DELFT OUTLOOK
NO. 3 OCT 2015 YEAR 32
TU Delft

CEES DEKKER
'Life is something you create together'

JACQUES VAN MARKEN
The social engineer

HURRICANES
Delta plan for Texas

THEME
Climate

Cover photo:
People live longer and healthier in a good micro-climate. An example is the 'Delftse Proeftuin'. This garden is maintained by volunteers and manager Marijtje Mulder. (groenkracht.nl)
Photo: Sam Rentmeester

Editorial
Frank Nuijens

Climate

Politicians meet at the climate summit at the end of November in Paris to discuss the IPCC (Intergovernmental Panel on Climate Change) report. Delft Outlook investigates which Delft scientists have contributed to this report, but also which research being conducted on campus could provide future protection from the elements stirred up by climate change. Is the engineer's job done when the technology has been developed? Thomas Stocker, Swiss scientist and at the moment of writing candidate for the chairmanship of the IPCC, said in an interview in September with the Science and Development Network (scidev.net) that one of his three priorities for the future is to improve communication between scientists and policymakers. He believes that everyone should be able to understand the communication that takes place on complex and interdisciplinary subjects such as climate change. 'The best ambassadors for communicating scientific results are the scientists themselves', he says. Prof. Patricia Osseweijer of Science Communication and head of the research group in Biotechnology and Society would agree, 'The task of a university is more than simply acquiring knowledge. It is also about transferring that knowledge to where it is needed. In fact, I believe scientists are ideally placed to make that link.'

Frank Nuijens,
Editor-in-chief

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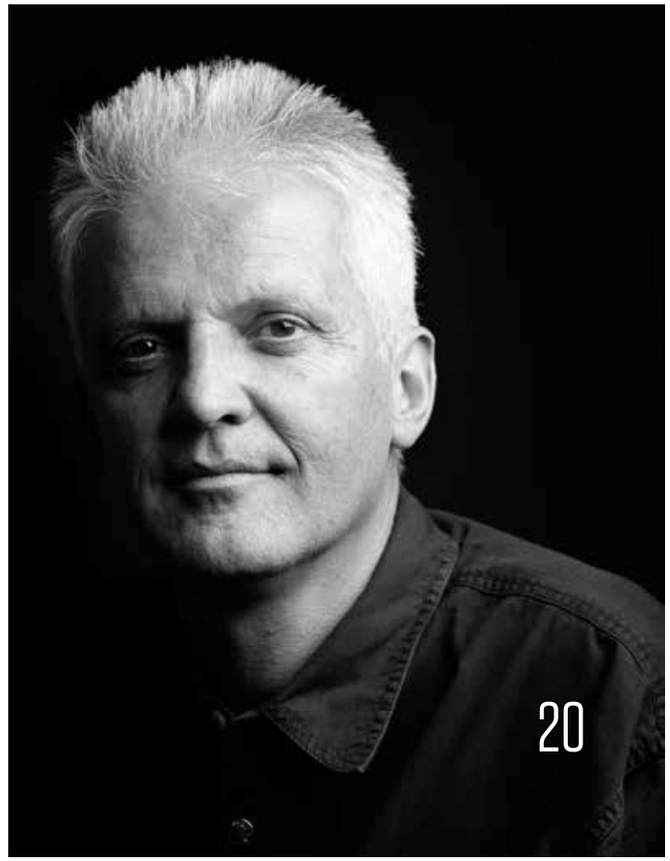
Theme Climate

PHOTO: SAM RENTMEESTER

COLOPHON
Cover photo Sam Rentmeester
Editorial staff Frank Nuijens (editor-in-chief), Dorine van Gorp, Katja Wijnands (managing editors), Saskia Bonger, Tomas van Dijk, Sam Rentmeester (image editor), Connie van Uffelen, Jos Wassink, T +31 (0) 15 2784848, **E-mail** delftoutlook@tudelft.nl
Contributing writers Jorinde Benner, Natalie Carr, Anne Blair Gould, Auke Herrema, Desiree Hoving, Christian Jongeneel, Tonie Mudde, Stephan Timmers
Design Jelle Hoogendam
Typesetting Saskia de Been
Printing MediaCenter Rotterdam
Subscriptions delftoutlook@tudelft.nl



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DELFT IN BRIEF

Bacteria printer

The biofilm printer made from the children's construction kit K'NEX was held in high esteem at the iGEM Jamboree, held from 25–28 September in Boston. The TU Project Biolink team was one of over 250 teams to take part in the final of the International Genetically Engineered Machine (iGEM) competition for university teams. The eight students won the overall prize for undergraduates and three special prizes, including that for best hardware – in this case the printer. The printer makes it possible for researchers to create layers of bacteria (biofilms) in a controlled manner that (as scale, growth or plaque) are hard to remove.
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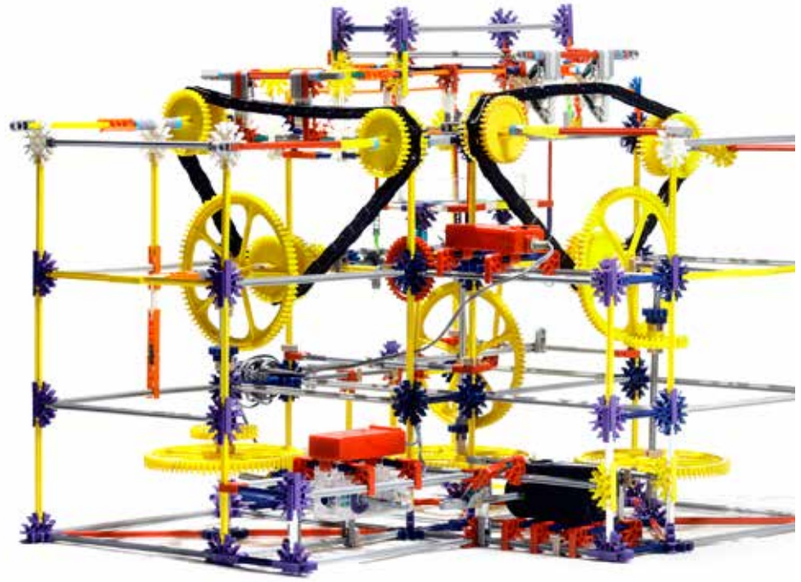

PHOTO: SAM RENTMEESTER

Remote control from space

PHOTO: ESA

On 7 September, astronaut Andreas Mogensen succeeded in controlling a rover on the ground at ESA in Noordwijk from the International Space Station. He manoeuvred it between a series of obstacles before placing a peg in a narrow hole with a tolerance of 150 micrometres – one sixth of a human hair. The project, named Interact, was run by Dr André Schiele, a researcher in biomechanical engineering at the Faculty of 3mE and founder of the ESA Telerobotics and Haptics Laboratory. The challenge lies in controlling the robot through touch (haptic control), despite a distance of 144,000 kilometres and a delay of almost twelve seconds.
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600,000

More than 600,000 people from all over the world have already registered for a Massive Open Online Course (MOOC) at Delft. TU Delft currently has 20 of these free online courses on offer, on a wide range of subjects. The first MOOC, which started in 2013, was on solar energy, and over 100,000 people have already registered for this course. This summer, TU Delft began a pre-university calculus MOOC, to refresh students' mathematical knowledge before starting their first year at university.

Einstein proved wrong

The experiment performed by Prof. Ronald Hanson and his team is the final nail in the coffin for locality and realism as the foundation of physics. Instead, quantum physics rules. At the end of September, their article was awaiting publication on arXiv.org. The article describes an experiment in which two electron spins in diamond chips placed a large distance from one another become entangled. One was placed in the physics building, the other at the nuclear reactor. The photons met halfway between the two, in the electrical engineering building. A long series of more than 200 measurements produced conclusive evidence that performing a measurement on one of the electrons had an instantaneous effect on the other. This non-localised effect was derided by Einstein as *spukhafte Fernwirkung* (spooky action at a distance).
delta.tudelft.nl/30435

Rembrandts old man

Art historians knew that there was another painting hidden under Rembrandt's Old Man in Military Costume, as this had been revealed when the painting was X-rayed in 1968. Now the painting, which hangs in the Getty Museum in Los Angeles, has been scanned again using a mobile XRF (X-ray fluorescence) scanner, which provides information about the chemical composition of hidden layers. The XRF scan and other research have enabled Prof. Joris Dik and researchers at 3mE and the Getty Museum to also reconstruct the colours of the hidden painting.
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Brain van

Researchers from VU Amsterdam and TU Delft have set up a van to be used to measure the brain patterns of stroke patients. With this van, they visit patients in rehabilitation centres, nursing homes or at home. The van is equipped with EEG (electroencephalogram) equipment that measures brain activity, plus a robot-controlled handle. Researchers want to investigate how patterns in the brain change during recovery while certain motor tasks are carried out. Prof. Frans van der Helm (biorobotics at 3mE) is running the research from TU Delft, known as the 4D-EEG project.
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Farewell

'Engineers are not cookies waiting to be baked.' It was with these wise words that Dirk Jan van den Berg, President of the Executive Board, bade farewell to TU Delft in Delta. After 7.5 years, he is leaving the university for Sanquin Blood Supply. On being asked, he says there are two things he will miss: the contact with scientists – 'Behind every door a miracle is taking place' – and the contact with students – 'Which teaches you to think beyond generations'.
delta.tudelft.nl/30469


PHOTO: SAM RENTMEESTER

Sleep well

Corine Horsch, doctoral candidate in interactive intelligence (EEMCS), has developed an interactive app together with Utrecht University and the University of Amsterdam to combat chronic sleeping problems. It is a virtual coach that gives advice on how to make behavioural changes. 'I am studying therapy compliance, because you can make something absolutely wonderful, but if people don't use it because they find it unrealistic, it is useless. We have included the possibility to 'negotiate' with the coach in our app. This means that if you really don't agree with the advised times, the coach can produce a more flexible programme.' Horsch is looking for participants for her research at
ikgalekkerslapen.nl

PHOTO: FORMULA STUDENT

Golden Dream Teams

The students of the Formula Student team achieved an impressive score to win gold both at Silverstone in Great Britain and Hockenheim in Germany. With the electric race car DUT15, they were overall the best on both circuits. The student team of the human-powered submarine Wasub5 also won gold this summer: with a speed of 13.7 km/h it achieved a new world record at the International Submarine Races in Maryland (USA).
The Human Power reclining bicycle Velox team, who in September tried to beat their own 2013 Nevada world speed record (133.78 km/h), were however less fortunate. After several crashes, the team was forced to give up the attempt. The Canadian AeroVelo managed to beat the Delft record, with a speed of 139.5 km/h.

4,051

TU Delft welcomed 4,051 new first -year students at the beginning of this new academic year. The number of Master's students enrolling for the first time at TU Delft also showed very strong growth, at 34 per cent. Besides this, 1,550 foreign students from 80 countries found their way to TU Delft. Around 2,800 first-year students attended the Welcoming Week in Delft. Under the motto 'Dit is jouw moment' they were given a thorough introduction to the city of Delft in five days.


PHOTO: SAM RENTMEESTER

THEME *climate*

Salt city

Making fresh water from salt water is common enough in deserts bordering on the sea. Eric Geboers came up with the idea to use the remaining salt as a building material. So, he went to the supermarket, bought a bag of salt and switched on the oven. It wasn't easy to create a strong building material, but he pulled it off. 'At first I was baking soft cakes, but I can now produce fairly strong bars. The bars are fairly similar to non-reinforced concrete, as used by the Romans. They are not very good at withstanding tensile forces, but can withstand compressive forces, which means you can only use it to build arches.' The resulting curving shapes give the scale models he built a rather exotic look. He also added a waterproof coating. Although the former student expects to be able to build up to two stories high, he first needs to carry out further testing to eliminate teething problems. And yet already Geboers has won awards from the Science of Future Cities Competition and the Challenge *Stad van de toekomst* (City of the Future Challenge). 'I am now looking for funding to build a small salt pavilion on the Dutch coast,' he says. However, the real work will be done in the desert, 'because there are better alternatives for sustainable building in the Netherlands.' SB

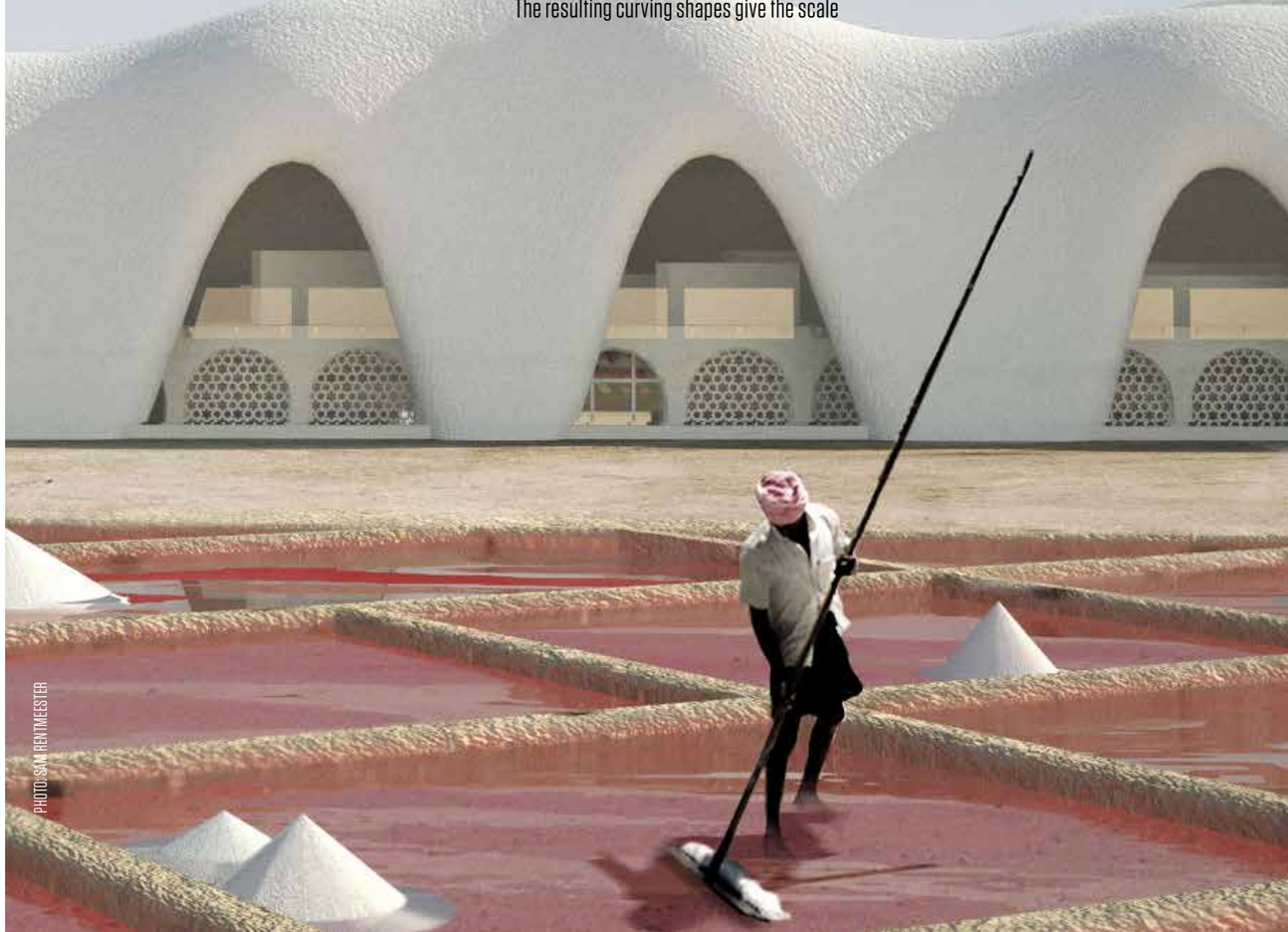


PHOTO: SAM RENTMEESTER

AUTHOR: JOS WASSINK
PHOTO: EPA/STEPHEN MORRISON

Contributions to Climate Summit

Politicians will meet at the Climate Summit in Paris to discuss the IPCC (Intergovernmental Panel on Climate Change) report. It provides an overview of the current state of climate knowledge, based on the work of thousands of scientists all over the world. Delft researchers have also contributed in various ways.

A villager wading through the flood waters that destroyed his home along the Juba river in southern Somalia near the village of Jamame. A flooding killed 120 killed and left tens of thousands homeless. Africa must be prepared for more droughts, floods and cyclones because of climate change, experts say.

What's it all about again? The UN Climate Summit, which will be held from 30 November to 11 December in Paris, is the 21st annual session of the Conference of Parties, or COP21, held within the framework of the 1992 UN Framework Convention on Climate Change (UNFCCC). Politicians discuss the latest version of the IPCC report (Assessment Report), which is updated every six years to include the latest data and scientific insights relating to the greenhouse effect and climate change. The current report is the fifth and is therefore called AR5. The report is divided into three parts, drawn up by Working Groups. The first part addresses the physical aspects of climate change (based on monitoring, models and projections). Part II assesses the impact of climate change on ecosystems, industry, cities, health and well-being. The last part, drawn up by Working Group III, focuses mainly on strategies for mitigating climate change through changes in energy use, transport, buildings, agriculture and industry.
Most of the Delft contributions were in Working Group I, in particular Chapter 3 (Observations: Ocean), Chapter 4 (Observations: Cryosphere), Chapter 7 (Clouds and Aerosols) and Chapter 13 (Sea Level Change).
Prof. Pier Siebesma, from the Department of Geoscience & Remote Sensing at the Faculty of Civil Engineering and Geosciences (CEG) and the KNMI in De Bilt, coordinated the European Euclipse research programme between 2010 and 2014, in which TU Delft, KNMI and ten other European universities and research institutes took part. The objective was to improve understanding of the role of clouds in climate change. Chapter 7 (clouds and aerosols) refers to 11 publications on the Euclipse project. Prof. Harm Jonker, Dr Stephan de Roode, Dr Johan van der Dussen and Dr Sara dal Gesso also took part in Euclipse on behalf of TU Delft.
Dr Ernst Schrama of the Astrodynamics & Space Missions research group in the Faculty of Aerospace Engineering contributed as a reviewer to Chapter 4 on the cryosphere and Chapter 13 on sea level change. These chapters also include several references to articles written by him. According to Schrama, the most important research outcome is the monitoring of the mass balance of grounded ice sheets on Greenland and Antarctica, carried out using the GRACE gravity satellite together with his then PhD student Dr Bert Wouters (currently working at IMAU, Utrecht). They concluded that Greenland is losing 270 gigatons of ice a year, and Antarctica 130 gigatons. Is that a lot? 'The speed at which this is happening is disturbing,' says Schrama. 'Since Roman times, the sea level has risen by about 60 centimetres in total, while it is currently rising by about 30 centimetres a century.'

> Most TU Delft contributions relate to observations of oceans and ice sheets, clouds and aerosols and sea level change

Chapter 4, on the mass balance of grounded ice sheets, also refers to research carried out by Dr Cornelis Slobbe, Dr Pavel Ditmar and Dr Roderik Lindenberg (Geoscience & Remote Sensing at CEG). In their 2009 article in Geophysics Journal International, they combined ICESat measurements (of ice sheet elevations) with measurements from GRACE (of changes in ice-sheet mass). They were therefore the first to make a distinction between volume changes in snow and ice, based on the different densities. It is because of this that we now know that, although a lot of snow falls on the glaciers in Greenland, the net loss in ice mass is higher.
Dr Riccardo Riva and Prof. Bert Vermeersen (Geoscience & Remote Sensing at CEG) looked at the resulting sea level change caused by the melting of ice sheets, as the water mass does not spread evenly across the globe. Their articles are cited in Chapter 13 of Working Group I (Sea Level Change) and Chapter 23 of Working Group II on regional projections for Europe. They calculated a sea level rise of 80 cm in Hamburg and London by the end of the 21st century (but a drop of 10 cm in Finland). They also noted that the sea level rise could be significantly higher (an extra 90 cm) due to ice melting in the South Pole region.
Finally, Dr. Miren Vizcaino co-authored Chapter 13 on Sea Level Change and contributed articles cited in the text. Vizcaino also works at the Department of Geoscience & Remote Sensing at CEG, where she uses climate models to predict the melting of ice sheets on Greenland and Antarctica for the coming centuries. Over a timeframe of thousands of years, she in fact sees Greenland turning green. The advanced model (Atmosphere-Ocean General Circulation Model) not only calculates the impact of the environment on the ice, but also the impact of the melting ice on the environment. An example is the weakening of the warm Gulf Stream as warm salty water from the tropics sinks less slowly in the arctic seas as a result of local warming and the influx of fresh melt water. In a world with CO_2 levels twice as high compared to pre-industrial levels (560 ppm vs. 280 ppm; we are now at 400 ppm), Vizcaino's model predicts a weakening of the Gulf Stream over the next 200 years followed by a slight recovery after 2200.

Although the editors have attempted to include all contributions by TU Delft scientists to the IPCC report, they do not claim to be exhaustive.

Biogas and cement from carbon dioxide

Dr Shiva Salek produces calcium carbonate by fixing carbon dioxide. Photos: Sam Rentmeester.

While working as a PhD student in the Department of Biotechnology (Faculty of Applied Sciences), Dr Shiva Salek developed a process that combines wastewater treatment and CO_2 fixation with the sustainable production of methane and cement. She received the Lettinga Award for this research.

Salek was the only participant at the Congress on Anaerobic Digestion (Santiago de Compostella, 2013) to have succeeded in using fermentation to produce raw materials plus CO_2 fixation, for which she received the Lettinga Award with a value of € 25,000. Salek currently works as a product engineer at Lely Industries in Maassluis. The greenhouse gas carbon dioxide (CO_2) is the main driver of climate change. As a PhD student, Dr Shiva Salek developed a process that fixes CO_2, while also making use of sewage water and ground limestone. The end products are clean water, methane and raw materials for biocement, fertilisers or fillers (grout).

Step by step, calcium silicate (from limestone) is converted into calcium carbonate ($CaCO_3$) by fixing CO_2.

Calcium carbonate is a raw material for the cement industry

Calcium carbonate is a raw material used in the cement industry. The first step, dissolving the silicate, requires acidic conditions, while the second step, calcium carbonate precipitation, requires alkaline conditions.

Salek uses organic decomposition (anaerobic digestion) and the production of fatty acids to create acidic conditions and dissolve the calcium silicate. The production of methane at a later stage in the process increases the pH so that the calcium carbonate precipitates in alkaline conditions. JW

Shiva S. Salek et al., Mineral CO_2 sequestration by environmental biotechnological processes, Trends in Biotechnology, March 2013.

Climate starters

A quick visit to startup fortress YesDelft shows that young entrepreneurs are also working on climate change solutions.

If it is up to the founders of **Nederdalize**, not just they but the whole world will soon be sitting comfortably - not because global temperature is rising but because they have found a sustainable solution: using the same energy twice. How? By heating buildings using data centre computers.

It means they need no cooling, while the people installing the computers do not need to turn on the heating. Energy supplier Eneco is interested in the idea and has installed radiator-shaped computers in the homes of a test group.

Aqysta takes a very different, almost mediaeval, approach. One of its founders, Fred Henny – an industrial designer – and his four partners have quite literally rediscovered the wheel. Their affordable Barsha Pump is in fact little more than a river water wheel that pumps up water to irrigate nearby farmland. It requires no electricity and is therefore ideal for poor areas such as Nepal and Indonesia, where ten prototypes have now been installed. No get-rich-quick scheme for them - the engineers are still operating using a subsidy from the Dutch government. 'This allows us to work on the full technical development of our spiral pump, for which we have applied for a patent, to produce a commercial version,' explains Henny, 'which we are doing completely by ourselves, by the way.'

'Ideal for remote areas faced with water shortages'

His YesDelft colleagues at **Giaura** (literally 'the air of the earth') began their startup at about the same time but are a bit further ahead in the process: the three – non-TU Delft – engineers are using a technology developed over the last fifteen years by ESA to remove polluting CO_2 from the air and supply it as an energy source to businesses – horticultural companies, for example, or aquariums or diving centres. Their philosophy: we need CO_2, for example to produce beer, fizzy drinks and medication, but the problem is it's in the wrong place. 'By capturing CO_2 and releasing it in the right place, you suddenly make the world's largest waste stream sustainable.'

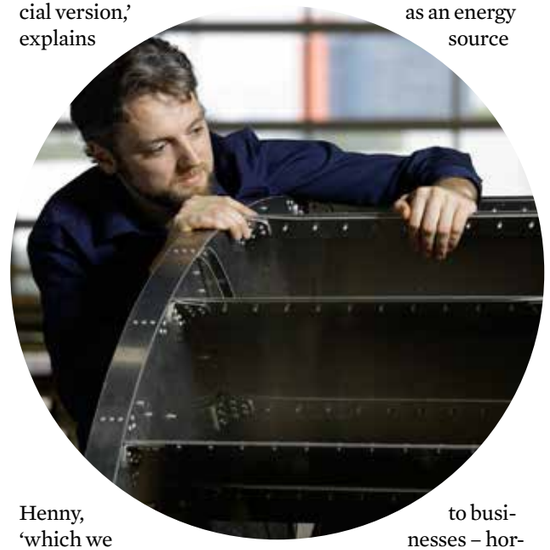


Photo Sam Rentmeester.

Add to this potable seawater and the Delft climate start-ups will – with their sustainable technological tours de force – help us create a paradise that is cleaner than we ever could have imagined. **Elemental Watermakers**, an initiative of Delft engineers Sid Vollebregt and Reinoud Feenstra, uses just solar, wind and wave energy to turn seawater and brackish groundwater into potable water. 'Ideal for remote areas faced with water shortages and a dodgy power supply,' the founders comment. Something for Climate Summit participants to consider while enjoying a sustainably produced glass of sparkling water. JB

nerdalize.com
aqysta.com
giaura.com
elementalwatermakers.nl

AUTHOR: CHRISTIAN JONGENEEL
PHOTOS: SAM RENTMEESTER

Biofuel seeks endorsement

PhD-student Peter Mooij takes a sample out of a pit. He is looking at possibilities for extracting biodiesel from algae.

Biofuels such as ethanol from sugar cane and cellulose 'waste' are theoretically sustainable, as their combustion releases no more CO_2 than is absorbed during production. Even so, they are also controversial, because they are believed to be grown at the expense of food crops, or because areas of rainforest are believed to the cleared for them. However, as far as sustainable energy forms are concerned, it is all hands on deck to halt climate change, and TU Delft is one of those hands.

Last summer, the Commission on Global Security, Justice and Governance, a think tank chaired by the former U.S. Secretary of State Madeleine Albright, launched its report containing recommendations, one of which was based on the outcomes of research conducted at Delft. The research focused on efficient land use for biofuel crops in developing countries. One of the main stumbling blocks turned out to be a lack of knowledge and access to patented technologies. Delft suggested financing this knowledge and access using the Copenhagen Climate Fund, and the commission agreed it was a good idea.

This is the kind of research that Prof. Patricia Osseweijer of Science Communication and group leader in Biotechnology and Society is proud of, as it connects technical knowledge with social issues. 'The task of a university goes beyond acquiring knowledge,' she says. 'It is also about transferring that knowledge to those places where it is needed. In fact, I believe scientists are ideally positioned to make that connection.'

On 1 September, Osseweijer was appointed Distinguished Lorentz Fellow for one year at the KNAW institute NIAS. This award encourages research at the interface between the humanities, social sciences and natural and technological sciences. She intends to use this year to increase the sense of urgency surrounding bio-based production. 'The EU has set climate targets for the year 2030, but the year is getting closer faster than the targets are.'

Sugar cane

Much of the controversy surrounding biofuels is unnecessary, says Osseweijer: 'Calculations show that the sustainable production of biomass is theoretically possible, and therefore not at the expense of nature and food production. The two main obstacles are political instability and war, and the fossil fuel-based financial system is also a problem.'

Osseweijer is aware that these are no minor problems. Biofuels have a long way to go, but there are already some good examples. One of these is Brazil, which has put the infrastructure in place over the last 40 years to produce ethanol from sugar cane, which is blended for up to one quarter of the volume with petrol. 'The sugar cane is grown on just 4% of the total area of agricultural land, well away from the Amazon area. What is more, the ethanol is cheaper than petrol.'

Although its potential is far from being fully realised, there is increasing success with the production of fuel from cellulose – long fibres that are difficult to break down. Worldwide, there are currently five factories that convert cellulose to ethanol. One of these is owned by the Dutch company DSM, based in Emmetsburg, Iowa, where maize production creates a lot of residual waste. The special yeast capable of decomposing both C5 and C6 sugars was developed at TU Delft.

'People won't take you at your word it if you say something is a positive development. You need to discover and recognise the values on which they base their opinions'

The factory is one example of fundamental TU Delft microorganism research reaching a large-scale production stage. The university was also regularly involved in the intermediary stages, such as the Bioprocess Pilot Facility in Delft, in which the university spin-off Delft Advanced Biorenewables (DAB) looks at how best to scale-up the conversion and separation of oil from biomass. 'This too is a great example of how you can integrate knowledge of fundamental biotechnology, processes and market forces,' says Prof. Luuk van der Wielen of Biobased Economy.

Van der Wielen realised ten years ago, when the first fundamental research into fuel from biomass began to bear fruit, that scaling-up to production levels would present a major challenge. 'By definition, biomass contains a lot of water, while you want to use it in existing fuel systems and combustion engines that do not tolerate water,' he explains. 'You would think that the oil will simply float on the water, but in practice you often get a kind of mayonaise from which you need to extract the oil.'

To compete with petroleum, such processes need to be operationalised without the funding used to develop them. Van der Wielen therefore also develops scenarios: is it possible to make a certain process cost-effective in the Netherlands and, if not, what can be done differently? For example, a recently published book, *Redefinery*, showed – based on a large number of studies – that it is possible to use biokerosene in Dutch aviation. All that is required is enough sustainably produced biomass.

'Our scenarios for the aviation sector are supported by the sector,' says Van der Wielen. 'They have been included in the Energy Agreement and are embraced by the Dutch government. They are set to become part of government policy.'

Oily algae

While van der Wielen focuses on the commercialisation of processes, fundamental research into new fuels continues. PhD candidate Peter Mooij, for example, is looking at possibilities for extracting biodiesel from algae.

Read more on page 14

Algae can grow in seawater, and therefore do not require valuable agricultural land or fresh water.
'Just like people, algae store energy in two different ways: as starch or as fat,' explains Mooij. 'We are looking for a recipe that ensures that nature selects the best algae. For example, regular exposure to cold nights can encourage algae to store energy. We now have a stable method, but the algae mainly store this energy in the form of starch.'
Mooij is continuing his search for algae that mainly store fat. One option could be to select the algae by weight, as oil is lighter than starch: scoop the top layer out of the barrel and use that for the next batch. As well as this practical approach, Mooij is focusing on why algae produce fat in the first place. This question is more difficult to answer but will result in knowledge that helps point algae in the direction of oil factories.

Support

Obviously there is no shortage of technological opportunities – from plausible scenarios to oily algae. 'Ultimately, however, we will need to rally more public support for biofuels,' says Osseweijer. 'People won't take you at your word it if you say something is a positive development. You need to discover and recognise the values on which they base their opinions, and then demonstrate that a technology can contribute to these values. I would like to analyse how this works for bio-based products, and I am actually organising a workshop in January with experts from various fields.'

'The two main obstacles are political instability and war. The fossil fuel-based financial system is also a problem'

She is particularly interested in looking beyond the Netherlands. TU Delft is also working with foreign partners, such as several Brazilian universities and companies, to continue to explore the possibilities of biomass (not just for biofuels). An agreement was recently signed that will result in 100 extra PhD positions in the coming years – a considerable, but highly necessary, expansion in research capacity. Osseweijer refers to a recently published report by the Scientific Committee of Problems on the Environment (SCOPE) that identified research needs: 'Current global biomass consumption represents about 10% of the total global energy consumption. Of this, about two thirds is used in poor areas, mainly as firewood for cooking. This is highly inefficient and unhealthy and, although there are good alternatives, insufficient use is made of them. Although it is theoretically possible to achieve both a higher food production and a sustainable energy supply on existing agricultural land, there are still many gaps in our knowledge to be filled before we can reach that point.'

The Bioprocess Pilot Facility in Delft, in which the university spin-off Delft Advanced Biorenewables (DAB) looks at how best to scale-up the conversion and separation of oil from biomass.

Speed of sea level rise may be **twice as fast** or more

Sea levels may rise a lot more this century than is assumed in the IPCC report. This is the conclusion drawn by Dr Riccardo Riva and his colleagues in a recent article in Climate Research.

Riccardo Riva, lecturer in the Department of Geoscience and Remote Sensing (Faculty of Civil Engineering and Geosciences) and the TU Delft Climate Institute, published an article in Climate Research last summer together with colleagues from Copenhagen, Liverpool and Beijing on sea level rise predictions in the 21st century for northern Europe.
There is no doubt that sea levels will rise, due to the accelerated melting of glaciers, the loss of land-based ice masses on Greenland and the South Pole that run into the sea, and expansion of the world's oceans as they warm. These various contributions together tell us what the global average sea level rise will be. The water will not rise uniformly across the globe. Local effects such as the uplift of continents that were covered with ice during the Ice Age may cause an annual sea level drop of one metre. The melting of the ice sheets also reduces the local gravitational pull, which means that melting ice on Greenland may cause a local fall in sea level as far away as Norway or Ireland. Such factors can impact local sea levels.
The researchers took the business-as-usual scenario of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) as their reference point. This scenario assumes only a slight decrease in CO_2 emissions, and continued economic growth, resulting in an average temperature by the end of the century that is five degrees higher than pre-industrial levels.

There is no doubt that sea levels will rise, but the water will not rise uniformly across the globe

For cities near the North Sea (from London to Hamburg), this means a sea level rise of 80 centimetres by the end of the century.
However, the researchers claim that an additional rise of 95 centimetres is also possible, due to melting ice on the South Pole. Riva and his colleagues point to other studies showing that the rate of melting of glaciers on Antarctica is accelerating, which is associated with a local knock-on effect. Therefore, 80 centimetres is the most likely scenario, but there is a significant risk of water levels rising more than twice as fast. Water levels will also continue to rise, and more rapidly, after 2100.
The researchers therefore recommend this to be taken into account in climate change policies. JW

Waslak Grinsted, Svetlana Jevrejeva, Riccardo Riva, Dorthe Dahl-Jensen, Sea level rise projections for northern Europe under RCP8.5, Climate Research, 17 June 2015

Urban Microclimates affect People's Health and Happiness

A well-designed urban neighbourhood with a good microclimate helps people live longer healthier lives, so microclimatology should be considered right from the start of the urban design process.

'People in towns should know how much happier and healthier they would be if they had a better microclimate', says Dr Marjolein Pijpers-van Esch, author of 'Designing the Urban Microclimate: a framework for a design-decision based support tool for the dissemination of the urban microclimate to the urban design process.'
By microclimate, Pijpers means the small-scale climate in streets, gardens, and town squares, which is influenced by factors such as solar radiation, sound, daylight, air-quality and wind. 'Of course microclimate is related to the regional climate but it's also hugely influenced by physical elements like buildings, paving and vegetation', explained Pijpers.
Microclimate has a much larger effect on human health than most of us realise. Back in July 2006, for instance, a heat wave killed 1000 people in the Netherlands, putting it in the world's top five countries most affected by natural disaster that year. Towns and cities are particularly warm, and the situation is exacerbated by existing urban design, argued Pijpers: 'We have less outlook on the sky so we can't lose heat easily, less wind because we block the wind with our buildings, we produce our own heat using cars, computers and factories, and we use air conditioners which cool down the inside but heat up the outside. So there's a sort of vicious circle.'

Natural systems

So how can urban designers build for global warming? 'You can do a lot with orientation and distances be-tween the buildings with respect to the sun and wind', said Pijpers. East-to-west orientation, with a minimum 15 degree angle which depends on height-on-width ratio of street, and if you calculate the right distances, there will be no temperature peak at midday. 'It doesn't need to cost any more', points out Pijpers, 'you just have to think about it.'
Pijpers also thinks that urban designers should make more use of natural systems: 'There's no down side to using vegetation and water. Trees can be planted in beneficial places such as open market places to give shade, and extra cooling as they transpire; they can also block the wind in winter.'
Microclimate is not the only issue in urban design of course but it need not conflict with other concerns such as sustainability or solutions for retaining water: 'That's a big problem in the Netherlands', says Pijpers, 'but planting vegetation will help retain water and improve local microclimates.'
So Pijpers' message to urban designers is two-fold: 'Get to know about your influence on the microclimate; and secondly, it's good that you can do so much with so little so use that influence.'
Meanwhile everyone else can contribute to improving their local microclimate: 'It's time we started thinking about the small, smart things again', said Pijpers, 'like insulation, solar panels, painting roofs white or using reflective roofing material, de-paving yards and sowing grass, and putting gardens on roofs. It all helps.'

'It's good that you can do so much with so little'

Climate proof cities

'Climate Proof Cities' is a research programme that explored ways to lessen the vulnerability of Dutch towns and cities to the effects of climate change – particularly heat stress and flooding. Carried out by a consortium of ten universities and research institutes (including TU Delft) and published in October 2014, the report said that the most efficient way to make towns in the Netherlands, big and small, 'climate-proof' is through numerous relatively small and local measures, which can often be carried out parallel to major maintenance work.

More climate-friendly wastewater treatment

Better treatment of waste water will release fewer greenhouse gases, says Mark van Loosdrecht, professor of Environmental Biotechnology, who is researching how to reduce N_2O levels in the air.

'N_2O is a party drug, did you know that?' says Mark van Loosdrecht, professor of Environmental Biotechnology, halfway through the interview, with a smile. 'It is also called laughing gas, and used for filling whipped cream canisters, for example.' The gas may seem fairly innocent – for extra fun at parties – but in fact nitrous oxide, or N_2O, is a greenhouse gas that is 320 times as strong as CO_2. Therefore, even small amounts escaping into the atmosphere can have serious effects.
Consequently, if we want to help stop climate change, we need to focus not just on reducing carbon dioxide emissions, but also on reducing the amount of laughing gas released into the atmosphere. This is what Van Loosdrecht is working on. According to Van Loosdrecht, 7% of global warming is due to N_2O. And, of all the greenhouse gases emitted during the wastewater treatment process, up to 80% can be N_2O.
So, how does it work? Wastewater contains high levels of nitrogen compounds such as nitrates (NO_3) and ammonia (NH_3), and these need to be removed. Laughing gas (N_2O) is released in the process, but in which processes exactly? The answer to this question is very complex, was the conclusion of PhD research she performed back in 2010. 'We are therefore taking this to the next level, focusing on bacteria in the lab,' says Van Loosdrecht. 'The problem now is that N_2O can be produced by two groups of bacteria. The first converts ammonia into nitrate, and the second nitrate into nitrogen gas (N_2).' Nitrogen gas is of course completely harmless, as it makes up 80% of the air we breathe.

Laughing gas is 320 times as strong as carbon dioxide

Van Loosdrecht is trying to use the bacteria in his lab to establish under which conditions N_2O is produced. For that reason he is involved in NORA, a four-year European research programme studying greenhouse gas emissions. He is also working together with a guest researcher from Spain who applies the microbiological knowledge to the water treatment process, to see whether laughing gas emissions are actually reduced in practice.

Own energy first

To deal with climate change we need sustainable energy systems, but foreign energy suppliers are currently pushing Dutch suppliers out of the market. 'EU policy needs to be better coordinated.'

With these words, Dr Laurens de Vries, senior lecturer in the Energy & Industry Section of the Faculty of Technology, Policy and Management, takes a look ahead to the Climate Summit in Paris. How can coordination be improved? This is exactly what his research group is studying. 'We are focusing mainly on the effects of carbon and sustainable energy policies on investments in the energy sector.'
His conclusion: countries in the European Union sometimes work at cross purposes when it comes to sustainable energy policy. 'This is because countries each have their own sustainability targets. For example, Germany is much further ahead than the Netherlands in this area. Electricity prices are low, because more than a quarter of the energy is generated sustainably. The result is that the Netherlands is importing more and more energy from Germany. Not only does this not help us achieve our sustainability targets, but it is also pushing traditional Dutch companies out of the market.'

Photo: Sam Rentmeester.

EU policy has a key role to play in this, says de Vries. 'It is poorly coordinated.' The carbon market, and the emissions trading system in particular, is the EU's most important policy instrument. Its aim is cost-effective reduction of greenhouse gas emissions through the trade of emission allowances: the right to emit a certain amount of greenhouse gases. Users and providers trade in emissions allowances, which results in a carbon price. 'However, lobbying, a drop in demand due to the economic crisis and more investment in sustainable energy than expected mean there are too many emissions allowances around,' says de Vries. The result is that large companies no longer feel the pressure to limit their emissions. Of course, each company needs to surrender as many emissions allowances as it has emitted in tonnes of greenhouse gases, but this has absolutely no impact if it has enough allowances. However, the researcher believes there is also good news: 'The European Parliament has accepted a proposal for a stability reserve for carbon allowances: if there is a surplus on the market, some will be placed in the reserve, and if the market is tight allowances are released from the reserve. The idea is to stabilise the carbon market, but our model showed that the original version failed to work as intended. After we presented our research to the European Commission, the time between acknowledging that there are too many allowances and actually removing them from the market was reduced from two years to one year. This lessens the risk of the reserve itself contributing to price bubbles in the carbon market. Of course, I don't know whether this was a direct result of our research.' JB

'There are too many carbon allowances around, which means large companies no longer feel the pressure to limit their emissions'

View

Climate change is a slow process, which means that its monitoring must not be swayed by the issues of the day, says Prof. Herman Russchenberg, director of the TU Delft Climate Institute.

'Climate monitoring is not really very sexy. It is not like we are making fantastic new discoveries every week. In fact, you need to persevere for decades. The government needs to ensure the continuity of this monitoring, but in practise it is increasingly under threat. A good example is the observatory in Cabauw, which is used by Dutch meteorological insitute KNMI, the institute for public health & environment RIVM, TNO and energy research centre ECN, as well as the universities. The government wants to know which of the data obtained there make a direct contribution to verifying environmental policy, and which an indirect contribution. It is prepared to pay for direct data such as temperature, but indirect data, which can show which physical processes contribute to future climate change, are under threat. Monitoring is currently carried out by KNMI, the Ministry of infrastructure & environment Rijkswaterstaat, RIVM, ECN and universities. It would be a good idea to coordinate this by removing overlap and filling in the blind spots. Monitoring should be carried out for the long term, by selecting a number of relevant variables to be measured over several decades.
A new institute, the Climate Monitoring Institute, could make that possible and could act as a central point for all climate monitoring. The institute does not even need to be an actual building – it is about the data, which is stored somewhere in the cloud.
The point is that such an institute needs to be able to guarantee the quality and availability of the data for 40 years or more. All the research institutes should have access to the data, but the business community too. If they develop applications that make a profit, for example for the wind parks currently being developed, then some of these profits should flow back to the climate institute.
Such a Climate Monitoring Institute could be a key part of an infrastructure for future research, as recently advised by the Royal Netherlands Academy of Arts & Science KNAW. It is possible to produce a fine-resolution simulation of the land and atmosphere in the Netherlands, preferably combined with a network of sensors that provide the model input.
The objective of the Climate Monitoring Institute should be to ensure the quality and continuity of climate data. This data should be open access, so that everyone bases their work on the same data. As well as climate data such as temperature and greenhouse gas concentrations, the institute could also monitor air quality. The institute would generate big data on the climate to which everyone would have access. In this way, the not-so exciting climate data sets could be used in some interesting applications.' JW

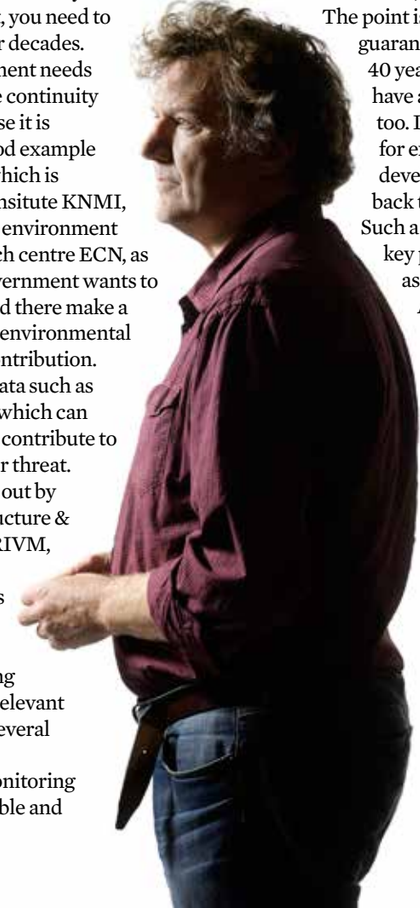


Photo: Sam Rentmeester.

‘Life is something you create together’

Biophysicist Professor Cees Dekker had a notable start to the year. He was appointed as a Professor of the Royal Netherlands Academy of Arts and Sciences for his life’s work and received a major European research grant to develop artificial cell division. Dekker (56) is now focusing on the development of artificial life.

AUTHOR: JOS WASSINK PHOTOS: SAM RENTMEESTER

At school, we were taught that a cell is a bag of protoplasm with a nucleus. After spending fifteen years on bionano research, how do you see the cell?
'Half a century of molecular biology has left us highly impressed by the huge complexity of cells. You could use various metaphors to describe them. Imagine a sealed-off entity like a spaceship as big as a city, with defence systems and gates to the outside world. There are energy plants to maintain life and a library of information for emergencies. There is a system of trams for moving from A to B, a waste collection service and even recycling plants. For every function in such a city, I can cite a protein complex with similar functions in the cell. The DNA serves as a library in which all the information is stored. It encodes information for protein-making factories. The proteins are like robots that combine to enable the whole thing to function. This is what fifty years of biomolecular research has taught us. In our own research in the last fifteen years, we have pinpointed some of these elements, such as the DNA repair mechanism, and precisely measured how it works.'

'It is our duty to explore and make use of nature'

Is that measurable?
'With precision, we are physicists and we measure forces, distances and energy conversions. We measure mechanistic information about molecules in a cell. A cell is a collection of huge numbers of molecules that together make up a functional, living system. It's fascinating. We can measure at detailed level the powers and energies of all these physical molecules in terms of elasticity and torsion, for example. We have conducted extensive single-molecule studies of this kind in the last fifteen years. The next challenge will be to explore how the components work together to achieve the cell's major functions, such as division and metabolism: absorbing nutrients, gaining energy and excreting waste. There is an idea looming on the horizon involving the use of a soap bubble to create a living cell filled with the components it needs for minimal functionality, as a way of gaining a better understanding of what life actually is.'

Is creating life the holy grail of synthetic biology?
'Yes, it is a great fascination for me and I have now launched several projects on it. I am focusing on cell division because it is pure physics. Metabolism, on the other hand, involves a lot of biochemistry and my counterparts, such as Groningen professor Bert Poolman, are working on that. In December, we are organising a workshop in Delft with twenty leading professors from across Europe to explore how we can work together to build a synthetic cell.'

As someone who is openly religious, do you not have issues with humans creating life?
'It's a bit early for that question. It is usually the last thing people ask. But no, I have no problem at all with it. The question is a purely scientific one: what is life and how do you piece it together from components? And if you ask me to interpret it religiously, then I would say I see it as my duty to explore nature and use it in the service of my fellow humans and in God's honour.'

You do not believe that God has the sole entitlement to create life?
'No, indeed I have already argued that it is our duty to explore and make use of nature. If that includes investigating how life forms from different components, I see that as very valuable knowledge that can also be put to other uses. We may be able to create a minimal structure for the photosynthetic conversion of energy or capture greenhouse gases. I recently wrote a column in a Christian newspaper about 'creating life in the lab'. It was about this very question and I have received very little criticism. Admittedly, it was in the middle of the holidays.'

When do you think we can expect to see this kind of artificial living cell?
'It depends on how you define life. If you look at the minimum characteristics, they are compartmentalisation, a sealed entity, metabolism, cell division and information used by the cell to define itself. That information needs to be sufficiently stable but also be able to adapt to enable evolution. If you take that as your working definition, I estimate that it will take around ten years to build a minimal living system.'

You believe we will live to see it?
'Yes. The point is that I believe that this metabolism is very difficult to achieve. Cell division is also complex but I can imagine it in around five to ten years. For my colleague Bert Poolman, the reverse applies. He sees cell division as being extremely complex but envisages possibilities for achieving metabolism with five components. That makes me optimistic and believe that a consortium of scientists can produce a living synthetic cell within a decade.'

On a different matter: this spring, you received an award for your life's work from the Royal Netherlands Academy of Arts & Science KNAW and a major European research grant to develop artificial cell division. What is your reaction to these two events?
'The KNAW prize is a great honour that I am very pleased about. It is an acknowledgement of my scientific work. It is also accompanied by a million euros worth of research funding. The European Research Council grant was acquired in a competition for research proposals. It will help me to continue my work. Five research grants expired last year, so I was ready for a new stage in my research. I am now madly recruiting and have dozens of applicants here.'

How do these people find you?
'I have a website and this time I also placed an advert on the Nature job website, because I have seven posts to fill. I also receive two or three applications by email every day, throughout the year. I just came back from leave to find 500 emails waiting for me. Half of them are spam, but still. Two emails per day is 500 applicants every year, and I appoint five of them – that is quite a selection threshold.'

So, how do you choose the one percent?
'I reject between 80 and 90 percent after reading the email. They receive a nice thank-you letter from my secretary. I ask the rest for references and then only proceed if they are really positive. I then interview via Skype, which rules out half of them. Interviews in person rule out half after that. That leaves just a few, who are the people who conduct the research.'

What are your selection criteria?
'They need to be exceptional in their field and I need to like them. I tend to rely on my intuition, because they need to be friendly and communicative people who can work well in a team. They also need to be driven and be able to discuss things quickly and openly.'

In around 2000, you switched from nano research to bionano research. Why was that?
'At that time, I became a full-time professor with a 25 to 30 year career ahead of me. I did not want to work endlessly on those nanotubes that we had made such a success of. They had lost their shine and I wanted to pursue a different route. In the late 1990s, the physicists at Delft began to move towards biology. People like Alexander van Oudenaarde, now the director of the Hubrecht-lab, Sander Tans, group coordinator at the Amolf and professor at Delft en Tjerk Oosterkamp, a professor at Leiden. Plus Marileen Dogterom, now also at Delft, but then based in Amsterdam. With this group of people, we pioneered single-molecule biophysics in the Netherlands. We studied biology at the level of individual molecules.'

They simplified biology to interaction between molecules?
'Yes, from the complex city that makes up the cell, we took a single molecule to explore mechanistically how it works. I found it fascinating to discover that there are molecular engines that carry out actions using energy sourced from combustion. It struck me as a fascinating field to which I wanted to contribute in order to discover and develop things. I also saw a relevant way in to the field, because we had already been developing nanotech instruments that could be used with single biomolecules straight away. The technology served as a bridge. I knew little about biology and needed to learn about it, but that turned out well. From there, fifteen years of work have brought us to molecular interaction. At its heart, biology is all about the interaction of molecules that together form life. A single molecule is not alive, it is the interaction with the surrounding proteins that make it a living system.'

There is an obvious parallel with the staff in the lab. You also expect them to interact well.
'You could put it like that: individually you are nothing, but only become alive when you are together.'

CV

Prof. Cees Dekker (1959) is Director of the Kavli Institute for Nanoscience Delft in the Applied Sciences Faculty and University Professor at TU Delft. Dekker studied experimental physics in Utrecht and joined TU Delft in 1993 as an associate professor. On his appointment to the Antonie van Leeuwenhoek Chair in 1999, Dekker focused on research into biomolecules, such as DNA. Now, fifteen years on, he thinks it is time to work with other experts to construct an artificial living cell. Dekker is one of the founders of the Delft Global Initiative, as part of which he aims to develop a kind of pregnancy test for the diagnosis of neglected tropical diseases in developing countries.

Victor van der Chijs
PRESIDENT EXECUTIVE BOARD UNIVERSITY OF TWENTE

Victor van der Chijs LL.M is the new chairman of the federation of the three universities of technology, a position which he assumes from ex-TU Delft president Dirk Jan van den Berg. Van der Chijs believes 'it is very important for the Netherlands that we provide high-quality education for potential new engineers.' He wants to invest more in people who contribute to scientific research, technology and innovative strength.
(Photo: UT)

Carolien Gehrels
MEMBER SUPERVISORY BOARD

Carolien Gehrels M.A. has been appointed Member of the Supervisory Board of TU Delft, having been nominated by the Works Council and the Student Council, as well as the Supervisory Board. Gehrels has worked for one year for the engineering and consulting agency Arcadis, before which she was an alderperson for the Labour Party in Amsterdam for over eight years, responsible for example for Art and Culture and Economic Affairs.
(Photo: Arcadis)

Nynke Dekker
MOLECULAR BIOPHYSICS

Nynke Dekker was recently admitted to the Royal Netherlands Academy of Arts and Sciences (KNAW). The professor of Molecular Biophysics (Applied Sciences) works at the interface of physics and biology, studying the physical properties of biomolecules. The new members were officially inaugurated at the end of September. Membership of the Academy is for life.
(Photo: TU Delft)

Wiro Niessen
MEDICAL IMAGING

Prof. Wiro Niessen will receive the prestigious Simon Stevin Meester award from Technology Foundation STW on 5 November. The award, worth 500,000 euros, will be used to continue his research into computer systems that can predict which diseases a person is likely to have, based on thousands of MRI and CT scans. 'I don't believe in a viable society', he states in Delta.
delta.tudelft.nl/30385
(Photo: Sam Rentmeester)

These are the best

Each year, TU Delft students choose the best lecturer in their faculty. From these, the best lecturer of the university will be chosen during the Best of TU Delft awards in the Aula Auditorium on 26 November.
The Lecturers of 2015 in the eight faculties are Dr **Matthijs Langelaar** of Mechanical, Maritime and Materials Engineering (3mE), **Frits van Loon**, lecturer in Landscape Architecture in the Faculty of Architecture and the Built Environment, Prof. **Giovanni Bertotti**, lecturer in Civil Engineering and Geosciences, Prof. **Wouter Serdijn** of Electrical Engineering, Mathematics and Computer Science, Dr **Ianus Keller** of Industrial Design Engineering, Dr **Alexander in 't Veld**, lecturer and test pilot in Aerospace Engineering, Dr **Jan Anne Annema**, lecturer in transport policy in the Faculty of Technology, Policy and Management, and finally EEMCS mathematics lecturer Dr **Fokko van de Bult**, who won the title in Applied Sciences.

After Delft

Travelling from Delft to a wedding in southern India by motorbike in 2011, Henk Wapstra met a British agricultural inspector in Iran. They got talking and at the end of the evening the Brit said, 'Henk, you're a mountain climber. The only problem is, once you're at the top you can't enjoy the view because you're busy thinking about the next mountain.' 'He hit the nail right on the head.'

It was an attitude that he had from very early on. As a boy, Wapstra wanted to become a carpenter like his father, to make something you could hold in your hands. Having completed gymnasium (pre-university education), he went to work in the building trade with his father, until he decided he wanted to continue his studies. He flew through his Bachelor's in Mechanical Engineering, completing it in three years, and found his next challenge in the Unitech exchange programme: six months studying abroad and a six month internship.
Wapstra chose Chalmers in Sweden, immediately adding another six months to get a fast-track Master's in Management and Economics of Innovation. 'I thought, I can do that faster.' His internship was at the Swedish bearings company SKF, where he

'Status quo makes me uncomfortable'

also carried out research into hybrid bearings used in particular in very cold applications such as LNG (Liquefied Natural Gas). 'I could have gone to Shell then', says Wapstra, 'but I thought I still needed more of a challenge technically-speaking.'
Back in Delft for the Master's in Solid-Fluid Interaction, he discovered that the Formula Student dream team was looking for a technical manager to design, build and drive a racing car in competition. 'Technical. Manager. Two words that give me energy', says Wapstra. Despite a lack of management experience, he got started. 'You find out pretty quickly what works and what doesn't.' And that was true. He found it difficult to get everybody in the multidisciplinary team thinking along the same lines. 'Sometimes you look around you and think: wow, it's just a big vacuum behind me. There is an old proverb that says, 'If you want to go fast, go alone. If you want to go far, go together.' There is a compromise somewhere in the middle.'
The dream team was good experience for his job at Shell in Moerdijk, as Maintenance Supervisor for the ethane cracker. Managing a team, defining the broad outlines, keeping everyone on board: he learnt it all in Formula Student. So, is there another mountain he wants to climb? 'I want to build a big, floating LNG plant, that would be fun', says Wapstra. 'Status quo makes me uncomfortable.'

AUTHOR: JOS WASSINK
ILLUSTRATION: STEPHAN TIMMERS

Dutchies in Texas

Engineers from Delft have designed a kind of Delta plan for Texas. The aim is to protect the inhabitants in and around Houston against floods caused by hurricanes.

A collection of flexible storm-surge barriers, double dikes and multifunctional coastal defences are covered in the book Delft Delta Design. This 'Delta plan' shows what can be done and aims to provide subject matter for discussion. 'We are taking the ingredients we need with us' says Prof. Bas Jonkman, Professor of Hydraulic Engineering in the faculty of Civil Engineering and Geosciences (CEG). 'It is up to them to make something nice with them.'

Vulnerable

The awful calamity of 1900 has not been forgotten. A storm surge flooded the port of Galveston, leaving it between 2 to 4 metres underwater. Around 8,000 people perished and the harbour was never the same again. On average, a hurricane hits the area once every nine years, the most recent being Ike in September 2008.

About six million people live around the Galveston Bay estuary that is about the size of the IJsselmeer. There are mudflats and sandbanks in the bay that provide a rich source of nutrients for shrimps, crabs, oysters and fish. It is an important stopping-off point for migratory birds on their route between North and South America. The nearby Houston harbour is home to a lot of petrochemical industry, comparable to Europoort near Rotterdam. Around the city of Texas, development tends to take the form of urban sprawl. Many incomers have little knowledge of the area's low-lying location and lack of effective dikes. Finally, on the Bolivar Peninsula, many houses are built on piles to protect against high water.

However, they have no protection against a hurricane, as Ike recently revealed.
'People have become more aware of how vulnerable the area is', says Antonia Sebastian, MSc., from Houston's Rice University who spent ten months in Delft on a Fulbright scholarship. 'It started with Katrina that devastated New Orleans in 2005. When hurricane Rita was heading for Houston a month later, 100 people were killed in the evacuation. This led Rice University to establish the Sspeed Center (Severe Storm Prediction, Education & Evacuation from Disasters, ed.). After Ike (2008), the centre received additional funding for its activities.'

> 'In Texas people hate the government and prefer to look after themselves'

By that time, Professor William Merrell from the Texas A&M University at Galveston was already working on a plan for an Ike Dike or coastal spine. His aim was to improve the protection of the coast and islands around Galveston Bay and prevent a storm surge from the Gulf of Mexico. His plans were the equivalent of a Delta Works for Texas.

Texans

This is why, starting in 2011, two separate groups of Texans visited TU Delft. Staff from the Sspeed Center visited Professor Han Meyer in Architecture and the Built Environment. Meyer is one of the chairs of the Delft Infrastructures & Mobility Initiative (Dimi). He was also involved as an urban designer in transforming New Orleans after Katrina.
At CEG, Professor in Hydraulic Engineering Bas Jonkman welcomed colleagues from the Texas A & M University who were eager to find out more about the Delta Works and navigational surge barriers. Based in Galveston, the A&M researchers were more interested in a primary line of defence against the Gulf of Mexico than in local protection for Houston and its industry.
'Two years ago, A&M and Rice were in two different camps', recalls Sebastian. 'A&M wanted a coastal spine, but the Sspeed people were more interested in how they could combine the dikes and dams in and around Houston into a single defence system.'
It did not take long before efforts on the Texas project at TU Delft were linked together. The design studio Delta Interventions (led by Han Meyer) began working with final-year students in hydraulic engineering and researchers at TPM.
The book has fifty authors, including five doctoral candidates, 23 final-year students and senior researchers from both Delft and Texas.
Although awareness of the vulnerability to flooding may have increased, work has yet to start, since no funding is available. Most of the research conducted so far has also been unpaid, and is thanks to all the final-year students, occasionally supported by a trip, a business internship, etc. Sebastian believes that the cultural differences between Texans and the Dutch play a role. 'The Dutch avoid risks and have great trust in the government. In Texas, the opposite applies: people hate the government and prefer to look after themselves.' But the realisation that major hydraulic engineering work is based on solidarity is only slowly sinking in.
There is also the golden rule of hydraulic engineering: the money only comes after a flood. That was also the case with Katrina (18 billion dollars invested) and after Sandy had flooded New York and New Jersey (12 billion dollars spent on measures). Ike was the exception, but it still caused 25 billion dollars' worth of damage. The demise of Goldman Sachs ten days after the hurricane seized all of the media's attention and Ike was quickly forgotten.


Aerial view of the residential community of Gilchrist after hurricane Ike. (Photo: Jocelyn Augustino/FEMA)

Download the book Delft Delta Design from the Delft repository: bit.ly/ddd-rapport or request a paper copy from b.l.m.kothuis@tudelft.nl

Dutchies in Texas

1 Closing the Bolivar Roads will not end the danger to Houston completely. The Galveston Bay estuary is so large that a hurricane can also cause dangerously high waters. This is why a navigational surge barrier is also planned in the Houston Ship Channel. This will be a 350-metre long steel wall that will be rolled out from the dock on the left on a rail to reach the other side. The design by ir. Martijn Schlepers (Civil Engineering) protrudes as far as 11 metres above the water as a result of upward pressure in the canal. The movable dam wall will primarily protect the harbour area and the petrochemical industry around it.

2 The oyster reefs are part of the natural structures that play a role in hydraulic engineering, supplementing dikes and coastal defences. The reconstruction of the reefs is an example of building with nature, as nature is used to reduce the risk of flooding. But the graduation project by civil engineer Robert de Boer reveals that the oyster reefs have a limited effect only. To use oyster beds to break the waves, they need to be placed close to the banks and high above the water, rather than at the centre of the Bay as here. However, depositing sand to build an archipelago of artificial islands would help.

3 The plan for the Bolivar Peninsula involves a 43-km long dike across the centre. The early draft designs are based on a dike-in-the-dunes concept integrated as far as possible into the environment. With a height of 5.8 metres above the average sea level, the dike can protect against a storm surge the likes of which happen every hundred years and will not overflow. The dike will offer no immediate protection to residents on the Gulf side, although it will keep the route on the Bay side of the peninsula free for evacuation. A side issue is the fact that residents often refuse to evacuate because they cannot imagine the effects of a hurricane. This means that there will need to be education for coastal residents as well as dike construction.

4 An unusual storm-surge barrier is planned for the narrow strait Bolivar Roads between Galveston Island and Bolivar Peninsula. The movable gate on it will be a floating steel or lightweight concrete caisson measuring 220 x 36 x 22 m (LxHxW). The concrete version of this colossus will weigh more than 70,000 tonnes and hang from the new pier. When open, the caisson will withdraw into the pier and the Houston Ship Channel will be accessible to ships up to 220 metres in width. If a hurricane is approaching, the caisson will turn 90 degrees and close off access to the Bay. Once in place, the caisson will be partially submerged: the concrete container will continue to float and protrude 5.5 metres above sea-level to withstand even the highest waves.

5 At the San Luis Pass, a storm-surge barrier has been fitted with a lift gate to enable smaller ships to enter. Larger ships travelling to and from Houston harbour pass through the barrier at Bolivar Roads (yellow). According to the graduation project by Maarten Ruijs (Civil Engineering, 2011), the partial closure of the San Luis Pass has only a limited effect on the current and water levels in Galveston Bay.

R PATENT

Energy-efficient oscillator

Inventor:
Dr.ir. Massoud Tohidian

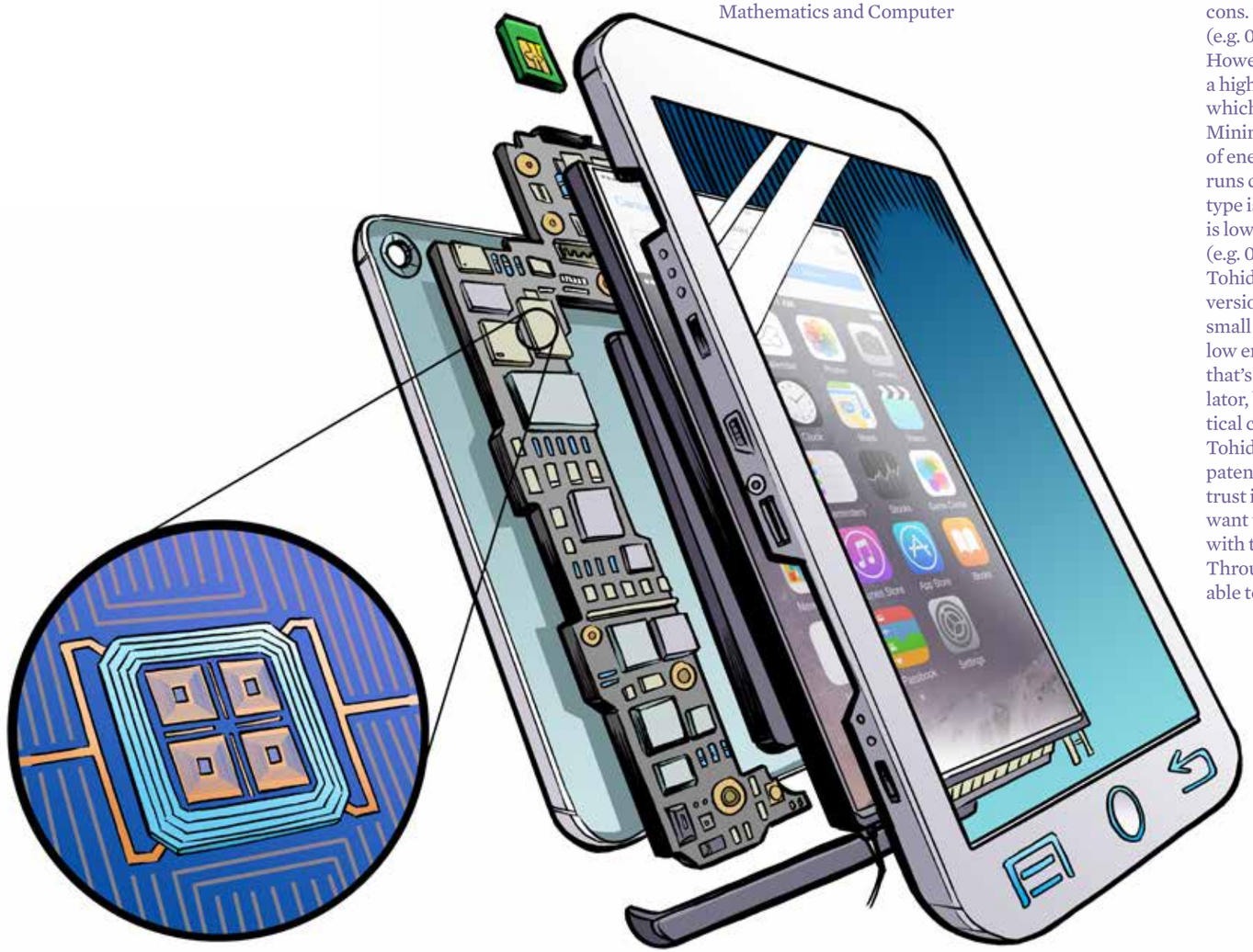


ILLUSTRATION: STEPHAN TIMMERS

Cheaper and better. With such succinct words of praise, a product is sure to sell itself. However, the practical application wasn't the central concern when Dr Massoud Tohidian was designing his extremely small, accurate and energy-efficient oscillator. In his own words: 'Our primary focus was on developing a new type of circuit'. In September, the native Iranian obtained his doctorate from the Electronics (ELCA) research group of the Microelectronics Department, part of the Faculty of Electrical Engineering, Mathematics and Computer Science. Earlier this year, he and three colleagues (among whom PhD-student Amir-Reza Ahmadi-Mehr) founded Qualinx, the company that holds patents including that for Tohidian's oscillator. For although his initial motivation was perhaps academic, he now believes that he's developed a ready-to-market product. Oscillators can be found in nearly all electronic devices. They generate the frequencies upon which mobile telephones, for example, communicate with each other. Up until now, manufacturers had a choice of two types, each with their own pros and cons. The ring oscillator is small (e.g. 0.01 m^2 chip area) and cheap. However, these oscillators generate a high amount of phase noise, which makes them inaccurate. Minimizing this noise uses up lots of energy, which means a battery runs down quickly. The second type is the LC oscillator. This type is low phase noise, but also larger (e.g. 0.2 m^2) and so more expensive. Tohidian's oscillator comes in two versions: one that's extremely small with low phase noise and low energy usage, and another that's the same size as an LC oscillator, but a lot more accurate. Practical considerations were behind Tohidian's decision not to sell the patent. 'Clients don't place their trust in a single prototype. They want to see it in a larger system with their required characteristics'. Through Qualinx, he expects to be able to deliver precisely that. SB

Tree cocoons

I hate lotteries, especially all the advertising they send in the post, but the Postcode Lottery's Green Challenge always brings a smile to my face. This is an annual event in which sustainable entrepreneurs present their new ideas. A jury awards the best idea with 500,000 euros to develop the business plan further.
This year Jurriaan Ruys from Land Life Company and a Delft graduate won with a kind of incubator for young trees and plants. A cocoon is placed around a seedling when it is planted, and this increases the chance of survival in dry areas in which nothing normally grows or flowers. The cocoon has a water reservoir and is full of fungi that help the plant become big and strong. The whole thing is robust and therefore protects the plant from wind and animals, but it is also biodegradable.
Brilliant! Another discovery at the Green Challenge was edible water bottles, instead of throwing them away you can tuck into them! And another: milk from a brewery, so that no animals are needed which saves a huge amount of fertiliser, methane emissions, and so on.
Each year when the Green Challenge takes place I think, as long as such creative, green spirits are walking the world we'll eventually find a solution to the global climate and environment crisis.
And then of course I read something else and my spirits sink again. Like last spring, on nu.nl: 'The Netherlands profits from new trade route through melting polar ice.'
The Netherlands Bureau for Economic Policy Analysis has calculated the economic effects of the ice melting in the North Pole for the Netherlands. The conclusion: the Netherlands benefits considerably if ships can travel this route. In fact, it could shorten the route between north-east Asia and north-west Europe (which currently passes through the Suez Canal) by a third.
Result: cost savings in transport and increased trade flows. Furthermore, in the search for new oil and gas fields, the Russians and others would like to see the ice melt sooner rather than later.
So there you are with your tree cocoons and your edible water bottles, while meanwhile world powers and multinationals are only interested in seeing the world go down the drain as soon as possible, because short-term economic interests almost always take precedence.
And at the next climate summit in Paris, will all those countries succeed in looking further than just the money to be made in the short term? It's not looking good, but then again it didn't look so good for young trees in arid areas either a while ago. And, as far as that is concerned, a little creativity, perseverance and money can go a long way. I suggest giving everyone attending the climate summit a seedling in a tree cocoon – maybe then they will understand.

Tonie Mudde is the Chief Science Correspondent at de Volkskrant. He studied Aerospace Engineering at TU Delft from 1996 to 2003.

AUTHOR: CONNIE VAN UFFELEN
PHOTO: ARCHIEF DELFT

The social engineer

A philanthropist with a double life. Jacques van Marken, founder of the Dutch Yeast and Methylated Spirits Factory and the Agnetapark in Delft, felt at one with his workers, and was the first businessman in the Netherlands to organise housing and pensions. TU Delft alumnus Jan van der Mast is working on his biography.

Jacques van Marken and his wife Agneta.

The Agnetapark in Delft is still thriving. A large, somewhat lopsided S-shaped lake is at the heart of the park, surrounded by lush green and streets populated with former worker's houses. Hiding in a flower bed are the busts of Agneta and Jacques van Marken, standing where their villa Rust Roest ('it's better to wear out than rust away') once stood. Even though he was an extraordinary engineer, Van Marken is all but forgotten, tells Jan van der Mast during a walk through the park. Extraordinary, not only because he was the first chemical engineer to graduate from TU Delft, but also because he grew into a socially-conscious businessman who became the first to found a workers' colony in the Netherlands. An embodiment of both humanities and the sciences, combined with a romantic soul, he dreamed of becoming a poet.

Van Marken has a keen eye for suffering in the world. He's a member of the student club and sees workers living in squalid conditions. He becomes secretary of the debating club and hears Prof. Pekelharing speak with passion about social issues. Van Marken subsequently doubts whether he'll actually graduate. He wants to help to solve the social issues.
His father, a clergyman in Amsterdam, is keen for him to become a model businessman. Through his father's network, Jacques meets Minister P. P. van Bosse, who offers him this advice: 'Lad, if you really want to make a difference, you should produce baking yeast. Bakers are complaining about the lack of good yeast'. Van Marken subsequently makes two educational trips to the Austrian company Fleischmann. One of the happiest times of his life, notes Van der Mast in his book *Agneta*. But he is also taken aback by the distrust the directors have of the workers. During the final two years of his study, he formulates a social engineer's 'responsibility'. He wants to increase worker happiness and ensure that they are in control of their own destiny.

Van Marken was an embodiment of both humanities and the sciences, combined with a romantic soul

Workers' colony

Two years after graduating, he marries Agneta Matthes and founds the *Nederlandse Gist- en Spiritusfabriek* in Delft. Starting out with 35 employees, he introduces a works council and pension scheme – the first businessman in the Netherlands to do so. Long before they were required by law, he also introduces reduced working hours and days off for his workers. In order to ensure their daily bread in the case of unexpected circumstances, he even arranges accident insurance and health insurance.
In 1882, Van Marken purchases four hectares of pasture land next to his factory. He asks Agneta to investigate workers' living conditions. She hands the results of her inquiries to Eugen Gugel, a renowned Architecture Professor in Delft. He designs a workers' colony, drawing inspiration from a cité ouvrière for workers in France.
A total of 78 workers' houses are built on the land next to the factory. Four under one roof, providing homes for four families.
Van Marken commissions acclaimed Dutch landscape architect Louis Paul Zocher to design the park in the English Landscape style. It was to become a complete village with shops, schools, a recreation centre (now De Lindenhof event location), allotments, a playground, a skittle alley and space for various associations.
'Community life, that's what it was all about', says Van der Mast, reflecting on this first Dutch garden village. 'This community gave rise to about fifty associations, including a brass band that perform on the bandstand on Sunday mornings. The whole of Delft can come and listen'.
Back then, like-minded people from all over the world came to see the park. It's viewed as a welfare state in miniature, with 350 citizens. After editions in London and Paris, the third International Cooperative Congress is held at the Agnetapark. Subsequent to his visit, soap manufacturer William Lever establishes a similar, but larger, workers' colony in Liverpool.
Van Marken and Agneta move into the villa *'Rust Roest'*, to live amongst his workers. 'Not as their boss, but as their friend', explains Van der Mast. 'He didn't want any hierarchical relationships. 'I have nothing to hide from you". Ironically, that's exactly what he did when it came to his childless wife. While, in 1886, Van Marken was at a health resort recovering from neuralgia and Agneta was running the factory, she opened a letter from a certain Maria Eringaard from Rotterdam in which she asks her 'Dear Jacques' what the delay is with her maintenance payment. The two women meet and it becomes clear that Van Marken is indeed the father of Maria's three children. Van Marken meanwhile is slowly but surely becoming addicted to morphine. When Maria dies of TB three years later, Agneta offers his children a home.

Calvé

In addition to the Gistfabriek, Van Marken also founded the Netherlands Oil Factory, which later became Calvé. In 1891, another two companies follow: the Glue & Gelatine Factory and *Van Markens Drukkerij* (a printing house), where a partnership of twenty people published productions including workers' magazine *De Fabrieksbode*.
'If they generated sufficient turnover, they would gain ownership of the printing business after twenty years. That was a revolutionary idea', says Van der Mast. 'It only took them ten years'.
The crowning glory of the park is the Community Building, now home to an architect's agency and a house construction firm. 'During the day, it was a reading room and conference hall where lectures could be held, and in the evening, Sparta trained in the hall', explains Van der Mast. When the building is opened by Queen Regent Emma and Princess Wilhelmina in 1892, Van Marken gives an important speech about the conciliation of labour and capital.
Poor health forces Van Marken to stop work in 1905. He passes away on 8 January 1906. The brass band accompanies an enormous funeral procession. Van der Mast: 'Without him, Delft would have looked a lot different. Van Marken brought the city to life'. <<

Produced by the VARA Broadcasting Association, *De Strijd* (The Struggle) will be aired in October – a ten-part documentary series focusing on the workers' struggle. The second part of the series examines the edification of the workers, also covering Van Marken.

HORA EST

‘However realistic a virtual environment is, as long as a trainee knows he or she is not in a simulator, he will not perform tasks as he would in the real world’

Iris Cohen, engineer in interactive intelligence

‘If trainees know they are in a safe simulator and that there are no, or very few, physical consequences if they do something wrong, their actions will be just that little bit riskier than they would in the real world. In one of my experiments, I analysed the actions of Navy cadets in a simulator. It was a very realistic ‘high-fidelity’ simulator. Subjectively (using a questionnaire) and objectively (using heart rate measurements), we were able to see that the cadets did find the situations stressful or exciting. But even so, there were times when they did things that would not be possible on a real ship, such as giggling together, having a short, private conversation, or reacting nonchalantly to mistakes that – in reality – are quite serious, such as steering the boat over a buoy by accident.’

TED lectures make you realise the importance of moving out of your comfort zone.

Tatiana Kozlova, physics engineer

Physical exercise decreases mental blocks.

Wiebe de Vries, biomechanical engineer

Application of your findings in practice is much morte satisfying than obtaining the intellectual property of it.

Roel Schipper, civil engineer

As energy conversion devices, fuel cells have a more promising future than Litium-ion batteries.

Jianwei Gao, materials engineer

Good chemists, good cooks.

Bishuang Chen, chemical engineer

Finishing a PhD thesis is not easy, especially with a baby sitting on each arm.

Guangtao Yang, chemical engineer

‘Do what you like’ is the most confusing sentence for students from China visiting Western countries.

JianFei Yang, physics engineer

‘Utopia lies at the horizon. When I draw nearer by two steps, it retreats two steps. If I proceed ten steps forward, it swiftly slips ten steps ahead. No matter how far I go, I can never reach it. What, then, is the purpose of Utopia? It is to cause us to advance.’ (Eduardo Galeano)

Saskia Maria Roels, hydrogeologist

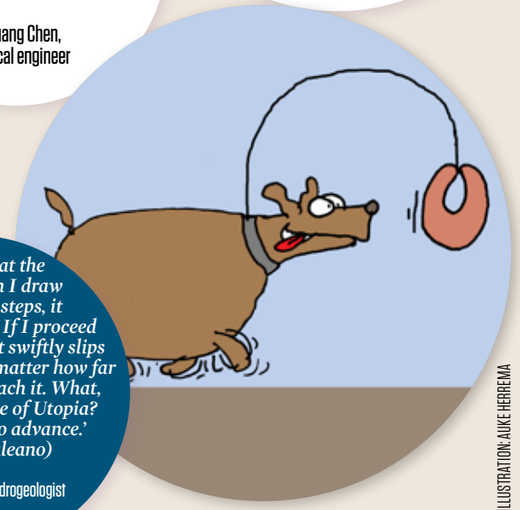


ILLUSTRATION: AUKE HERREMA

THE FIRM

A life free of stress thanks to smart planning software? It sounds too good to be true. But Calendar42, TU Delft alumnus Michel Boerrigter’s company, has built a software platform to achieve just that and it is proving increasingly popular with businesses.

A surgery assistant needs to go home because her child is sick, but an operation is scheduled in a few hours. The telephone list of potential replacements includes 300 names. It does not specify who is qualified for this particular surgery or who is available. Stress in the hospital.
Another example: a storm has hit the Netherlands. Insurance companies are being inundated by calls from people with flooded homes. Loss adjusters are travelling back and forth, and the victims have to stay at home to be there when they arrive.
Is there a better way of doing this? Definitely, for businesses that use Calendar42, explains its founder, TU Delft alumnus Michel Boerrigter.
His company has created a software platform that relieves planners of their work, by linking real-time data to smart algorithms. Users can easily access it via existing calendar apps or new concepts.
For example, the hospital enters the details of the operation time and the qualifications that a replacement will need to have. All potential candidates are then sent a message on their phones. They simply press a button to respond.

PHOTO: SAM RENTMEESTER

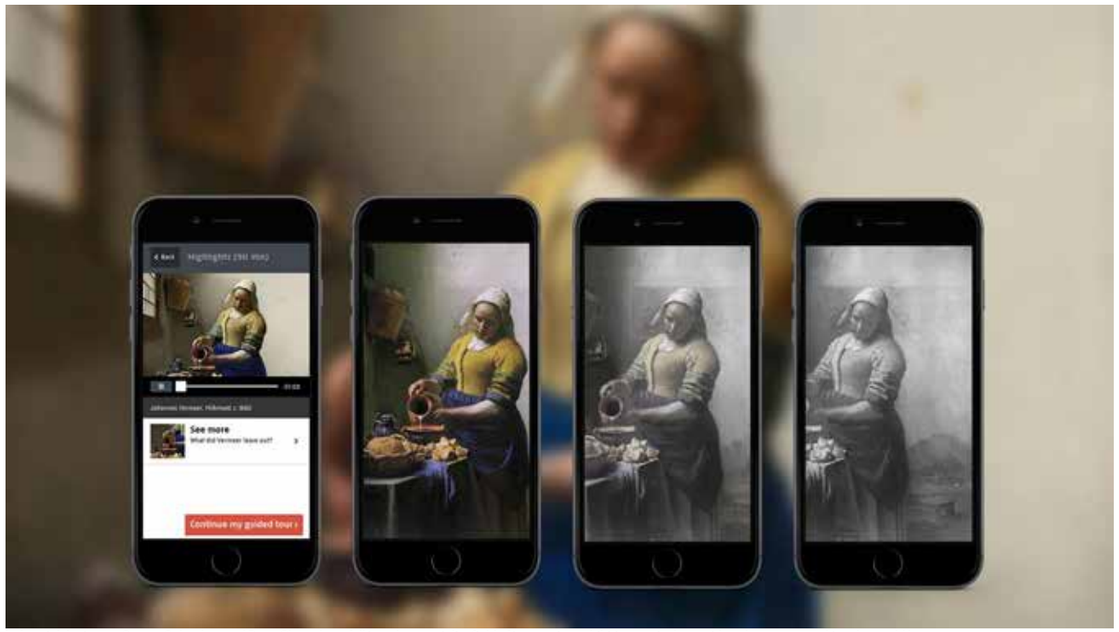
The insurance company sends customers with damages an email or text message. The customer can then decide when the loss adjuster should arrive. The software schedules all the appointments. ‘The result is a fuller agenda for the loss adjuster and reduced mileage’, explains Boerrigter.
He says there is a solution for any scheduling issue. It is therefore no surprise that Calendar42 works with businesses from many different market segments, including government agencies and construction companies, as well as insurers and healthcare providers.
The company has 14 staff on the payroll and international ambitions. ‘We see the Netherlands as a pilot and R&D market. It has a good infrastructure, people are open to new ideas and yet still critical. If the concept works well here, we can roll it out internationally. We are already active elsewhere in Europe’, says Boerrigter.
Currently, the company has yet to make a profit. The entire turnover is being re-invested in the product, just like the one million euros in funding that Calendar42 received from investors last summer. Boerrigter believes that the secret of a successful entrepreneur is to continually revalidate one’s assumptions. ‘Success is all about structure and perseverance. You can make a lot of mistakes, as long as you ensure that any impact remains minor. I do not believe in luck, just working hard and avoiding too many setbacks.’ SB

Name:	Michel Boerrigter
Study:	Industrial Design Engineering
Company:	Calendar42
Founded:	2011
Product:	Software platform for real-time planning
Mission:	A planning-free world
Turnover:	‘I do not comment on that’
In five years’ time:	‘We are not looking that far ahead, but we’ll probably be bought out or floated on the stock exchange’

The storytellers of NorthernLight

They designed the Rijksmuseum app, which this year won several awards, and will release what they believe is the new standard for museum apps in October. TU alumni Steven Schaeken and Peter Slavenburg talk about their passion for design and technology.

AUTHOR: CONNIE VAN UFFELEN PHOTO: SAM RENTMEESTER



Industrial designers Steven Schaeken and Peter Slavenburg fell into the specialist field of interactive exhibitions quite by accident, but are now taking the world by storm.

Museums boring? For industrial designers, they are a source of many innovation opportunities, believe Steven Schaeken and Peter Slavenburg, founders of the creative design agency NorthernLight. They fell into the specialist field of interactive exhibitions quite by accident, but are now taking the world by storm. 'I don't think there is a single continent that we haven't visited', says Schaeken.
The industrial designers met during a study trip in Barcelona and became colleagues at the Science Center NEMO in Amsterdam, in 1993. NEMO was being built at the time and was looking for designers. For both of them, the attraction was that the interactive exhibits were about science and technology. This is why the field suits industrial designers 'incredibly well', says Slavenburg, despite the fact that they do almost the opposite of what industrial design is, in other words design a place for the general public to visit rather than a product to take to the public.

Through audio and short films, the visitor is given information about the various museum pieces.

Visitor's centre

After the opening of NEMO Schaeken and Slavenburg created NorthernLight in 1998. One of their first projects was for a visitor's centre for the then still national post delivery company PTT Post, to help people understand the operational processes involved. The 'interactive experience' that they developed was almost unheard of in the Netherlands at the time, but turned out to be an up-and-coming field.
They worked on projects for numerous science centres outside the Netherlands, initially by simply travelling around the UK, where cities wanted public attractions for the turn of the millennium. It was later that they also started to work on digital exhibitions for museums. For the Netherlands Institute for Sound and Vision, for example, they used radio-frequency identification (RFID) in 2004 to allow visitors to make a digital record of their visit.

> 'Cross an architect with a game designer and you get us'

Children's book

Two years later, they used PDAs (personal digital assistants, the personal computers that were the precursor to the smartphone) for Kelvingrove Museum in Glasgow. Teenagers used them to go on a digital tour and record the tasks they carried out along the way in a personal finale. 'It was very ambitious', says Slavenburg now. 'Technically speaking, it led to the idea that you could do things in the museum using a mobile, intelligent device without needing to make any physical changes.'
A multimedia experience, therefore, without the need for screens on the wall. The rise of smartphones offered new opportunities. In 2012, NorthernLight produced an interactive children's book for the iPad for the National Museum of Antiquities in Leiden.
And then the Rijksmuseum app was released this year, with Kiss the Frog from Delft responsible for the technology. Through audio and short films, the visitor is given information about the various museum pieces. Users can follow a tour, search for a specific collection number and play a family game.
It is all based on storytelling. 'Cross an architect with a game designer and you get us', says Schaeken. As engineers, however, they couldn't resist adding all kinds of new technology to the app, such as photo navigation to show people the way in the building, and 3D audio, which allows visitors standing in front of a winter landscape to actually hear the skaters passing them by.

iBeacons

The app has won several prizes, including the Heritage in Motion Award. NorthernLight will also launch an app for Museum Volkenkunde in Leiden in October. This app should set the new standard for museum apps in 12 different ways, but in particular with its indoor navigation using iBeacons: small boxes that emit a signal so that you no longer need to point your smartphone in a certain direction or type in a number to receive information. This opens up the way for a new 'hey, come here' function, for if you want to show something you have seen to someone else in a different room. There is already international interest in the idea.

Alumni news

UfD IHC-Teamwork Award: Binder - Done that!

Each year, the Delft University Fund awards a prize to a team that has conducted particularly innovative and unique work in research or teaching at TU Delft. Three winners were selected in 2015: Binder, Formula Student Team Delft and PLUG.

The first prize, a cash prize of €7,500, was won by Binder – Done that! Binder is a group of honours students who have developed a platform to make it easy for students to borrow textbooks from each other.
This is a response to the increasingly popular sharing economy. Uber and Peerby are other successful examples, and now we see it applied to the textbook market.
Books are getting more and more expensive, and the end of the student grant means that they will become unaffordable for some students. Also, despite the digitisation of books, hard copies remain popular.
This platform therefore helps students who own books to lend them to other students for a rate of their choosing. The app links them to students who need to borrow the book but cannot or do not want to buy it.

Incentive prizes

PLUG and Formula Student Delft both received incentive prizes worth €2,500 each. Team PLUG developed an app for KLM and LVNL to replace all the letters and faxes between the various parties at Schiphol airport. Formula Student team Delft was able to considerably reduce the weight of their new car, the DUT 14, with a new wheel design.

TU Delft Career Centre

TU Delft Career Centre for Young Alumni

Are you wondering whether you are in the right job, are you unsure of the direction you want your career to take, or do you just want to talk to an independent advisor about your options and how best to present yourself to potential employers, also on paper? Why not make use of the expertise of our career advisors at the TU Delft Career Centre?

Consultations in Delft or Den Bosch.
For a small fee, you can receive personal advice from a career advisor who is fully acquainted with the TU Delft programmes and the job market. A consultation lasts for one hour, can be conducted in either Dutch or English, and can be held either at the TU Delft Career Centre or in Den Bosch. It is only possible to carry out the consultation by Skype if you are located abroad. In all cases, a small fee applies, and please note that failure to cancel an appointment on time will incur a penalty.
Make an appointment in Delft (Monday or Tuesday evening) at alumniportal.tudelft.nl or send an email to alumnibureau@tudelft.nl for an appointment in Den Bosch or a Skype call.

The TU Delft Career Centre is the official TU Delft career service for its students, doctoral candidates and recent alumni. Our career advisors can answer your careers enquiries or help improve your job application skills through workshops, activities, personal consultations and digital tools. These services are also available for alumni who graduated up to five years ago.

Who will be the Best Graduate 2015?

Prizes are awarded each year to the best graduates of the eight TU Delft faculties. These graduates, nominated by the faculties, are now known, and the Best TU Delft Graduate is chosen from these.
The award ceremony will take place this year on Thursday 26 November, at 16.00 in the Auditorium of the Aula Congress Centre. Alumni are welcome to attend; please register at universiteitsfonds.tudelft.nl.

The faculty winners are:

- Architecture and the Built Environment:
  Nadia Remmerswaal
  'TRA Digital Hybrids: Using digital fabrications to create a hybrid design for developing countries'.
- Civil Engineering and Geosciences:
  Marcel Mol
  'The effective transport difference. A new concept for morphodynamic model validation'.
- Electrical Engineering, Mathematics and Computer Science:
  Vincent Hellendoorn
  'Empirical Software Linguistics: An Investigation of Code Reviews, Recommendations and Faults'.
- Industrial Design Engineering:
  Alec Momont
  'Drones for good'
- Aerospace Engineering:
  Tim Visser
  'System Identification with Multivariate Multiplex Splines'.
- Technology, Policy and Management:
  Tariq Abdul Muhaimin
  'Electricity Market of the Future: Assessing Economic Feasibility and Regulatory Constraints for Demand Response Aggregator in Europe'.
- Applied Sciences:
  Hanan Al-Kutubi
  'Synthesis and Characterization of Nanostructured Metal Oxides and Metal-Organic Frameworks'.
- Mechanical, Maritime and Materials Engineering:
  Guido Novati
  'Bio-inspired locomotion of a rotating cylinder pair'.

ENERGY CLUB
Delft University of Technology

Energy Alumni Club

Are you interested in energy and sustainable energy and would you like to meet fellow alumni and students who share your interest? Then join the TU Delft Energy Club. After registration you will be regularly informed of events and activities in the field and be given the opportunity to share or find information in the network. Register using your LinkedIn profile at **energyalumnidelft.nl**

Activities calendar

No alumni activities are currently planned; all activities are published on the website: **alumni.tudelft.nl**

CONTACT
Do you have tips, ideas, questions or comments for the alumni office? Send an e-mail to: alumnibureau@tudelft.nl or call +31 (0)15-2789111

ALUMNIPORTAL
Do you want to change (alumni) information, communication preferences or sign up for alumni events? You can do that through the alumni portal www.alumniportal.tudelft.nl

LINKEDIN
Do you want to contact other alumni? Join the 'Delft University of Technology –Alumni LinkedIn' group.

FRIENDS OF UFD FUND:
Become a 'Friend of TU Delft' and support Talent, Technique and TU Delft with your contribution. Bank account IBAN number NL48 ABNA 0441 4822 95, account name 'stichting UfD', description 'friends'. universiteitsfonds.tudelft.nl

PHOTO: SAM RENTMEESTER

The lab of...

Electronic Components, Technology and Materials

It's definitely the cleanest place on campus: the Class 100 cleanroom within the Dimes Technology Centre (DTC). It's called class 100 because there are 100 dust particles per cubic foot, which pales in comparison to a typical lab's count of 10,000 dust particles.
Being able to fabricate everything which you can find on a chip, ECTM focusses on micro-fabrication. Many in the group work closely with industry partners like PhD candidate Violeta Prodanović from Serbia. The National Institute for Nuclear Physics and High Energy Physics (Nikhef) chose Prodanović for her expertise in microelectromechanical systems. She is attempting to fabricate one part of their photon detector using microelectromechanical systems. 'These photon detectors are special because they are really ultra fast, with a time resolution of a couple of pico seconds,' says Prodanović. Coupling that with their small size makes them perfect for their application in medical imaging techniques. NC