fate takes its course. Justine answers that in that case John has forgotten something important: '*He's forgotten about the magic cave.*' In the ingenious final of the film we see Justine, her sister Claire and Leo tightly holding each other's hands, sitting in a 'magic cave' built of thin branches and twigs. Justine's face has a peaceful expression. The director has succeeded in suggesting to viewer that the ultimate apocalypse unfolds as a sublime, heavenly moment rather than a horrible fate.

In the real world fate is of course generally more complex and less easy to interpret than a planet approaching at high speed. Still, it is possible to recognise two known, archetypal lines from the history of science and technology in John's and Justine's responses. These archetypes are derived from a scientific-technological and a mythical world view. The first

sees man as the maker and user of tools, a *homo faber*. The other primarily considers man as a storytelling, imaginative and symbolic creature, a *homo symbolicus*.

These two images or archetypes are, as in the film by Von Trier, often put in contrast with one another. The normative, mythical world view with its narrative way of thinking, based on



religious beliefs or magic, offers comfort and something to hold on to. Consolation is offered by placing the mysterious, often tragic human fate in a framework of symbolic interrelations, shaping it through rituals. In the modern world this approach is systematically overshadowed by the enlightened, scientific approach. In this approach the future is seen as something that can be largely known and controlled and in which values can be rationalised. Seen from this scientific approach the mythical variant is associated with emotions, dogmatic values, speculation, rhetorics, ignorance and superstition. We should in fact prefer to be led by objective data that have been checked empirically, realistic explanations and workable solutions.

Steering on the rational compass of the Enlightenment has, however, not always led to the degree of control that the Johns of this world are hoping for. The future turned out to be more fickle, unpredictable and less controllable than we thought, which is partly due to the intertwined dynamics of society and technology. The same knowledge and means that were thought to help the world progress have often — unintentionally and unexpectedly — instead turned against prosperity, security, health and other important social values. Just think, for instance, of the grim downsides of energy production (such as exhaustion, radioactive waste, oil wars and the greenhouse effect). Or think of the recent privacy infringements through the internet or the growing medicalisation of abnormalities due to new methods and medications. No technological sector can steer clear from the tragic ambivalence inherent to progress, from agriculture to (phone) traffic, from pharmacy to medicine, etc. Technologies that still have to prove themselves,

such as robotics and nanotechnology, may also be instrumental in a wide range of undesired scenarios.

If innovation — by which of course I do not mean the development of gadgets for the market, but the so-called ‘responsible innovation’ (aiming at the complex, mutually interacting problems of society such as climate change, deforestation, child mortality, scarce energy, etc.) — is mainly directed at keeping control, the past shows us that it will probably be thwarted by the fundamental uncertainties of which the shape or size cannot be known through the constraint knowledge we have. The Titanic disaster led to an extraordinary amount of victims because engineers had not taken failure into account and neglected the provision of sufficient lifeboats.

Our optimism about progress may not only be barred by icebergs, hurricanes and environmental disasters. In many cases apparently valuable innovations fail because of sudden changes in how these are socially conceived or because of conflicting interests. Where for example engineers see practical progress looking at care robots, those robots are met with revulsion by careworkers because they feel that daily care tasks cannot be reduced to instrumental acts. Another notorious example is the genetically modified so-called *golden rice*, presented as the solution to eradicate hunger, but facing ferocious protests against what was then called Frankenstein food. Or think of nuclear energy, presented as the prodigious solution to produce cheap energy in the sixties, but becoming many times more expensive in the seventies, when there was a growing awareness about the risks

involved. Or take the introduction of wind energy that was rather unexpectedly slowed down, at least in the Netherlands, by protests against horizon pollution.

So how can we prepare for an uncertain future with these lessons from history in mind and without letting fatalism paralyse our will to act? Maybe a *magic cave* should be part of our knowledge agenda for the future and be included into the STT Horizon Scan 2050. Indeed, when thinking about innovations that may benefit society and about directions of its development we would do well to take into account the wisdom contained in a more symbolic approach to fate.

This is not to say that scientific rationality should be traded for an archaic world view where values and social practices are set. Nor is it to say that innovations should be limited at the start by fixed social values, although this in itself is not a wrong approach. I am, first and foremost, referring to an attitude that does not cling to existing methods, certainties and values and that does not just anticipate the *known* dangers and that avoids *groupthink*. It is about an attitude that acknowledges the fundamental limits of what we can know, leaving room for the unknown, for different visions and alternatives, where, in short, resilience and the capacity to learn play an important role.

If this capacity to learn becomes a core issue in the Dutch knowledge and innovation agenda for 2050, *homo faber* and *homo symbolicus* will collaborate in a way that is much more intense, open and equal than ever before. If we look closely at the history of science and technology we see that the technological and

symbolic approach are actually always interacting. Science and technology are floating on stories and imagination, just like premodern mythical knowledge, even if the utopian images of the technological future from scientists tend to differ from the imaginations and desires from non-scientists.

Technological images of the future often do not materialise, like the persistent, almost 100 year old dream of a leisure society by way of robots has not come true. And yet, if these images and promises start to materialise in some way, then they need to be adopted by non-scientists — new users and other stakeholders — and be fitted into their social practice.

Imagination plays a large role in this process of acceptance: in a way, abstract promises will have to be fitted into a meaningful symbolic order. During this fickle process of acceptance it is not just the technological promise (the hardware) that often changes shape. The same happens to the (symbolic, societal) order of desires, values, needs and convictions. Along the innovation process people start to rethink what is worth striving for. What do, for instance, health, nature, comfort, prosperity and progress really mean, in practice?

In this manner innovations often change society in a way that is much more profound than people expect. Innovations may promise for example efficiency and ease of use (like email replacing the handwritten letter), but in fact they led to changing daily practice (in the case of email and internet working habits and the view on working hours have seen a great change). In this manner innovations also challenge our views on the

makeability of our lives and bodies, as is shown by our changed views on abortion, euthanasia and the admissibility of prenatal research.

The interaction between the technological-scientific and symbolic approaches often follows a jerky route, with frequently disappointing outcomes and societal impasses. Partly this is due to the fact that homo faber ranks higher than homo symbolicus. This ranking is of course an error, because they very much need each other from the start. In the present situation scientists and engineers usually take the initiative, meaning that their imagination is leading. Only in second instance societal groups and citizens are invited to say what they make of it and express their imaginations, if they are invited at all. Often their opinion has to speak only through their wallet.

This explicit and intense collaboration of homo faber and homo symbolicus would allow them to mutually adjust their diverging imaginations and views on specific future needs and desirable practices at an early stage of the design process. This will improve not just the quality of the design and the required societal arrangements, but also the quality of the imagined future.¹ Unfortunately, not much experience has been gained yet with this type of collaboration. The knowledge agenda for the future should actually aim for experiments with various forms of collaboration between these two schools, allowing them to stand hand in hand in a magic cave to welcome 2050, looming on the horizon.

¹ This type of collaboration was elaborated in my research on vision assessment. See A. van der Plas and M. Smits, (2010). 'Beyond speculative robot ethics: a vision assessment study on the future of the robotic caretaker'. *Accountability in Research* 17(6):299-315.



Que sera sera

PAUL RADEMAKER

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Paul Rademaker became an affiliate professor in Future Planet Studies (Universiteit van Amsterdam) in 2005. He also presided the Club of Rome Nederland and the Netwerk Toekomstverkenningen (Network for Future Studies).

‘Que sera sera. Whatever will be will be. The future is not ours to see. Que sera sera.’

These words were used by Doris Day in the sixties of the last century in the film *The man who knew too much* by Hitchcock. They were more or less setting the tone for our attitude towards the future. Curious, full of expectations, but without the idea that we ourselves can actually shape it. The future was seen as something we could not know or grasp — that is, by Doris Day.

We can also look at the future in a different way. Not that we will ever really know it. Anyone making this claim is ‘someone who knows too much’. Or, as Popper (the philosopher and progenitor of critical rationalism) defined it already in 1935: ‘Eine Annäherung an die Wahrheit ist möglich, aber sicheres Wissen ist uns versagt.’ For the more dreamy Laplace, a determinist philosopher, the principal impossibility to know the future may be a nightmare, others view this future, also called the open future, as a challenge or assignment that will finally turn man into human. This openness of the future means that people (or politics) are able to and should make choices. Making choices means taking responsibility.

Open society is characterised by a critical attitude — in modern jargon called deconstruction — and personal responsibility, two characteristics that are in line with my own view of the world.

Not everyone, however, is happy about the idea that the future is open — there is even a fear of the void (horror vacui). The social psychologist and philosopher Erich Fromm refers to this phenomenon as the fear of freedom. We do not love what we do not know and are unable to live comfortably with doubt and uncertainty. Man is sometimes characterised as a no-sayer, knowing better what he does not want than what he does want. In the same vein we see that the grand challenges of the STT Horizon Scan are rather problem-oriented than a search for new opportunities. We primarily focus on maintaining what we have (and what is threatened) instead of looking for radical change. Which is fully understandable. The existing institutions, leading powers and stakeholders groups benefit from the status quo as it is. If change is required we rather see an adjustment in small stages (an incremental approach) than a big

leap forward combined with a paradigm shift. It is not surprising that our politicians state they have no desire for a vision of the future, and describe the utopia of the ideal state as dangerous and totalitarian.

Still, the question remains whether an inspiring vision of the future isn't exactly what we need. Whether the lack of social imagination will not destroy us in the end. Our society shows little reflection and ignores the structural developments threatening its very own existence. Already forty years ago the Club of Rome pointed out some of these unsustainable developments, but the message still has not come across everywhere. To me the current credit crisis is a typical example of structural failures in the government system. Referring to these issues as just a mistake is cynical and unacceptable.

So how can we develop the required social imagination, to whom can we turn for that? This should of course have been the core task of politics, although universities and NGOs should also be able to play a role. There must be room to experiment and play, or, as was so wonderfully described by the futurologist Bart van Steenberg, we need test gardens of society. This will require:

- (a) A coalition of well-meaning people — who are ready for a radical debate about the foundations of our society
- (b) Consensus about the direction we should take (approximately)
- (c) Co-creation in a joined but differentiated approach to realise the desired aims

Following this 3C imperative (coalition, consensus, co-creation) we have to return to the question what the future will look like. Technological developments and geopolitical shifts receive ample attention. We only need to think of information technology or the rise of China. There is, however, much less attention for the view on ourselves and the world, for norms and values or changing priorities in our society. Do they come second because we think they are only derived from the other, more tangible developments? This would mean we adhere to the Marxist view that the tangible assets such as technology and economy determine softer assets such as norms, values and ideals. Or do we let these softer assets come second because of our failure to get a grip on difficult concepts such as the view on mankind and the world, on norms and values? To what extent do these soft powers actually drive, steer and determine the future? When in 1935 Stalin and the Vatican were at odds, Stalin reportedly asked how many troops the Vatican had. Voltaire, on the other hand, stated that the pen or the word was mightier than the sword. So what do we — groping researchers of the future — think: will it be Stalin or Voltaire?

Ethics from within: providing ethical guidance to technological developments¹

PETER-PAUL VERBEEK

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Any view of our technological future necessarily has an ethical dimension. The possibilities facing us are without doubt both fascinating and frightening. Technology will give us much power over the future of man and society, and with that comes responsibility. Are we not overplaying our hand? How far can we go when interfering with nature and ourselves?

This mix of fascination and fear can also be found in many mythical and literary stories dealing with technology. The sorcerer's apprentice who invoked powers that he could no longer control. The Tower of Babel that nearly touched the sky, until the people that were building it could no longer understand each other. The wings of Icarus that fell apart because he wanted to fly too high, so that the heat of the sun melted the wax that kept the feathers together. If we decide to link ourselves with technology until we become a hybrid, overboldness lurks, *hybris*, from ancient Greek.

The large influence of technology on man and society is a formidable challenge for ethics. Not just because new technologies always raise questions about their desirability — this has always been the case, from writing to nanotech — but mainly because technologies also influence moral itself. The frameworks we build our ethical judgments on change through technology. For instance, prenatal diagnostics have changed our moral judgment on the dignity of life and of human suffering. Anaesthesia has influenced our norms on the level of pain that is still bearable. The standard used to measure things is influenced by the thing we measure.

This means that shaping new technology also needs shaping new moral standards. And this raises complex questions. The most obvious — and most often asked — ethical question about new technologies is: is it allowed? Is it a desirable technology? In order to answer this question we will have to investigate how technology shapes our moral standards, and how we can deal with this in a responsible manner when evaluating and designing things. Before we judge *hybris* we must first thoroughly explore our

¹ This essay is based on the introduction of the book *On the wings of Icarus, how moral moves with new technologies (Dutch)* (Lemniscaat, 2014)



own hybridity.² And this is not done very often in ethical debates on technology.

A key notion to visualise the influence of technology on man is 'mediation'. Technology mediates in human practice and experience. Rather than just being a functional means it influences the way we do things and the way we look at the world. Rather than seeing technology as the opposite of man, technology is a 'medium' of our existence.

An example. A team of the University of Twente is working hard on lab-on-a-chip technology, minilabs the size of a chip. They can be used for anything, from the detection of cancer to the measurement of blood levels. A recent application is the assessment of the human sperm quality. In case of fertility problems this will save men having to bring an embarrassing visit to the hospital. However, this new technology also offers a radically new opportunity, since 'female' sperm cells are slightly heavier

than 'male' sperm cells. So by separating the sperm according to gender it becomes possible to decide whether you want a boy or a girl.

This technology is by far not ready for the market yet, and the selection of gender of your unborn child is prohibited in the Netherlands. But it nonetheless raises the relevant question what it will mean for society if people can buy a DIY kit to determine having a boy or a girl. For as long as man exists the gender of children has always been something that happened, but in the future it may become a matter of choice. So a few engineers can actually forever change the meaning of parenthood in our society.

Many people will feel uncomfortable about this. Tinkering with our offspring is tinkering with mankind itself. The question is, however, whether this fear will be a good compass. Because shouting 'no' at a new technology often equals trying to turn a steering wheel that is not connected to anything. It is better to transform this fear of 'hybris' into a responsible dealing with 'hybridity' and to see if there are ways to embed this technology into society.

² With the term hybridity we mean: hybrid fusions of men and technology.

This requires thorough research. Why was gender selection prohibited in the Netherlands in the first place? Does it come from the era in which having a son was the greatest gift you could have? This may mean this ban is obsolete. Or is it about the principal refusal to allow people to make choices about their own offspring, because each human being is equal? Still, we are allowed to select embryos and fetuses on the ground of hereditary diseases. We can only find out what the effects of free gender selection are and which ethical questions this will raise through careful experimenting.

By helping people with their choices and following them we will gain more insight into the ethical dimensions of a technology. What will be the consequence for our appreciation of men and women in society? Will it be a tough choice to have your children grow up in a household with four boys or four girls? Which new ways will emerge to be able to deal responsibly with this new technique?

If ethics are limited to the question whether a technology is acceptable or not the technological mediation of the moral that is involved remains invisible. This will limit the ethical debate, because ethicists' answers to technological developments will then be limited to 'yes' or 'no'. Whereas the more important question should be how a new technology may be embedded into society. The answer to this can only be found after a thorough investigation of how human existence may be shaped by interaction with a specific technology.

This way we arrive at an 'ethic from within', an ethic that does not assess a technology on the basis of previously set criteria, but takes the interaction between technology and moral into

account. The core task of 'ethics from within' is, according to the Belgian philosopher Gilbert Hottois, guiding technological developments rather than assessing them.³ Getting as close to this technology as possible. Not by applying ethical theories to technology, but by visualising ethical questions from within, in close contact with the process of design, use, and implementation of the new technology.

Just like Icarus was not allowed to fly either too high or too low, we must learn to let go of the idea of just saying 'yes' or 'no' to new technology. The urge to immediately say 'no' denies the fact that human existence is developing along with technology, whereas an unconditional 'yes' boils down to putting man in danger through overconfidence.

The core thought of the idea of providing ethical guidance to technological developments is that ethics cannot judge from the outside. Any useful judgment has to come from inside. We cannot act like the question whether specific technologies should have been made can be answered afterwards. The moment a technology arrives it changes the world and we will have to deal with it. People denying this fact don't recognise the power of technology. People embracing it without thinking are overconfident. Technology requires we learn to live with it.

³ Hottois, G. (1996), *Symbol and technology*. Kok Agora, Kampen.



5. CONCLUSIONS & RECOMMENDATIONS

The world is facing a number of Grand Challenges (GCs). This calls for a coherent strategy. The GCs cannot be solved by any individual actor, at a specific location, or in just one way. The solution must come from an integral approach.

The STT Horizon Scan 2050 addresses six of these GCs, connecting them in various ways with the so-called Signals for Change (SfCs) and with blind spots, the Unknown Unknowns (UUs). It presents a unique image of events we may come across on the road to 2050. It also raises many questions.

This book aims to inspire the reader to actively engage with its content. It offers governments, science and industry important insights for long-term planning. The future starts now.

The STT Horizon Scan 2050 covers a wide range of subjects while looking at the distant future. This makes it easier to think out-of-the-box, and creates space for human imagination. This book aims to contribute to an improved quality of the imagined future(s) and to stimulate vision development.

Its theme cuts across domains and disciplines. That is why we actively sought the collaboration of experts from all domains and disciplines. Following a thorough literature review, over 300 experts from the government, science and industry shared their visions with us in various ways. An important contribution was also made by non-experts from the creative sector and storytellers. This multi-disciplinary cross-over approach was instrumental in defining the following aims:



Inspiration. This study reconfirms what the future Grand Challenges are. It adds the richness of the Signals for Change, and it aims to stretch our imagination to the very limit with the Unknown Unknowns. Together they provide the crucial inspiration for research, policy studies, innovation and the societal debate. They also identify specific domains where major developments will occur. The Netherlands needs to have the competencies to deal with these developments, if one wants to survive in the future global competition.

Vision. The future is in the making. Reflection on the Netherlands in 2050 allows us to create an insight into tomorrow's profitable business models. What do the developments identified in this book mean for our economy? Where will our future profits come from? And what will be the position of man in this economy dominated by robotics and interconnectivity? Should we pursue each and every technological possibility? There is an ethical issue involved here, with far-reaching implications for our future social dynamics. And what will all this mean for the Dutch so-called Top Sectors? What will these be like in ten years time as the result of entirely new innovation models? In many business sectors human labour will be affected by increased automation and the rise of robotics. This requires a vision on the way society will make its income, but also on how this society will deal with social issues, such as the distribution of labour and income.

Risk analysis. The STT Horizon Scan 2050 links today's and tomorrow's Grand Challenges with the Signals for Change and potential Unknown Unknowns. This makes it an essential reference book for long-term risk analysis.

Innovation. The expert input suggests that in the future social and ethical factors may become more important than mere technological developments. An interesting perspective. Will the Netherlands be global leader in social innovation in 2050?

The STT Horizon Scan 2050 is a snapshot. It must be repeated periodically to enable comparison. It is a starting point not just to stimulate further debate, but also to boost new research, policy studies, innovation processes and societal debate.



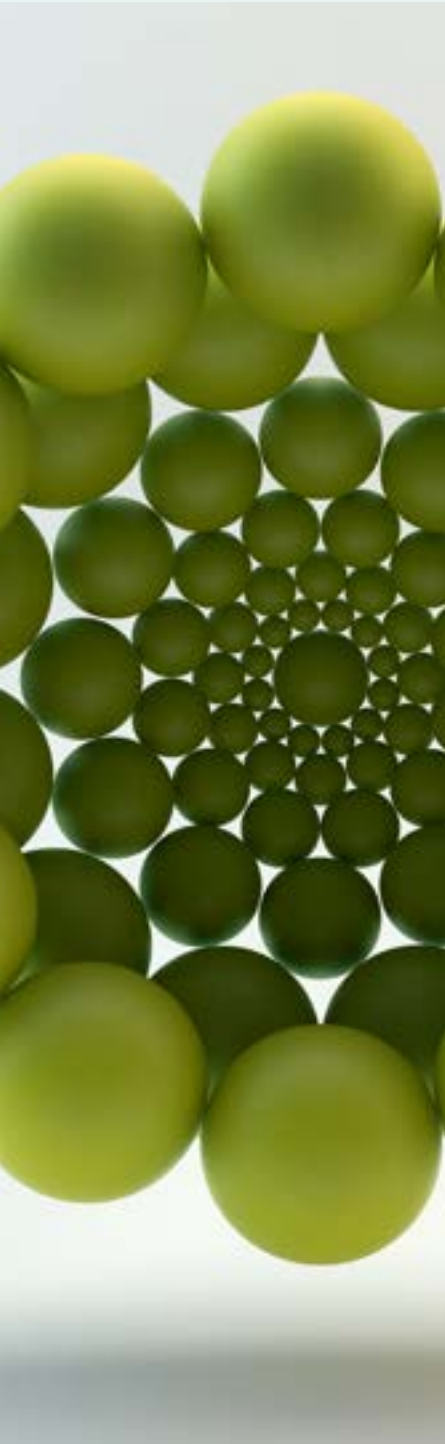
The future is not something that just happens to us. We can shape it together along the way. Much, however, will remain uncertain, which is inevitable. An example: at present we still understand too little about the potential effects and desirability of, for instance, programmable matter, the exocortex, utility fog, artificial photosynthesis and subcutaneous screens. This will require further research.

Many signals have a mutual influence on each other. They may reinforce or weaken each other, creating effects in more than one domain. The coherence between the various domains and disciplines involved is complex. Anchoring the themes from the STT Horizon Scan 2050 therefore requires an integral and interdisciplinary approach that cuts across the various domains. An approach that goes far beyond the present frameworks in politics, government, industry, and society as a whole. We recommend to organise such an approach. The future is an important challenge that needs to be addressed by politics and social partners alike. It also requires a *sense of urgency*. This is where STT wants to offer a contribution through the STT Horizon Scan 2050.

IMAGINING THE FUTURE

What will the Dutch economy be like in 2050? What competencies will the Netherlands have to keep the competition at bay? And will we be able to keep these? Did we respond to new developments in time? Who will be future competitors, who our partners? Are we ready for a world of global and digital connectivity? Who will benefit and who will lag behind? Who will be successful on the labour market and in society, and who will be vulnerable? What are the new sectors and professions in 2050? Who will become redundant? Who are the newcomers to the labour market: migrants, the elderly, robots or cyborgs? And how do we prepare the younger generation for the future and the role technology will have in tomorrow's society?

From a technological view, there are many developments that will help man — living in a then totally different society with a new economy — cope with the GCs. The results from our workshops indicate an optimistic belief in technology.



In the end the question is how society will deal with all these new technological possibilities. Man, or rather the changing social relationships, will determine which technologies will emerge and whether we dare to trust them. It is hard to predict what future mankind will want to achieve. What is clear, however, is that technological innovation must be accompanied by social innovation. It is therefore recommended to focus research on technology assessment and social impact.

Robotics, IT and big data will change society entirely. How we make decisions, how we travel, how we share information. Allowing robots into our lives, in healthcare and in industry also means that our own role changes. Here we also see an image on the horizon an image of the man-machine connected to the internet of things. What will the smart systems of the future be like? Will *we* be these systems? And how will responsibility be assigned in tomorrow's world? This could in fact very well become a future Grand Challenge. Time to explore the role of man in 2050.

Our social and societal values determine which technologies will be accepted in society, but at the same time sociological developments appear to be the most uncertain of all factors involved. We already see previously solid institutions, such as banks, insurance companies and the national government, undergoing changes. These changes are hidden in a mist of visions that are both alarmist and idealistic. We do not know, however, in which direction we are actually heading and what the institutions of the future will be like. What, for instance, will be the task distribution between government and industry (businesses)?

In the same line of thought we can wonder about the readiness and ability to steer developments. About the future role of politics, science, industry, informal networks, NGOs and individual persons. Nearly each challenge can be solved, but it will require strong governance and deliberate action. Right now, not tomorrow.

6. REFLECTION

Looking at the results from the past two years, how does the researcher herself view the possible futures in store for us? What, for instance, should we do with the signals that were rated ‘I don’t know’ by experts? Are these the Unknown Unknowns that we should watch? And how do they affect the results of previous GC workshops?

What keeps us human?

JACINTHA SCHEERDER

In a world where ever more means of communication render us very conscious of ourselves and each other, it seems increasingly difficult to lead one’s ‘own’ life. In the old days people were only aware of what other people were doing when they saw each other or spoke to each other (on the phone). We now live in an age in which we give people and organisations permission to follow us in everything we do, in which we feel also forced to follow. A world in which it is becoming increasingly difficult to step back and take time to reflect. In which we do sometimes not find the time to decide whether we want to share things or keep them for ourselves. In this era of technology — stealthily mingling with the world around us — we are almost unknowingly, but ever more often, playing with the thought who we are, what it means to be a human being. What makes us human? Or rather, what keeps us human?

This book presents a mix of pessimistic and optimistic views of the future. The rise of tomorrow’s technological developments, now underway at universities around the world, effectively means we are in a no way back situation. Inherent to this vision of technology as a solution there is a feeling of powerlessness. In the year 2014 — similar as in centuries before — we fear technology, but at the same time embrace it. Which is confusing.

This confusion is partly due to the feeling that in the next decades we will totally lose our grip on these developments. The course of many future developments is, although initiated by man, almost impossible to be influenced. Artificial smart systems are made by man, but subsequently follow their own directions. We seem to be heading for a stalemate. We



are unable to live without technology (the choices we made are responsible for that), but find it increasingly difficult to live with it. A scary feeling.

If technology literally becomes a part of man — so that we can no longer distinguish between biological and technological body parts — this may also irreversibly change the norms and values of humanity. Humanity, life in harmony with one's own consciousness, could acquire an essentially different dimension if this consciousness is partly determined by the interaction between the human brain and a computer. If we start making decisions in direct consultation (or connection) with an artificial, autonomous and (more) intelligent digital entity, we will have to rethink the concept of responsibility for one's actions. This requires a new vision of what makes us human.

Another striking and seemingly constant battle is the question whether the future involves networks or autarky. Do we want independence or do we want to share everything with everyone? Or both, by sharing within small, protected networks but being independent of a big (or bigger) system such as the government or Facebook?

The distrust of an elitist political system — the way political decisions are made and the institutions and organisations playing a role in this system — is not exactly new. In decades to come this may lead to people turning away from politics, preferring an autonomous (local) policy they can experience as their own. It reminds one of the mid-sixties of the last century, when dissatisfaction with Dutch politics led to demonstrations by students, artists, intellectuals and workers. The rise of social security services and the notion that

prosperity was here to stay completely nullified respect for authorities, previously fed by the memory of recent war and occupation. Young people were bored and stopped being compliant.

In 2014 we see a similar development taking place, although the cause does not appear to be boredom (bubbling up from too much sense of security), but rather a loss of trust caused by a sense of *insecurity*. From the moment the financial crisis started in 2008, security has been put on hold. The global banking system, due to the securitisation of loans and the selling of these loans, turned out to be highly vulnerable. Added to the uncertainties around the euro, an economic crisis erupted. The policy banks and governments followed caused even more damage to people's bank accounts and in the first decade of the 21st century led to new unrest.

Besides smaller and independent, protected networks (*glocal sharing societies*) and new forms of democracy without political parties, elections and even parliament,⁴ people also seek new economic systems and financial means to replace the current (vulnerable) monetary system. Circular economies instead of linear economies. Or a biobased economy in which the economy is driven by biomass instead of fossile natural resources. Suppose, for instance, that we discard the whole principle of paid labour and eternal growth, and provide everyone with a standard basic income. In that

case money would automatically acquire an entirely different value, working for money could become a thing of the past and we could look for a new purpose of life. After all, if work is not the purpose of life, then why are we on earth? What defines our humanity? At present many people think that the purpose of life (essence) and our existence is work. Or, as Pulitzer Prize winner Annie Dillard once wrote: 'How we spend our days is, of course, how we spend our lives.' [Dillard, 1989] According to her it would be better to rate *presence* higher than *productivity*, thus turning our back on the fear that a society obsessed by efficiency and productivity generates. Are we really heading for an era in which we will trade [money for meaning](#)?

What we do not see

What are the blind spots, the weak signals, the 'what ifs' we do not see, passing us by unnoticed by the media? Or is it because they are not picked up by the media that they escape our attention? So that we do not study them? What are the signals that were left out by our experts? And why is that?

One example of a weak signal is the embodied avatar (like the ones from the 2009 film by James Cameron), in which people in a sleeping state have a wireless mental connection with an avatar that interacts with its environment, on another planet perhaps. The avatar is controlled by the brain of its sleeping 'connector', who can see, feel, smell and experience what it is like in this other world.

⁴ After Terrill Bouricius.



The rise of the Travelling Wave Reactor appears to be another weak signal eliciting uncertainty. This is a fourth generation nuclear reactor deemed feasible by nuclear engineers. It is able to transform heavy isotopes such as uranium 238 and thorium 232 into useful fuel. Experts from other, not nuclear domains, however, wonder what the impact of this reactor may be, posing questions about its desirability.

The third powerful 'what if' signal is programmable matter. This material is able to adapt its physical properties — shape, density, standard measures, conductive properties, optical characteristics, etc. — to the user feeding it with information. The material is able to autonomously understand, process and use this information.

A final blind spot more or less connected with this third development is the utility fog [Storrs Hall, 1993], a swarm of networking microscopic robots (nanobots) that may take any shape. This will irreversibly change our physical landscape, and in time maybe also our body.

All these weak technological signals should not escape our attention. Signals that are not being addressed since they are rather unknown or undesirable. But if they do become reality in the decades to come, they will alter the way we look at ourselves, at each other and at the world around us. They may lead us to solutions or create even greater challenges. They have — especially in combination with unexpected

disruptions, tipping points, or black swans — the potential to create a shock, and even more so if we haven't taken them seriously. Ethicists and creative thinkers from the arts and theatre also came up with a number of Unknown Unknowns. Although the exact nature of these Unknown Unknowns proved an obstacle to be clarified, they thought a confrontation between politics and private issues — in relation to the power to act — the most likely. I propose to address one of these Unknown Unknowns that still requires further study, namely the idea of giving up permanent, shared values as a result of technological revolutions. A supercomputer becoming the largest common denominator that will be switched off in the end. Does this mean we will be going back to the old days?

Perhaps not such a bad idea...

This Unknown Unknown shows a strong link with the blind spot that is crucial when values evaporate. Values that are intrinsic to what makes us human, and this supports my view of future mankind splitting up into two groups. One group able and willing to surrender to the complexity of the ongoing technological track and the other distancing itself from these developments, going back to basic values.

Approaching the unknown. A fascinating exercise, as the STT Horizon Scan 2050 also proves. This book leaves many questions, for instance, how far ahead we should try to look. It does create room, however, to chart



the expectations we may have of the future, together with other views from anyone who is ready to share them with us.

To STT the question is not whether there is room to create our own future. It is the focus on how we see this future that really matters.



APPENDIX 1. DEFINITIONS AND ABBREVIATIONS

Some of the definitions below were taken from the *1st EFP Mapping Report: Practical Guide to Mapping Forward-Looking Activities (FLA) Practices, Players and Outcomes* [European Foresight Platform, 2011]. If use was made of other sources this will be indicated.

Horizon scanning

Horizon scanning is the systematic examination of potential (future) problems, threats, opportunities and likely future developments, including those at the margins of current thinking and planning. Horizon scanning may explore novel and unexpected issues, as well as persistent problems, trends and weak signals [Van Rij, 2010].

Grand Challenge (GC)

Challenges that are of sufficient scale and scope to capture the public and political imagination, create widespread interest among scientific and business communities and NGOs and inspire younger people. They must be capable of acting as an important tool for percolating attention at all levels of society all the way down to civil society and the public at large. Example: the effects of climate change.

Signal for Change (SfC)

A high-impact event leading to a disruption of or change in a trend, influencing the Grand Challenges (GCs). A Signal for Change may be expected or unexpected, e.g. the emergence of new technologies in sustainable energy [DCDC, 2010].

Trend

A trend is a measurable development indicating clear and relatively steady changes over time. Example: the emergence of left governments in South-America: Venezuela (2001, 2007), Brazil (2003, 2011), Argentina (2003, 2007), Uruguay (2005, 2010), Bolivia (2006), Ecuador (2007) and Peru (2011).

STEEP

STEEP is the acronym for Societal, Technological, Environmental, Economic and Political. It provides the framework for systematic analysis of the various dimensions of a scenario, problem or trend.

S: Societal Social developments such as demographics, lifestyle, social and cultural values, ethics, consumer behaviour and consumer influencing (advertising).

T: Technological Technological developments are progressing at an exponential rate. New products and services affect our way of life, the way we work and education. This means technology affects all other domains (societal, environmental, economic and political domains), e.g. where innovation, transport, energy, communication and research are concerned.

E: Environmental Ecosystems are subject to environmental developments. Opportunities and threats occur in e.g. water, wind, soil, food and fossil fuel.

E: Economic The economic situation is strongly related to consumer purchasing power, which in turn is influenced by interest, taxes, international trade, entrepreneurship and job availability.

P: Political Political developments have a large influence on citizens and business life. Politics are a volatile trade, e.g. when specific political parties suddenly become very popular. One should always be aware of sudden power shifts, with major consequences for e.g. environmental legislation, anti-trust legislation, financial markets and trade [Foresightcards.com, 2013].

Storytelling

Storytelling is *a way to render events that are linked to each other*. The way our brain operates explains the power of storytelling. Our brain can easily relate to an interesting story, that is a logical vehicle to process knowledge. Our brain breaks down the story into smaller bits, making it easier to remember. Hearing or reading stories activates our mirror neurons, as if you experience events yourself [translated from: Storytellinghandboek.nl, 2013].

APPENDIX 2. LONG LIST SIGNALS FOR CHANGE

The 151 Signals for Change which were used as input for the expert questionnaire

SOCIETAL

1. Collapse of large urban areas in developing countries
2. Change in (American) thinking regarding equal rights of people (more rights for minorities)
3. Emergence of 3D printers for consumers, also for the production of food
4. Virtual meetings become as lifelike as physical encounters
5. Reduction of the welfare state in many (European) countries
6. No driver's licenses needed anymore, thanks to the emergence of autonomous driving cars in daily life
7. Rise of hunger in Europe
8. Robots will be better with everyday life tasks than humans (e.g. nurturing, caring, house-keeping)
9. In everyday life, robots will be smarter than humans
10. Emergence of human rights within the virtual world on the internet
11. Reduced solidarity between people
12. People move/ travel less physically in the future
13. Emergence of self-build. End users take the lead and build their own home
14. The advent of singularity — the moment that machine and man become one
15. Extreme self-organisation and self-dependent people (without government interference)
16. Emergence of a completely artificial intelligent environment, resulting in completely different ethically accepted lifestyles
17. Enriched reality. Virtual appearances are added to reality, for example by using glasses or contact lenses
18. A behavioural change towards a more holistic approach in life
19. Creativity is the greatest value generator. The meaningfulness of humankind can by 2050 particularly be found in creativity
20. Regulated food security

21. Exorbitant overpopulation creates new ways of interacting
22. Society's well-being is guaranteed along with the rights and privileges for the individual when using information about people obtained by the internet
23. Open access to the private sector personal information industry by third parties, especially access by the many enforcement agencies at federal, state and local levels (law enforcement, tax authorities, drug enforcement, welfare and social assistance programmes). But also access by lawyers or other components of the judicial system — divorce lawyers, public prosecutors, availability to the discovery process of law suits
24. ALL use of information is controlled, so access to it is controlled; this is a basic tenet of computer security & safety
25. Breakthrough in healthcare technology which makes chip implants much safer and therefore frequently applied (and ethically accepted)

TECHNOLOGICAL

26. Emerging potential of stem cells
27. Generating gasoline out of air, using electricity
28. Generating plastics out of biomass
29. Generating plastics out of methane
30. Use of algae for the generation of food, chemicals and fuels
31. Profitable generation of solar energy worldwide
32. Profitable generation of energy out of the ocean
33. Breakthrough in low-energy nuclear reactions (cold fusion)
34. Profitable generation of energy out of wind
35. Breakthrough in healthcare thanks to the introduction of computer chips in the human body
36. Commercial application of self-healing materials
37. Extracting fresh water from air to remedy fresh water shortages
38. The potential of nanotechnology
39. Climate engineering
40. Solution of the fresh water problem: producing food without the use of fresh water (and virtually no fossil fuels)
41. The possibilities of 'next generation' IT infrastructures
42. Breakthrough in energy storage
43. Wireless charging
44. Emergence of 'intelligent' clothing
45. Revolution in construction: building within a week instead of months/ years
46. Communicating through our brain instead of using speech
47. Microchip implants as a means of identification

48. Pursuit of prognostication capabilities through big data has a tremendous consequence; future human behaviour can and will be calculated
49. Breakthrough of nanogenerators, with the implication that charging portable electronic equipment is no longer necessary. These generators utilise body movement
50. Autonomously moving cars
51. A drone (an autonomous aerial vehicle) on every driveway
52. Multiple use of graphene, a material that makes computers faster, thinner and more flexible
53. Ability to fix single genes through gene therapy
54. Emergence of a sophisticated supercomputer (smarter than the human brain) by 2050
55. Emergence of machine-augmented cognition: a research field at the frontier between human-computer interaction, psychology, ergonomics, and neuroscience that aims at creating revolutionary human-computer interactions
56. Emergence of remote presence: technologies enabling a person to have a humanlike presence in another, possibly distant location using a remote presence device. Remote presence differs from telepresence in that the device is mobile, human size, and can be driven by the remote operator
57. Emergence of the exocortex: a theoretical artificial external information processing system that would augment a brain's biological high-level cognitive process
58. Emergence of immersive virtual reality: the science and technology required for a user to feel present, via perceptive, cognitive and functional immersion and interaction, in a computer-generated environment
59. Emergence of neuro-informatics: a research field concerned with the organisation of neuroscience data by the application of computational models and analytical tools
60. Emergence of skin embedded screens: a subcutaneously implanted touch-screen that operates like a cell phone display, with the potential for 3G video calls that are visible just underneath the skin
61. Emergence of retinal screens: liquid crystal displays which are claimed to have sufficient pixel density for the human eye not to notice pixilation at a typical viewing distance
62. The emergence of embodied avatars: the avatar interacts with the environment through a physical body (controlled by a person's mind)
63. Emergence of utility fog: a hypothetical collection of tiny robots that can replicate a physical structure. As such, it is a form of self-reconfiguring modular robotics
64. Hybrid-assisted limbs: a powered exoskeleton suit designed to support and expand the physical capabilities of its users
65. Emergence of artificial retinas: the capacity to restore normal vision; to restore sight to the blind; to detect facial features and track moving images
66. Emergence of nanomedicine (the medical application of nanotechnology): From the medical applications of nanomaterial to nano-electronic biosensors, and even possible

- applications of molecular nanotechnology
67. Emergence of Anti-ageing drugs: to slow down or reverse the processes of ageing to extend both the average and maximum lifespan
 68. Emergence of a molecular assembler: a proposed device able to guide chemical reactions by positioning reactive molecules with atomic precision
 69. Emergence of nanowires: structures about tens of nanometers thick or less with an unconstrained length. Molecular nanowires are composed of repeating molecular units either organic (e.g. DNA) or inorganic (e.g. Mo₆S₉xIx)
 70. Emergence of programmable matter: refers to matter which has the ability to change its physical properties (shape, density, moduli, conductivity, optical properties, etc.) in a programmable fashion, based on user input or autonomous sensing
 71. Emergence of artificial photosynthesis: a chemical process that replicates the natural process of photosynthesis, converting sunlight, water, and carbon dioxide into carbohydrates and oxygen
 72. Emergence of an enernet: a smart grid mimicking the internet to provide connected and cheap (free?) energy
 73. Emergence of a Travelling Wave Reactor: a fourth generation nuclear reactor that nuclear engineers anticipate can convert fertile material into usable fuel
 74. Emergence of space-based solar power: the concept of collecting solar power in space (using an SPS, a solar power satellite or a satellite power system) for use on earth
 75. Emergence of the space elevator: a space transportation system. Its main component is a ribbonlike cable (also called a tether) anchored to the surface and extending into space. The space elevator is designed to permit vehicle transport along the cable from a planetary surface, such as earth, directly into space or orbit, without the use of large rockets
 76. Emergence of solar sail (also called light sails or photon sails): a spacecraft propulsion using the radiation pressure (also called solar pressure) of a combination of light and high-speed ejected gases from a star to push large ultrathin mirrors to high speeds
 77. Emergence of desalination: refers to any of several processes that remove salt and other minerals from saline water. More generally, desalination may also refer to the removal of salts and minerals, as in soil desalination
 78. Emergence of carbon sequestration: the capture and long-term storage of atmospheric carbon dioxide (CO₂)
 79. Emergence of arcologies: combining architecture and ecology, architectural design principles aimed at the design of enormous habitats (hyperstructures) of extremely high human population density

ENVIRONMENTAL

80. A deadly pandemic, for example via pets
81. Sudden or even brutal acceleration of climate change impacts
82. Widespread melting of the Arctic and Antarctic
83. Methane release from permafrost
84. A major natural disaster ecological
85. Emergence of large quantities of artificial meat to replace most 'natural' meat
86. Significant reduced impact on the environment, despite an ongoing growth of the world population
87. Growth of the general level of prosperity worldwide
88. Discovery of new but difficult to exploit oilfields
89. Emergence of CO2 cap & trade (emissions trading)
90. Collision of an asteroid, comet, or other celestial object with earth
91. Global change in the mentality of climate change, perhaps triggered by the 'experience' of the consequences of climate change
92. A faster rise of sea levels than currently predicted
93. Foundation of a colony on Mars
94. A completely ice-free Arctic, faster than currently expected
95. Ecological crises of greater magnitude than any financial crisis
96. Desertification due to global warming
97. Insects as daily food in the West
98. Rising sea levels have halved the actual shape of Europe (Western Europe is swept away)
99. Growing (back) biodiversity, for example, due to an alternative for natural resources causing less or no more unnecessary damage to the environment
100. Tropical rainforest will have (almost) completely vanished
101. Availability of potable water is threatened by extraction of unconventional gas (e.g. shale gas)
102. Potable water demand grows. Desalination of water is by 2050 conventional and will be produced with renewable energy
103. Emergence of arcologies: combining 'architecture' and 'ecology', is a set of architectural design principles aimed toward the design of enormous habitats (hyperstructures) of extremely high human population density

ECONOMIC

104. Limits of growth have been reached in the West
105. Growth of the experience economy — intangible products: goods become services
106. Emergence of the informal labour market, in which prolonged labour relations are less common

107. Emergence of the 'shit' economy (due to the phosphates, energy, nutrients, etc. that can be extracted from it)
108. Repetition of the financial and economic crisis with incalculable consequences
109. Collapse of financial markets and introduction of barter (exchange trading)
110. Total dependence on information and communication technologies within the economic system
111. Emergence of a new economy: breaking the chains of consumerism
112. Splitting of the Eurozone
113. The end of Moore's Law regarding computer capacity
114. Debt crisis becomes uncontrollable: people are born with debts
115. Easing of the monetary policy of Europe
116. Cities lose their economic importance because of the transition to virtual reality
117. Much tighter regulation and stricter supervision of the financial sector
118. End of US dollar as world currency
119. Strong protectionism of national economies
120. Energy crisis, caused by geopolitical reasons
121. Increased wealth inequality between poorest and richest people on the planet
122. Decrease of birth rate distorts economic growth because it reduces labour potential
123. Wars causing disruption of the world economy
124. Euro becomes global reserve currency
125. Chinese Yuan becomes global reserve currency
126. A yet unknown currency becomes global reserve currency
127. Resource scarcity inhibits economic growth
128. Rise of virtual (online) economies in which people can create their own identity, with an exchange rate with 'real world' economies

POLITICAL

129. Changing ways of dealing with terrorism (without using violence)
130. Nuclear disarmament by 2050
131. Use of nuclear weapons with the risk of extinction of the human race
132. Threat of a major war or World War (e.g. new Cold War, escalating situation in the Middle East, water war, religious war, etc.)
133. Threat of a technological drama with effects for governments worldwide
134. Emergence of a supranational governance
135. Threat of regional wars, for example (in the South China Sea) over disputed islands
136. Falling apart of the European Union
137. New world domination by China
138. Loss of US world domination

139. Citizens increasingly lose confidence in government and governance
140. Creation of the 'United States of Europe'
141. Increasing complexity and coherence between economics, politics, technology and media change the world. Existing institutional political system may cease to have influence on these changes, leading to uncontrollable crises (e.g. economic crisis 2.0)
142. More and more wealthy countries become failing states because they cannot feed their own people anymore. This will lead to a changing purpose of government
143. Bioterrorism as an important threat (even more dangerous than nuclear weapons)
144. Enemy nations and terrorists are gearing up to attack the US and other countries using electronic means, delivered over the internet, to induce devastation, calamity and financial destruction at a level that may make 9/11 look insignificant
145. Threat of cyberterrorism makes us go 'offline' again. If governments are not prepared for this, countries may become ungovernable
146. Europe becomes a mosaic of local cultures instead of a federation of national states by 2050
147. States become less important. 'New' institutions such as NGOs, internet networks and (for now) Unknown Unknowns determine policy instead
148. Multinationals (and only them) rule the world
149. European Union repels failing states in order to survive. Provided loans are thus waived and feed a debt economy
150. Conflict and cooperation over natural resources in developing countries has social and political effects on the countries involved as well as on developed countries. This will threaten existing political ties
151. Long-distance migration becomes increasingly commonplace in the globalised world. Transnationalism, with its social and cultural effects on the countries involved, leads in particular to major religious conflicts and more dividedness (by 2050)

APPENDIX 3. OUTPUT ONLINE SURVEY

SOCIAL		degree of impact			desirability			possibility		
SfC		average	standard deviation	I don't know	average	standard deviation	I don't know	average	standard deviation	I don't know
12	Reduced solidarity between people	5,70	1,69	0	1,42	0,37	1	4,95	0,58	0
6	The reduction of the welfare state in many (European) countries	5,60	0,57	0	3,28	2,45	2	5,65	0,87	0
20	Creativity is the greatest value-generator. The meaningfulness of human kind can be found in particular in creativity (by 2050)	5,53	1,49	1	5,50	0,85	2	5,26	1,09	1
18	Enriched reality. Virtual appearances are added to reality using, for example glasses or contact lenses	4,71	1,85	3	4,71	2,47	3	5,82	1,15	c
5	Virtual meetings become as lifelike as physical encounters	5,45	1,10	0	5,15	1,50	0	5,70	1,38	0
16	Extreme self-organization and self-dependent people (without government interference)	5,65	1,61	0	3,37	2,91	1	3,65	3,19	0
9 & 10	Robots will be better with everyday life tasks than humans (e.g. nurturing, caring, housekeeping)	5,30	1,38	0	3,85	2,87	0	4,40	3,20	0
19	There will be a behavioral change towards a more holistic approach in life	5,19	1,76	4	5,47	1,51	3	4,41	3,26	3
25	ALL use of information is controlled, so access to it is controlled; this is a basic tenet of computer security & safety	5,47	3,60	1	2,39	3,31	2	4,37	4,36	1
15	The advent of singularity - the moment that machine and man become one	5,89	1,77	1	2,59	3,26	3	3,72	4,57	2

TECHNOLOGICAL		degree of impact			desirability			possibility		
SfC		average	standard deviation	I don't know	average	standard deviation	I don't know	average	standard deviation	I don't know
4 & 5	Generating plastics out of alternative sources, e.g. biomass and methane	4,71	1,31	2	4,95	2,90	1	5,81	0,56	2
2	Emerging potential of stem cells	6,05	1,09	1	5,57	1,66	2	5,67	0,63	6
17 & 28	The possibilities of "next generation" ICT infrastructures (e.g. caused by the use of graphene, a material that makes computers faster, thinner and more flexible)	6,05	1,15	1	5,79	1,84	3	6,32	0,80	0
6	The use of algae for the generation of food, chemicals and fuels	5,13	1,48	0	5,32	1,85	1	5,71	1,01	5
23 & 26S	Micro-chips-implants for monitoring healthcare. Could also be used as a nemans for identification	5,45	1,78	0	2,81	3,06	1	6,32	1,08	2
40	Hybrid assisted limbs: a powered exoskeleton suit designed to support and expand the physical capabilities of its users	4,63	2,25	3	5,55	2,47	2	6,16	1,14	3
55	The emergence of Arcologies: combining "architecture" and "ecology", is a set of architectural design principles aimed toward the design of enormous habitats (hyperstructures) of extremely high human population density	4,69	1,70	5	3,59	2,76	4	4,29	1,14	0
36	The emergence of Skin embedded screens: a subcutaneously implanted touch-screen that operates as a cell phone display, with the potential for 3G video calls that are visible just underneath the skin	3,94	2,53	4	2,25	1,67	2	4,13	3,32	7
38	The emergence of Embodied avatars: it interacts with the environment through a physical body (that a mind is placed into)	4,93	2,99	8	2,31	2,23	9	3,08	3,41	6
49	The emergence of a Traveling wave reactor: a type of fourth-generation nuclear reactor that nuclear engineers anticipate can convert fertile material into usable fuel	4,23	2,19	9	4,62	4,76	9	4,27	3,42	9
47	The emergence of Artificial photosynthesis: a chemical process that replicates the natural process of photosynthesis, a process that converts sunlight, water, and carbon dioxide into carbohydrates and oxygen	6,44	0,80	6	6,00	2,38	5	4,83	3,61	11
9	A breakthrough in low-energy nuclear reactions (cold fusion)	6,22	1,18	0	6,00	1,80	2	3,20	3,64	10
27	There will be a drone (an autonomous aerial vehicle) on every driveway	4,30	3,27	2	3,68	5,45	3	4,95	3,83	3
33	The emergence of Exocortex: a theoretical artificial external information processing system that would augment a brain's biological high-level cognitive processes	6,13	0,98	7	4,60	3,97	7	4,25	4,07	3
46	The emergence of Programmable matter: refers to matter which has the ability to change its physical properties (shape, density, moduli, conductivity, optical properties, etc.) in a programmable fashion, based upon user input or autonomous sensing	5,36	2,09	8	5,14	2,75	8	4,46	4,10	6
39	The emergence of Utility fog: a hypothetical collection of tiny robots that can replicate a physical structure. As such, it is a form of self-reconfiguring modular robotics	4,47	3,98	7	4,00	3,23	8	3,79	4,64	9
24	The pursuit of prognostication capabilities through Big Data has a tremendous consequence; future human behavior can and will be calculated	5,20	2,27	2	3,52	3,16	1	4,52	5,06	8

ECOLOGICAL		degree of impact			desirability			possibility		
		average	standard deviation	I don't know	average	standard deviation	I don't know	average	standard deviation	I don't know
SfC										
4 & 5	Widespread melting of the Arctic and Antarctic	5,35	2,12	1	1,29	0,22	1	4,53	1,39	1
21	Growing (back) biodiversity, for example because of an alternative for natural resources whereby less or no more unnecessary damage is caused to the environment	4,73	2,92	2	5,53	2,55	2	4,50	1,65	3
24 & 53T	Potable water demand grows. Desalination of water is conventional (by 2050) and will be produced with renewable energy	5,00	2,46	2	5,25	1,30	4	5,00	1,67	3
9	The growth of the general level of prosperity worldwide	5,69	1,30	1	5,38	1,45	1	4,13	1,72	1
11	The emergence of CO2 cap & trade (emissions trading)	3,81	2,56	1	3,94	2,73	1	4,63	1,98	1
13	Global change in the mentality of climate change, perhaps triggered by the "experience" of the consequences of climate change	5,08	3,08	4	5,85	1,47	4	4,08	2,91	4
7	The emergence of large quantities of artificial meat to replace 'natural' meat for the most part	4,31	3,03	1	4,13	3,05	1	4,31	3,03	1
14 & 20	The faster rise of sea levels than currently predicted	4,75	1,13	1	1,31	0,23	1	3,93	3,21	2
12	The collision of an asteroid, comet, or other celestial object with our Earth	6,00	1,86	2	1,38	1,05	1	2,71	3,91	3
15	The foundation of a colony on Mars	2,33	4,67	2	2,33	4,10	2	2,50	4,53	1

ECONOMIC		degree of impact			desirability			possibility		
SfC		average	standard deviation	I don't know	average	standard deviation	I don't know	average	standard deviation	I don't know
8	Total dependence on information and communication technologies within the economic system	5,47	1,27	1	4,00	2,00	2	5,33	0,67	1
19	Increased wealth inequality between poorest en richest people on the planet	5,20	1,74	0	1,27	0,21	0	5,20	0,74	0
3	The growth of the experience economy - intangible products; goods become services	4,69	1,83	0	5,00	1,38	2	5,38	0,92	0
14	Cities loose their economic importance because of the transition to the emerging virtual reality	5,07	2,69	2	2,46	1,60	3	2,20	1,03	1
21	Disruption of the world economy caused by wars	5,67	1,52	0	1,33	0,67	0	4,53	1,12	0
11	The end of Moore's law regarding the capacity of computers	4,73	1,64	1	3,79	2,95	2	4,40	2,69	1
2	The limits of growth have been reached in the Western part of the world	5,47	1,70	1	2,80	2,46	1	4,00	3,60	0
7	Collapse of financial markets and introduction of barter (exchange trading)	5,31	1,43	0	1,79	1,10	2	3,13	3,72	0
23	Chinese Yuan becomes global reserve currency	5,14	1,52	1	2,77	2,36	2	3,64	3,79	1
26	The rise of virtual (online) economies (in which people can create their own identity), with an exchange rate with real world economies	4,62	3,09	2	3,08	1,91	2	4,23	4,03	2

POLITICAL		degree of impact			desirability			possibility		
		average	standard deviation	I don't know	average	standard deviation	I don't know	average	standard deviation	I don't know
SfC										
10 & 11	Loss of USA world domination, new world domination in the hands of China?	5,21	1,29	1	3,94	1,58	2	5,00	0,89	
12	Increasing loss of confidence in government and governance	5,21	1,06	1	2,42	1,48	1	5,26	0,98	
18 Econ	An energy crisis, caused by geopolitical reasons	5,87	1,12	0	1,47	0,70	0	5,07	1,07	
19	Europe is a mosaic of only local cultures instead of a federation of national states by 2050	4,11	2,10	2	3,67	2,82	2	4,61	1,43	
8	The threat of a regional war, for example in the South China Sea over islands	4,74	1,87	1	1,26	0,20	1	4,88	1,74	
20	States become less important. Instead the role of 'new' institutions as NGO's, internet networks and other (for now) unknowns determine policy	5,06	2,18	3	3,13	1,98	4	4,00	2,63	
5	The threat of a major (global) World War (e.g. new Cold War, situation in the Middle-East escalates, water-war, religious war, etc)	6,17	2,50	2	1,11	0,21	1	4,28	2,68	3
3	Nuclear disarmament by 2050	4,63	3,69	1	5,68	2,67	1	2,67	2,71	
16 & 17	The threat of bio terrorism and attacks using electronic means, to induce devastation, calamity and financial destruction at a level that may make 9/11 look insignificant in comparison	5,32	3,01	1	1,42	1,04	1	4,26	2,98	
4	Use of nuclear weapons with the risk of extinction of the human race	6,88	0,11	3	1,06	0,06	2	3,82	3,03	

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Mr. J.S. van der Woude, Company Secretary and Legal Director Continental Europe, Reed Elsevier NV

Prof. A.N. van der Zande, Director-General National Institute for Public Health and the Environment (RIVM)

Advisory members from the STT Academy

STT professors

Prof. M.F.W.H.A. Janssen, Delft University of Technology; ICT en governance

Prof. M. Martens, University of Twente, human factors

Prof. V.A.W.J. Marchau, Radboud University; uncertainty and adaptivity of societal systems

Prof. W.J. de Ridder, University of Twente; futurology

Prof. T. de Vries, University of Twente, ICT and health; ICT and fraude; data analytics

Research fellow

Dr P. van der Duin, Delft University of Technology; methodology of foresight; foresight and innovation

Director STT

Drs. P. Morin

APPENDIX 7. STT PROJECTS

Some previous foresight projects (75):

- Aspirin Sandwich (trends and uncertainties in food, medicines and prevention of diseases) 2013
- The Future of Super Intelligent Transport Systems in Society (2012)
- Wisdom of the Crowd (use of social media for governance, open innovation and health) 2012
Final publication nominated 'management book of the year'.
- Technology and Art (2014)
- Serious Gaming (2011)
- Technology in Africa (2011)
- Brain Vision (2008)
- Bargaining Norms and Arguing Standards (Foresight on Infrastructural Networks in Europe)
- Converging Technologies (2006)
- Genomics (2005)
- Ocean Farming (2004)
- Reliability of Technical Systems (2001)
- Nanotechnology (Basis for the Establishment Of Nanoned) (1998)

More information on our projects and publications can be found online: www.stt.nl