DELFT OUTLOOK
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TU Delft

IONICA SMEETS
'It's not effective to paint people as idiots'

ARCHEOLOGY OF THE FUTURE
Ancient clay tablets scanned

New step to artificial life
DNA copies itself

THEME
Sea

Cover photo:
"The beach of Westkapelle is my favourite spot for taking photos of the sea. There is a high dune near the sea with a path above. Wooden poles stand out as breakwaters and even on a sunny day it is not really crowded on the beach."
(Photographer Sam Rentmeester)

Editorial
Saskia Bonger

Sea

What do you think about as you gaze out at the North Sea, sitting on the beach with your feet in the sand and sunscreen at your fingertips? Perhaps your thoughts go no further than which beach bar you'll visit for lunch, or perhaps you lose yourself in pondering how wonderful it is to see the endless void on the horizon.

But that void is an illusion. In this summer Sea issue, you can read about Architecture and the Built Environment researchers who are mapping the urbanisation of the North Sea. That's right: the urbanisation. That is necessary because seas and oceans are becoming built environments just like cities, full of physical and legal constructions that are largely invisible to the public.

Despite all the discussion about it, CO2 storage will also largely take place out of sight, especially if it happens at sea. Professor Allard Martinius (civil engineering) foresees a new future in which geoscientists make that possible. In our 'View' column, he talks about the benefits and explains that we need better explanations to impress the public.

Perhaps he could benefit from our interview with Alumnus of the Year Ionica Smeets, Professor of Science Communication in Leiden. She knows better than anyone how experts can ensure that they get their message across. 'It's not effective to paint people as idiots and then try to convince them', she told us in her illuminating interview. That may seem rather obvious, but it could also be food for thought as you sit on the beach and look out over the not-quite-empty sea.

Have a great summer!

Saskia Bonger, editor-in-chief

Page 07
Theme Sea

PHOTO: SAM RENTMEESTER

02

DELFT IN BRIEF 04
AFTER DELFT JOACHIM COENS
IN PERSON 29
COLUMN REMCO DE BOER 29
HORA EST 32
THE FIRM REBOOCON 33
3D-PRINTED BRIDGE 34
BEST PROFESSOR AWARD 36
ALUMNI NEWS 38

COLOPHON
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20
Ionica Smeets
'Discussing mistakes is part of the engineering mentality'

24
Archeologists become investigators
Antique clay tablets in CT scanner

30
New step towards artificial life
DNA in liposome replicates itself

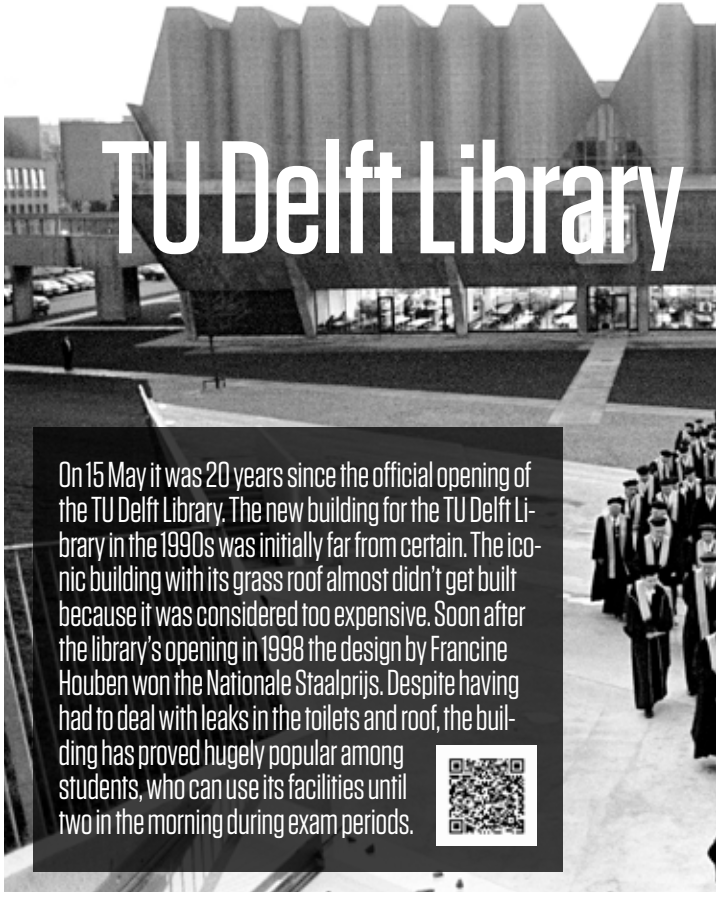
DELFT IN BRIEF

E.Refinery, sustainable fuels

The e.Refinery initiative brings four faculties together (TPM, Applied Sciences, 3mE and EEMCS) to develop sustainable production of fuels and chemicals. The new electric refinery takes small molecules from water, air and biological sources, cracks them and synthesises the fragments into basic industrial feedstock such as methane, carbon monoxide and hydrogen. The process is powered by electricity and may be used to buffer fluctuations in the future power grid. The E.Refinery project collaborates closely with the industry and will help modernise it.

Solar panels for refugees

Students from Energy for Refugees (EFR) are bringing solar panels to PIKPA, a small refugee camp on Lesbos that shelters vulnerable people such as the elderly and children. TU Delft, the Student Employment Agency and Students for Sustainability have contributed financially to the project, and Exasun has donated the solar panels. This year, 40 panels will be installed to reduce the monthly energy bill of over 10,000 euros. The students from EFR hope that this project, hosted by TU Delft Energy Club, will continue until the whole camp is solar powered.



TU Delft Library

On 15 May it was 20 years since the official opening of the TU Delft Library. The new building for the TU Delft Library in the 1990s was initially far from certain. The iconic building with its grass roof almost didn't get built because it was considered too expensive. Soon after the library's opening in 1998 the design by Francine Houben won the Nationale Staalprijs. Despite having had to deal with leaks in the toilets and roof, the building has proved hugely popular among students, who can use its facilities until two in the morning during exam periods.

PHOTO: SAM RENTMEESTER

The science of gluing glass

Metal disks glued on glass can often replace bolted supports in glass façades, recent TU Delft research shows. Dr Christian Louter and Prof. Rob Nijsse (Faculty of Architecture and Built Environment) published in the scientific journal Glass Structures & Engineering after the glued connections were tested under repeated varying loads to simulate wind loads. In order to gain confidence from the building industry, the researchers will continue investigating glued connections under accelerated aging and for sustained loading, while at the same time constructing mathematical models which describe the glued connections.

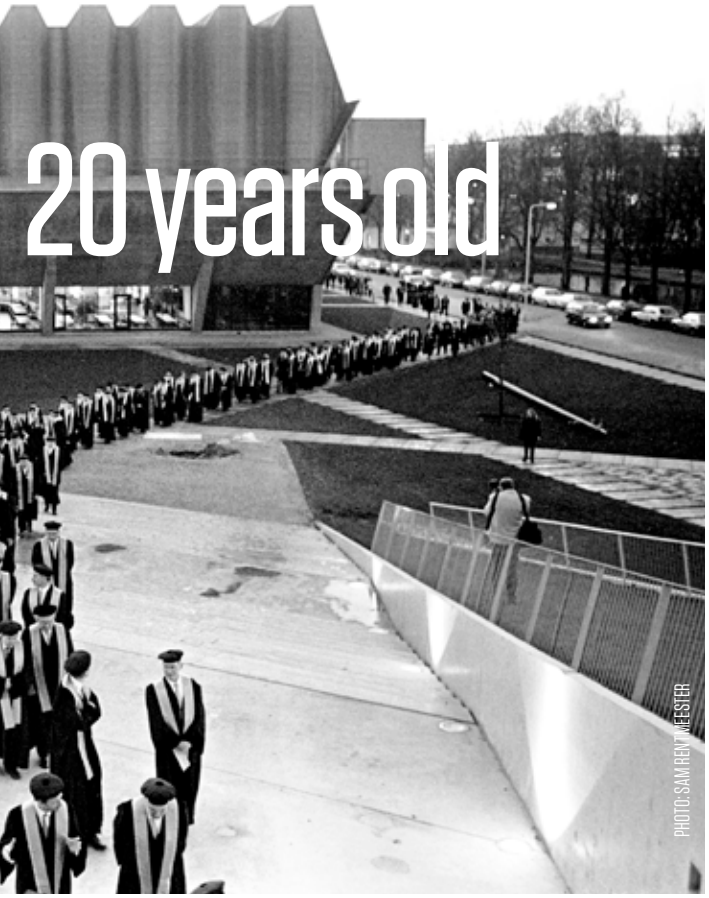


PHOTO: SAM RENTMEESTER

Your data at TU Delft

The new European General Data Protection Regulation took effect in May. We therefore wish to inform you that TU Delft processes data from alumni. We do so not only because of statutory recordkeeping requirements but also because maintaining an active and involved alumni network is an important objective of the university.

What data does TU Delft retain about you?

The fact that Delft Outlook has landed in your mailbox means that we have your address. We also use email to inform you, and we may have your telephone number. We store graduation data, and sometimes collect career data from alumni. This is valuable information for students who still have to start their working lives.

How does the university obtain this data?

The Alumni Relations Team is responsible for processing your data, which it receives from the student administration after you complete your studies. If you subsequently move house or change your email address, we no longer have your contact information unless you update it with us. For career information, we depend on the data you provide to us by such means as the online tudelftforlife community or via email. We only actively collect this data in special cases, such as a public function.

What can you do if you object to this?

You can unsubscribe from Delft Outlook by indicating so on the address label and sending it back to us. You can unsubscribe from emails by clicking on the unsubscribe link at the bottom of our emails. You can also send an email to alumnirelations@tudelft.nl to request that we no longer contact you or delete your data (to the extent that we are legally allowed to do so). You can also send other specific requests to that address.

Measuring thunderstorms

Tens of millions of euros will be invested in atmospheric research in a new consortium and research platform called the Ruisdael Observatory – named after the 17th century painter Jacob Ruisdael. Good news for TU researcher Ricardo Reinoso (Geoscience and Remote Sensing) and his colleagues, who perform measurements on heavy rain and thunderstorms with radar technology. His work should lead to much more accurate measurements and predictions of precipitation in cities at the extremely fine-grained level of one hundred metres. The aim of the project is to develop a nationwide dense network of measuring points with high-resolution simulations and the necessary computing power in order to map out the changes in local weather, climate and air quality at a scale of 100 square metres.


PHOTO: SAM RENTMEESTER

Combatting food shortage


PHOTO: SAM RENTMEESTER

The creation of an 'internet of cyber plants' that will combat food shortages and result in more insight in regional weather patterns and pollution. These are the goals of a research programme that is about to start and in which TU Delft has a leading role. Climate change, pollution, growing world population and increasing urbanisation. The times ahead promise to be challenging. Especially when it comes to cultivating enough food. The Plantenna research project's goal is to gain a greater understanding of crops climate change and pollution, with the ultimate aim of increasing yields.

Good reputation

Dutch universities enjoy a good reputation worldwide. Of the hundred most prestigious universities in the *Times Higher Education* reputation ranking, five are in the Netherlands. Just as last year, TU Delft is in the shared place 51-60, making it the top Dutch university in the annual ranking. Every year the British magazine asks ten thousand academics worldwide which are the best ten universities in their field. The reputation of a university is just one of the twelve criteria used for the annual *THE World University Rankings*, which were published last autumn.

Red alert on white paint

Titanium white paint, used by artists such as Picasso and Mondriaan, may crumble under the influence of UV light. Material scientist, Dr Birgit van Driel, has studied the effect of photocatalysis, the process triggered by UV radiation that breaks the chemical bonds, on the paint's binder. Without the binder, the paint turns into powder. Although it has not occurred yet, Van Driel is certain that some late 20th century paintings will suffer from 'chalking' within the next 50 to 500 years if they are not tested and shielded appropriately.

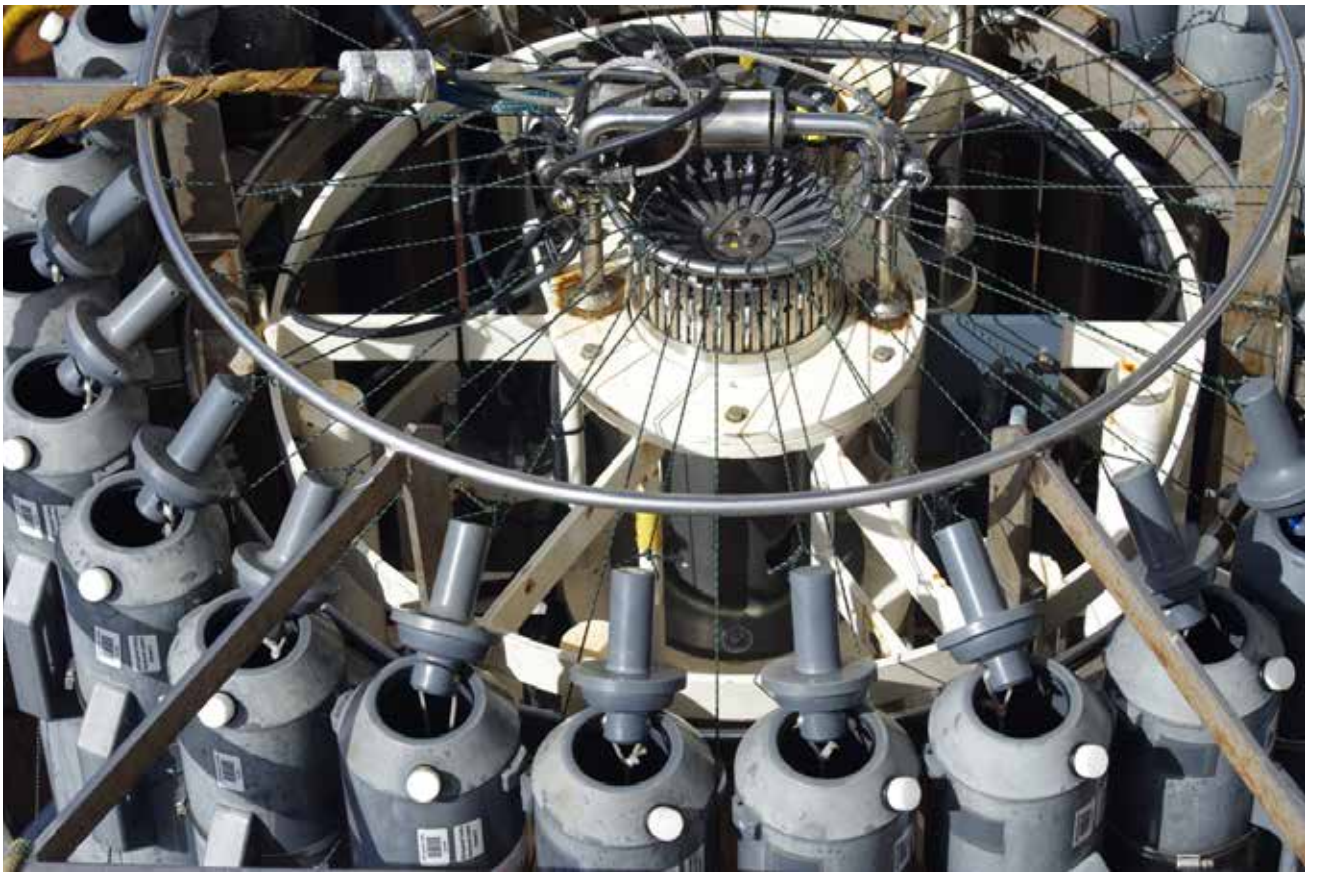
THEME
Sea

PHOTO: SAM RENTMEESTER

PHOTOS: NICO EXPEDITION

Finding eddies and fresh water

Delft researchers are investigating how salt and nutrients are transported by ocean currents, and how submarine groundwater discharge affects coral reefs. They took part in a large research expedition across the ocean aboard the research vessel RV Pelagia, which left Texel in December last year.



One of the most important instruments to study eddies is the CTD, which stands for conductivity, temperature and depth.

How can we gain a better grasp of the changing oceans? That is the central question of this expedition, called NICO (Netherlands Initiative Changing Oceans). The RV Pelagia, the research ship of the Royal Netherlands Institute for Sea Research (NIOZ), sailed south to Gran Canaria, then crossed over to Curaçao and Sint Martin. It is now heading back to Europe. In total, the research team consists of about 130 scientists who joined the crew at different legs of the journey. The journey will finish at the end of July. Delft researchers joined the crew in the Caribbean in February.

Right from the start, the expedition proved not to be for the faint-hearted. With high waves and a 7 Beaufort wind force, RV Pelagia left its home port of Texel – where NIOZ is based – on 13 December, two days later than planned. The crew encountered some unexpected technical problems. One of the fuel tanks leaked and needed repair. "Nothing to worry about," said Thomas de Greef, head of the NIOZ marine facilities. "This is a common problem with old ships like the Pelagia. The metal just gets thinner over the years." But he did add that the ship is still seaworthy.

Diameter of over 100 kilometers

"Maybe it was a good thing that I did not board the ship myself to do the experiments," says oceanographer Dr

Caroline Katsman, laughing. Katsman, who works at the Faculty of Civil Engineering and Geosciences (CEG), is an expert on whirlpools in the ocean, also called eddies, and how these large, slowly spinning vortices – with diameters that can sometimes amount to several hundreds of kilometres - affect ocean currents. She designed the measurement programme that took place when the ship sailed the Caribbean.
Katsman's colleagues and students performed measurements along a transect that cuts right through an eddy with a diameter of over 100 km between the islands of Aruba and Sint Martin. They measured the salinity and temperature at depths of up to 5 km. This is exciting because until now, researchers have only observed eddies superficially with satellites. Eddies are interesting because they affect ocean currents at large and as such, the earth's climate. Moreover, their higher temperatures mean that they may also fuel hurricanes.
One of the most important instruments to study eddies is the CTD. CTD stands for conductivity, temperature and depth. "On the Pelagia, this instrument is mounted in the centre of a steel frame of approximately two metres square, and has twenty-four water sampling tubes, called Niskin bottles, on the outside," oceanographer Kirstin Schulz, postdoc NIOZ Sea Research, writes in the blog of the NICO expedition. "Each Niskin bottle contains 12 litres of water, has an opening at the top and the bottom, and lids at each end which are connected with a spring in the middle of the tube. A system of ropes and hooks keeps the spring under tension and the Niskin bottle open until a signal from the connected computer on board releases a hook, and the lids snap and close the bottle. This steel frame is lowered into the water with a winch from the ship. It takes almost an hour to reach a depth of two kilometres. "On its way up, the Niskin bottles are released at certain depths to collect water samples. The samples are analysed for their nutrient content. The CTD is then brought back on deck, which is again an adventure – with all the bottles filled, the frame now weighs a ton.
In addition to the salinity profiles (calculated from the electrical conductivity of water) and temperature, the CTD also has sensors to estimate the oxygen and chlorophyll content of the water.
The Delft team is collaborating with biologists from Wageningen University who took water samples to study plankton. Since the salinity and temperature of the water in the eddy differ from those of the surrounding water, it is believed that the fauna also differs. The researchers are also studying marine mammals, seabirds, turtles and large fish species like sharks and sunfish.

Groundwater into ocean

On the island of Curaçao, hydrologist Boris van Breukelen (CEG Faculty) hopped on board. Together with colleagues from Wageningen University and the University of Amsterdam, he is researching where and to what extent groundwater from the island flows into the ocean. Most fresh water that flows from the island into the sea seeps undetected through the ground since the island is made of very porous rock.
"We want to get a clearer picture of the hydrology of the island and the surrounding sea. The groundwater contains a lot of pollutants, like nitrates and phosphates, that cause algal growth and threaten the coral reefs," says Van Breukelen. Among the measurements performed by the team were those on salinity and temperature in the waters surrounding the island to detect the areas where the polluted water flows into the ocean. It is a tough challenge to find the sources of fresh water in the vast ocean as the differences in temperature and salinity are very subtle. TMD

PHOTO: SAM RENTMEESTER

Using natural forces to strengthen the coast

Large-scale hydraulic engineering projects such as the Afsluitdijk and the Delta Works are often built for the wrong reasons, Professor of Ecological Engineering Peter Herman explained during his inaugural address.

"My inaugural address was a plea for caution', recalls the Flemish ecologist. "You have to base changes to the coast on how the coastal system actually works, not on grand plans that try to solve all problems at once."

That's why Herman does not regard artificial islands in the North Sea as the solution to environmental problems ranging from dredging waste and windmills to expanding the airport. An example of his 'cautious approach' is Herman's vision of Zeeland, where powerful dams have closed former estuaries to provide agriculture with fresh water. He continues: "Something had to happen in Zeeland after the flood. Two alternatives were developed: raising the dikes or damming the estuaries. These alternatives had approximately the same cost and both were feasible. Raising the dikes would have been considerably easier than what they ultimately did. The reason they chose to shorten the coastline and dam the estuaries was to provide fresh water for agriculture. In the end, all kinds of water quality problems meant that that was only achieved in Haringvliet."

The Delta Works may seem powerful, but their replacement is already being considered. In a few decades they will be too outdated, too weak or too low to protect the people of Zeeland from the rising sea level. And although a 'Sand Motor' does not work along the slippery coast of Zeeland, Herman also sees opportunities for natural water defences there.

"You could consider making these coasts wider by reducing the sludge. For example, you could construct a zone of summer polders in the outermost polder ring and combine that area with agriculture or aquaculture. I think that alternatives along those lines can be invented – alternatives that strengthen the scenic and natural value of those coasts, and that are also economically realistic because they still allow a kind of food production. In the long term, this would create a broader coast that is far less vulnerable than a single dike that becomes increasingly vulnerable as sea levels rise. There are limits to how high dikes can be raised. The value of the land that lies behind it is not such that you can endlessly invest in such a dike.

If you can use natural forces and thus reduce the investment costs, that could be a viable alternative. There is an opportunity to cultivate aquaculture in those zones, and aquaculture produces products that are worth much more than onions. Think of saline agriculture or oyster beds. Much of the agricultural land in the Netherlands is being used for marginal profits, so it is not so difficult to invent something that is competitive in terms of revenue." JW

Listening to the waves

Analysis of 'inaudible' infrasound high in the stratosphere can improve weather forecasting and climate models, Dr Pieter Smets (Faculty of Civil Engineering and Geosciences) believes. Ocean waves can be a good source of this infrasound.

Geophysicist Dr Pieter Smets, who also works for the Royal Netherlands Meteorological Institute (KNMI) in the group of Prof. Läslo Evers, is interested in the climatic conditions in the stratosphere, the atmospheric layer situated at an altitude of between 10 and 50 kilometres. Hardly any data are available on wind force and temperature above 30 kilometres. Climate models and weather forecasts could be improved with more understanding of this atmospheric region.

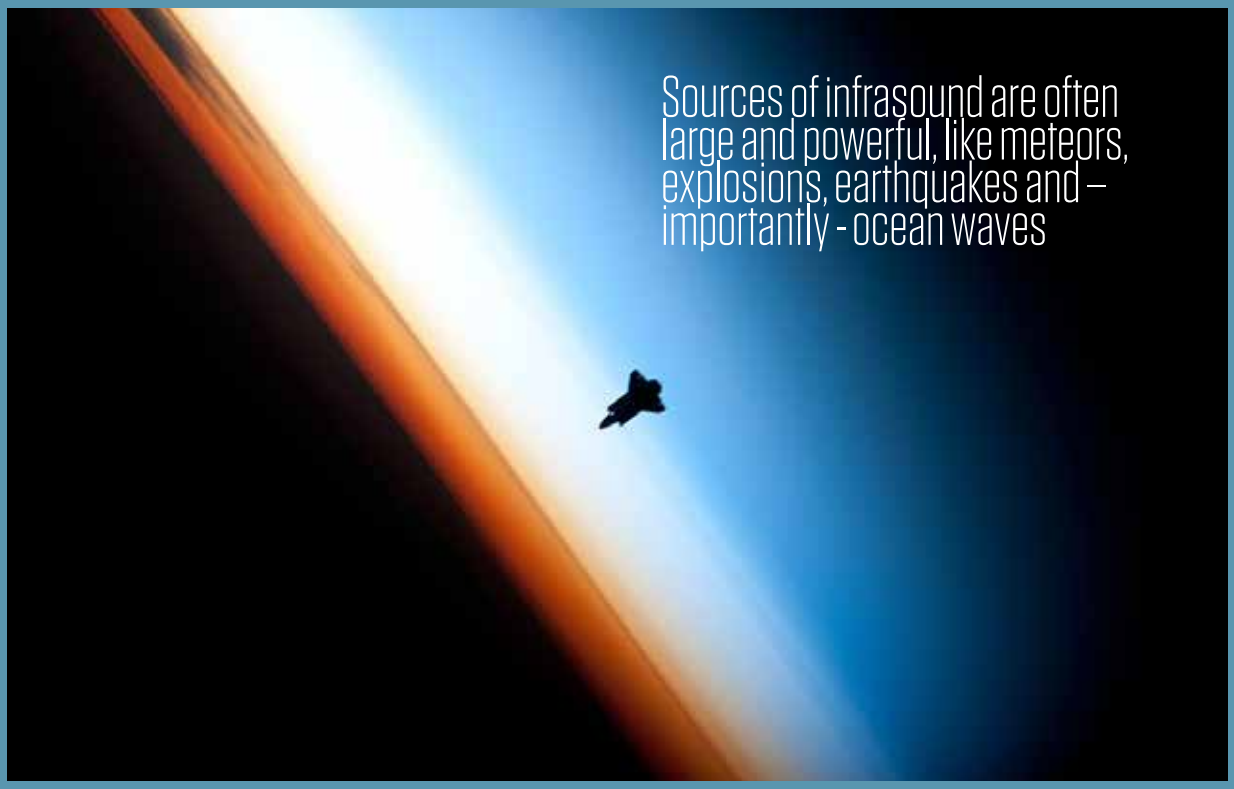
Wind forces and temperatures can be deduced by analysing infrasound that has travelled through these atmospheric layers. Or so concludes Smets who recently defended his PhD thesis Infrasound and the Dynamical Stratosphere, A new application for operational weather and climate prediction.

Infrasound, sound with a frequency below 20 Hertz, is measured with arrays (series) of highly sensitive microbarometers. Sources of infrasound are often large and powerful, like meteors, explosions, earthquakes and – importantly - ocean waves.

Dozens of microbarometers have been set up in the Netherlands and around the world to listen to the infrasound.

An especially interesting use of the research is the study of sudden stratospheric warmings – dramatic events in which the midwinter stratosphere changes into a temporary summer-like situation over the course of a few days. "Before climate scientists can incorporate these kinds of phenomena in their models, we need to do a lot more work," Smets warns.

Smets captured infrasound that was produced by the eruption of volcanoes, amongst which the eruption of Mount Tolbachi in Russia in 2013. Läslo Evers and Pieter Smets will continue in the same line of work but will use continuous background noise of infrasound created by ocean waves instead. TvD



Sources of infrasound are often large and powerful, like meteors, explosions, earthquakes and – importantly - ocean waves

PHOTO: ESA

Living on a drilling platform

PHOTO: BENJAMIN KAMPER

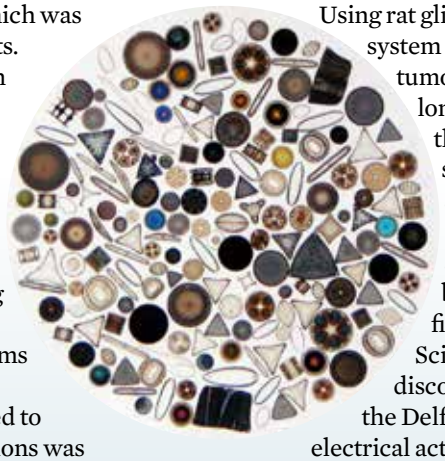
If oil and gas extraction ends in the future, there will be about 150 unused drilling platforms in the North Sea. What can we do with them? Recent graduate Benjamin Kamper has a solution.

In his Master's thesis project *Running Out Of Gas On The Fast Lane*, Benjamin Kamper (A+BE, Robotic Building) proposed using artificial intelligence to accommodate various residential functions on a discarded oil platform.
Work, recreation, living space, food supply, energy generation: everything was given its own colour while swarm intelligence arranged the spatial distribution of the functions and assigned more or less predetermined volumes or 'spheres' to them. Kemper then covered the volumes with an external skeleton and connected them with pipes that have a connecting and supporting function. The whole is a bit like a bony, grown structure. Kemper sees parallels with Peter Cook's Montreal Tower and the Atomium in Brussels. See more about this project via the QR code. JW

Electrical activity in the dark

You would expect scientists to know all there is to know about diatoms. They are after all a major group of microorganisms found in the oceans, waterways and soil all over the world, numbering in the trillions.

Diatoms generate about 20 percent of the oxygen produced on the plant each year and contribute nearly half of the organic material found in oceans. Yet how these tiny algae communicate has been shrouded in mystery. Now a group of scientists discovered that diatoms become electrically active when the light goes out.
"Under stress, such as light deprivation and probably temperature rise, diatoms start releasing Ca2+ ions to communicate. It is a cell to cell signalling technique," says Dr Dago de Leeuw (Faculty of Aerospace Engineering), one of the authors of the study which was published in Scientific Reports.
"The microorganisms let each other know that it is time to migrate closer to the surface or, to the contrary, dive deeper in the water to obtain optimal light and temperature conditions." For the very first time – according to De Leeuw - collective electrical oscillations of diatoms have been measured.



The measuring technique used to register the electrical oscillations was first used for a totally different purpose: to investigate what happens in the brains of people with brain tumours, making this a nice example of cross pollination of research fields.
Brain tumour cells respond to increasing acidity with bursts of electrical activity, a process that could directly disturb healthy neurons and lead to epileptic seizures. A team of researchers, amongst whom De Leeuw, and scientists from the University of Bath, were able to observe this using a very sensitive detection method they'd developed, involving a transducer with large-area electrodes that maximise double-layer capacitance, thus increasing the sensitivity.
De Leeuw: "Basically, what we did is that we designed a detection method with electrodes that measures electric activity with extreme precision but not with very high spatial resolution. You always need to make a trade-off. When you focus on the electrical characteristics of a single cell, you gain in spatial resolution but you lose in signal sensitivity. When you zoom out, you lose spatial resolution, but gain in sensitivity."
Using rat glioma cell line as a model system (glioma cells are a type of tumour cell), and performing long-term live recordings of the electrical activity, the scientists showed that, although glioma cells are nonelectrogenic, they display a remarkable electrical burst activity in time. The finding was published in Science Advances in 2016. The discovery was a lucky shot, says the Delft researcher. "We noticed electrical activity after we had neglected the cells for some time; after we had stopped providing them with nutrients."
Not much later, a colleague from Portugal – an oceanographer from the Universidade do Algarve knocked on their door. He brought a bucket of sea water with him from the surf of the Portuguese town of Cascais, containing, amongst others, Pseudo-nitzschia fraudulent, a diatom which had caused an important bloom off the Portuguese coast in October 2014. Why not also bully these cells and see what happens, he proposed. Talk about serendipity.

ILLUSTRATION: STEPHAN TIMMERS

Static Liquefaction Tank

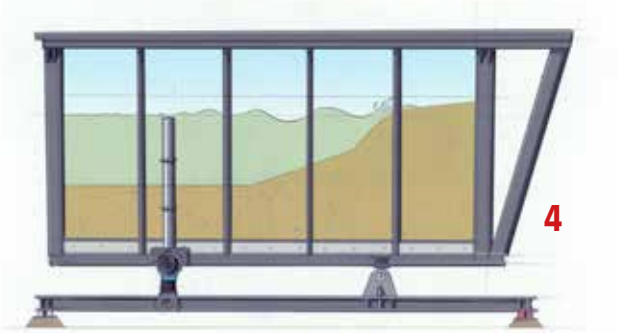
A huge tank filled with water and sand has been placed on the ground floor of the Faculty of Civil Engineering and Geosciences. It will test solutions for problems with the seabed of the Eastern Scheldt Storm Surge barrier.

When you put a stone on a sand layer in a stream, water will flow around it with such power that a gap will form in the sand layer downstream of the stone. This is called a scour hole. This same phenomenon could be happening close to the pillars of the Eastern Scheldt storm surge barrier. To prevent this, a layer of protective stones was laid on the seabed to keep the sand in place. Unfortunately, scour holes began to grow behind the protective layer, some at a depth of 30 metres. The deeper the hole, the bigger the chance that it will collapse and that the protective stone layer might be affected.

What to do? Professor Amin Askarinejad (Geo-Engineering, experimental soil mechanics) and his team are researching just that question. For testing, they needed a tank with water and sand. The bigger the scale of the tests, the better the test results. This is why they are using a tank of five metres long, two metres wide and two metres high. The tank is fully equipped with sensors, pumps and even 3D printed dredging heads.

Before testing, the sand is loosened by pushing water from below to simulate the formation of the seabed by settlement of the sand (1). The tank can be tilted to up to 10 degrees, but by dredging the sand and making a slope in the tank, the simulated scour holes can be steeper (2). In the end, the tank is tilted to simulate the steepening process of the walls of the scour holes. At a certain angle, the slope fails, triggering a fast landslide (3).

The tank can also be used to study the triggering mechanisms of tsunamis caused by submarine slope failures(4) or novel anchoring systems for floating wind turbines (5). At present, most wind turbines are fixed to the seabed with piles. With an efficient anchoring system, turbines could be placed further offshore where the sea is deeper and the wind stronger. Askarinejad is planning to research this anchoring system in the future. RvT



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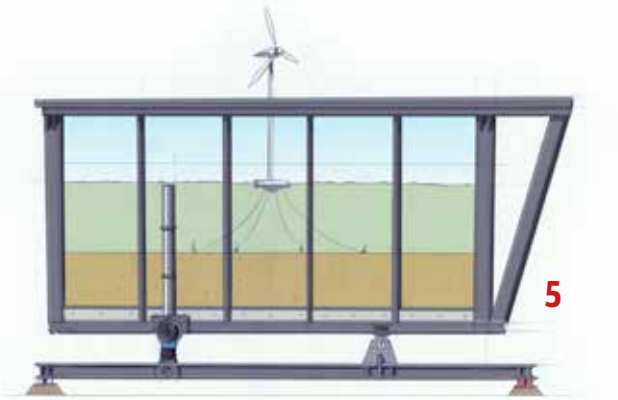

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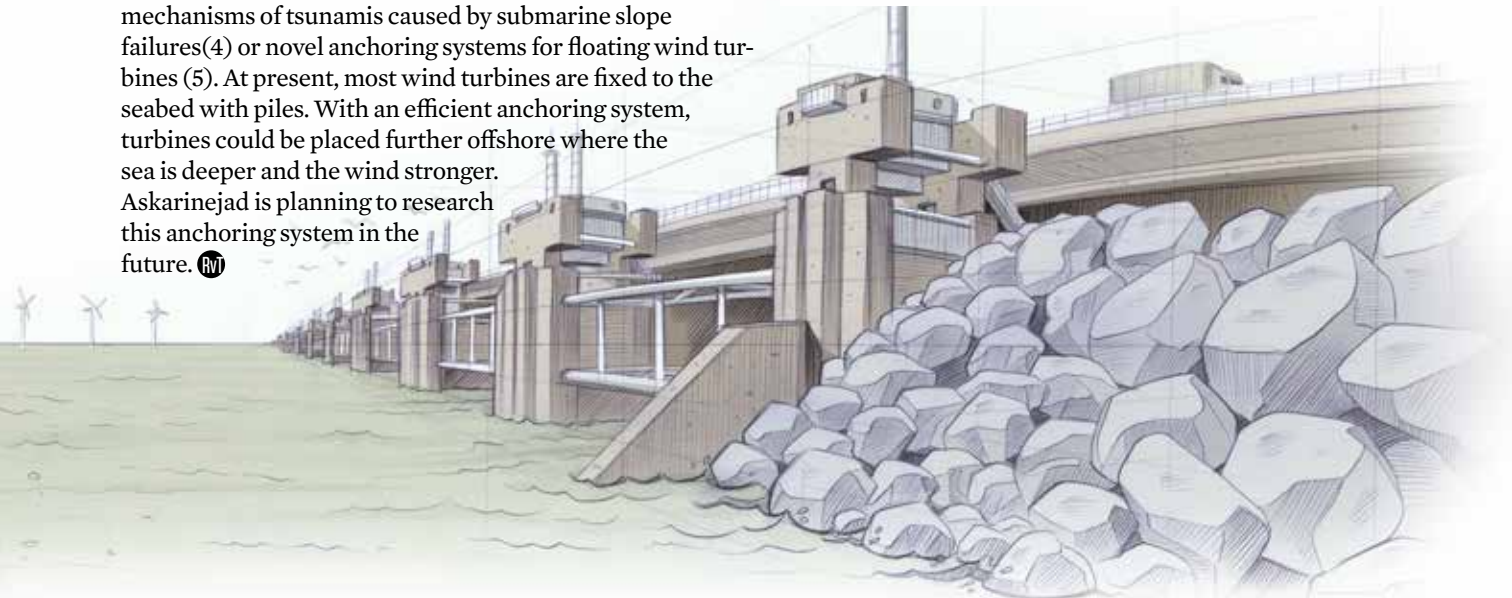


PHOTO: ENECO

Another wind

According to the Energy Agreement, wind farms at sea will become the most important energy source in the Netherlands. Professor Simon Watson (faculty of Aerospace Engineering), the new director of the Delft research institute for wind energy, DUWIND, outlined the new research agenda in his inaugural address.

The wind blows in an entirely different direction for Watson than it did for his predecessor, Gijs van Kuik. Van Kuik embodied the optimism of the 1970s, but that did not change the fact that he had to fight his entire life to convince people of the importance of wind energy to our energy supply. Only after his retirement did the government issue a call for tenders for the first large wind farms at sea.

The National Energy Agreement now stipulates that in five years' time there must be 4,450 MW of capacity in the North Sea. At the moment capacity is at 957 MW, less than a quarter of that amount. Offshore wind will therefore have to grow at an unprecedented rate over the next few years, and this expansion is likely to continue tenfold through 2040. The rapid growth of wind energy raises many research questions.

With a larger role for wind energy comes an increase in the need for detailed wind forecasts. A detailed network of sensors linked to increasingly fine-tuned forecasting programmes, such as Professor Herman Russchenberg's (CEG) Ruisdael Observatory is equipped with, can improve predictions on how many megawatt hours can be produced by wind energy.

Modern wind turbines are heavy-duty structures that are designed to withstand varying turbulence loads. Professor Jan Willem van Wingerden (3mE) is working on blades that can respond to variations in the wind. These active blades would experience 30% less load and could therefore be made lighter or longer.

Encroaching wind farms are bad news for porpoises and seals. Reports about the environmental effects

state that the driving of ever-larger steel pipes could cause temporary or permanent hearing loss. Vibrating foundations seems to cause less disturbance, but it is unclear if those foundations retain their strength. Researchers in the group led by Professor Andrei Metrikine (CEG) are investigating this as part of the GROW consortium.

Replacing a gear box at 150 metres above sea level is a complicated process that can cause nightmares for service departments. Watson has found that electrical failures are the most common, but mechanical failures require more repair time. By embedding software that analyses the electrical output of generators, developing malfunctions can be detected earlier.

Wind turbines in an offshore wind farm can influence other windmills. The wind speed behind a turbine is not only slower, but also more variable. This results in less revenue – a matter of a few per cent, according to Watson – and more stress on blades and structures. One of van Wingerden's doctoral candidates is investigating how a wind turbine can reduce or adjust its wake so that downwind turbines experience fewer problems.

If you generate hundreds or thousands of megawatts of electricity in the North Sea, you need a good plan to incorporate that power into the electricity networks of neighbouring countries. The international networks and energy markets of the future will regularly have to deal with energy surpluses such as those that have so far mainly occurred in Germany. During his inaugural address, Watson emphasised the importance of large-scale storage and mentioned the Battolyser, designed by Professor Fokke Mulder (Applied Sciences), which combines battery operation with hydrogen production. In addition, according to Watson, we will also not be able to avoid making demand flexible. In other words: we must use power when it is abundantly available.

Some 30 doctoral candidates are currently working on this and other questions under the umbrella of the Dutch National Doctoral College in Offshore Renewable Energy and PhD@sea. They are located within five faculties: AE (15), CEG (3), EEMCS (5), 3mE (4) and TPM (2). JW

Wave predictions pay off

A pilot who has to land his aircraft on a rolling aft deck, or an engineer who has to transfer pipes to another ship on the open sea – people like these use their experience to estimate when the water is calm enough to act, but it is always tricky.

Last year, Dr Peter Naaijen was awarded his PhD for a project about predicting wave heights and ship movements. He and his colleague Karel Roozen have now founded the company NextOcean to bring that technology to market. The company won the Innovation Award at the Offshore Energy Exhibition & Conference last year. Knowing when the water is calm enough to work is extremely important to offshore industries. If they can see calmer periods coming more accurately, they can still sail under harsher conditions. The NextOcean system requires hardly any hardware. Instead, it analyses data received from existing radar installations and uses it to infer wave height and wave length. The system can predict between three and five minutes ahead.
Offshore company Allseas wants to use the NextOcean system this summer for the installation of a ready-to-use oil platform off the Norwegian coast. "It's a big advantage if you can show the customer that you can avoid all the high waves when installing a platform," explains R&D engineer Ate te Voortwis, who is involved in the project. JW

PHOTO: SAM RENTMEESTER

Extended urbanisation in the North Sea

The North Sea is not only a huge body of water but also a site of unfolding urbanisation processes. Marie Curie Fellow Nancy Couling is mapping layers of different uses of the North Sea to illustrate the high levels of urbanisation.

We tend to think that urban processes stop at the threshold between land and sea, but these processes continue, Couling states. Seas and oceans have become built environments. There are marked shipping lanes, pipelines, cables and drilling platforms. Most of them are not visible to the general public and are only accessible to specialists. In addition, there is a legal construct (United Nations Convention on the Law of the Sea) which divides the sea like a pie among littoral countries, thereby forming the grounds on which drilling licences are issued.

According to Couling, there is no central pool of knowledge for information on marine urbanisation and many people have identified it as a real issue. Professor Carola Hein (History of Architecture and Urban Planning) has done a project on mapping oil flows and the concomitant built environment to visualise the impact of petroleum over the last 150 years. "Understanding how oil flows have determined the sea space and are providing the framework for future development is a next step," says Hein. "Wind farms at sea, for example, are competing with shipping lanes."

Couling is looking at the bigger picture in her Oceanurb the unseen spaces of extended urbanisation in the North Sea project. She is gathering and putting together layers of different sea-uses. These layers will be open-source data. "TU Delft has a data bank and assists in the development of a data management plan for these layers." She looks at history and visits sites where interesting or conflictual developments are taking place that are new or emerging and are slowly changing the character of things on land. "It is about where the developments come back to land. How does wind farm development affect coastal ports or settlements? These are often very small places that are only changing incrementally."

Last June, Hein and Couling held an interdisciplinary conference at TU Delft where Couling presented the results to date. Maps visualise what is normally unseen and demonstrate how the space of the North Sea is at a premium. "It needs to be negotiated and thought about very carefully," she says. GVD

Wind farms at sea are competing with shipping lanes

Landing obligation

Undersized fish that are thrown overboard usually die. From 2019, fishers will be required to land these unsaleable fish, reducing their revenue. For their Bachelor's graduation project, Industrial Design Engineering students developed solutions for the landing obligation problem. For example, Francoise Linke and Sjoerd Kruimer applied modern technology for selecting fish on the seabed, leaving the smaller fish alone. Carlijn Geerse took a different approach: building breeding systems for the undersized fish in offshore wind farms. Shanon de Jong chose to focus on passive fishing, in which bait attracts fish to a trough from which the larger ones cannot escape.

More on the projects: bit.ly/IOvissen

View

Professor Allard Martinius (faculty of Civil Engineering and Geosciences) foresees a new task for geoscientists and a revenue model for storing CO_2 at sea.

"Knowledge from the applied earth sciences has so far mainly been used for extracting oil and gas. Almost all this knowledge and technique can also be directly applied to extracting geothermal energy or storing CO_2. CO_2 storage is a good way to remove greenhouse gas from the environment and permanently contain it in layers of the earth. Geoscientists can play a vital role in that because they know better than anyone where the oil and gas reservoirs are.

You can therefore use that knowledge to extract oil and gas from those fields and replace it with CO_2 in such a way that it will remain trapped there. You could also use closed underground geological units (reservoirs) in impermeable layers where oil or gas has never been because no oil has ever been generated in the vicinity. The question is how you can do that in the best way.

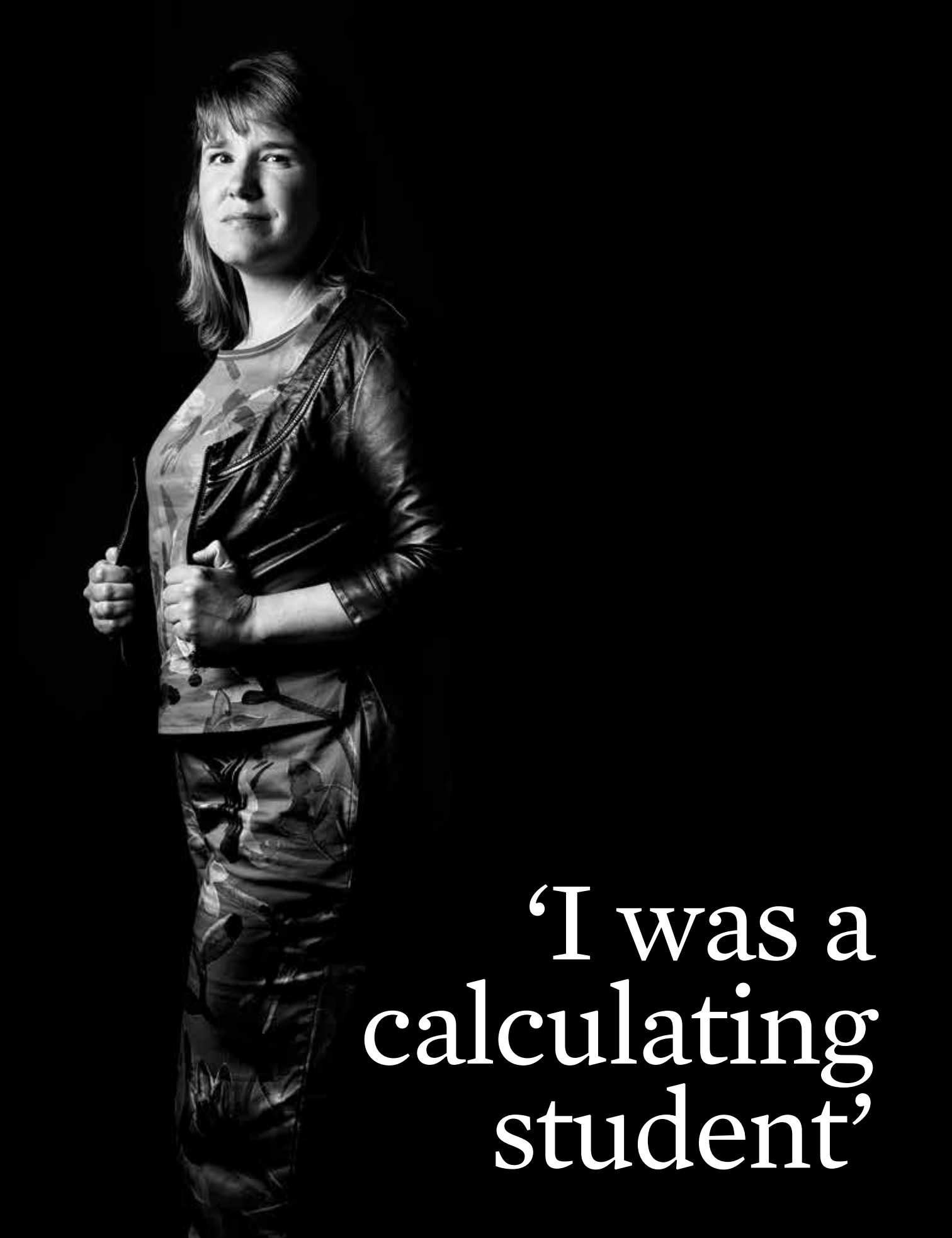
CO_2 storage is a sensitive topic. The public doesn't always understand what is happening; that should be explained better. On land – as we have now seen in Drenthe – there can be effects on the surface of the ground. There are fewer problems at sea, which is why we prefer to look for suitable locations there. In principle, there are enough locations there; after all, we also have all those oil reservoirs at sea that we have emptied.

PHOTO: SAM RENTMESTER

Norway is already quite far along with all sorts of tests and has already looked extensively into CO_2 storage at sea. In the beginning, CO_2 was stored to increase oil and gas production while simultaneously accumulating CO_2 . CO_2 was used as a propulsion mechanism to push gas and oil out of the rock.

Now there are projects underway to get the industry to participate as much as possible in capturing, compressing and shipping their CO_2 and storing it in a suitable underground location at sea. Companies that store CO_2 in such a way will get a tax advantage, while those that continue to emit CO_2 will pay extra taxes. People want to make this an industry, developing an industrial model from which money can be earned. Then you will have an economically viable situation, at the same time doing something about the climate.

I am a supporter of taxing CO_2 because then there will be more developments around this problem. As long as no tax is levied on CO_2 emissions, there will be too little pressure on companies that produce carbon dioxide on a large scale and on society to actually do something to combat these emissions. We get away with it too easily, and I think a CO_2 tax could help that situation. It doesn't have to be an exorbitant tax; it is primarily about sending a warning and making money available to conduct relevant research. I think the carbon tax would be a big win." JW



‘I was a calculating student’

Ionica Smeets, Leiden University Professor of Science Communication, has been chosen as TU Delft Alumnus of the Year. "My academic counsellor in secondary school thought that mathematics would be too easy for me."

TEXT CONNIE VAN UFFELEN PHOTOS SAM RENTMEESTER

You started in computer science but switched to applied mathematics after the first year. Why?
"I couldn't decide between mathematics, Dutch, language and culture studies, and acting school. Fairly extreme differences, but if you're good at science subjects you have to do something with that, and can do other hobbies alongside it. My father is also an engineer, so I went to TU Delft. I originally considered studying applied mathematics, but that was discouraged because, in 1998, computer science was the profession of the future. My academic counsellor in secondary school made the – in hindsight – ridiculous remark that he thought mathematics would be too easy for me. Too easy? How could it ever be too easy? You can make maths as difficult and abstract as you want!"

What was the deciding factor?
"I was persuaded by the argument that if you studied computer science, you also learned maths and programming. I finished my first year, but I thought it was pretty awful. I had joined the Christiaan Huygens study association and thought the mathematicians were more fun, just like their programme and lecturers. The dean who presented our first-year diplomas said, "once you've earned this diploma, finishing your programme is a formality because after this the drop-out rate is zero". Then I can stop, I thought."

What type of student were you?
"I was very well-behaved in the beginning; I didn't really go out. If I went to see a band, I would drink apple juice or cola and wait for a friend's father to come pick us up afterwards. That good behaviour changed when I moved into a pretty wild student house on Choorstraat. Then I went out a lot and studied almost as an afterthought. I also had a lot of jobs on the side: I worked at the library, sold tickets at a theatre, wrote for Delta Magazine and did fun things for the study association. I was quite a calculating student because I kept an eye on the minimum requirements I needed to do well."

Were you a mediocre student?
"No, I was an ambitious honours student. I looked at what I needed to do to earn a nine, but I didn't do much more than that. Silly, of course. I remember there was a subject where it was said you had to spend four hours on an assignment. But that assignment was far too difficult. Other students worked on it for three days, but I thought "sorry, it said four hours, so I'm just going to turn in what I have after four hours' work". Later I wondered whether the lecturer thought I was dumb or lazy. I don't know which would be worse.."

As a professor of science communication, you are studying the gap between experts and the general public. What did you think of that communication in the Netherlands?
"That's a little ambiguous. On the one hand, a lot happens and that is positive. You have lectures, a lot of science on TV, series of popular science books and the University of the Netherlands. Much of it is good. But on the other hand, a lot of it is rather ad hoc and not very effective. That sometimes makes me wince. As a scientist, you try to prove things and make them work, but then you mess up your communication. That's a shame, and sometimes a waste of time and energy. What I like about TU Delft's communication is that it focuses on student projects. Let students build something like the Nuna solar car and describe it themselves, instead of having a professor do it. That's a more effective way to communicate than sending all kinds of press releases."

More effective for recruiting students?
"That too, but it has to be more than that. A while ago, I wanted to do a project aimed at primary schools and especially disadvantaged children. "Why would you focus on them?" someone asked. "They're not going to take a degree here." But maybe that's because we are not doing anything for them. Eventually, they will become the citizens who will pay the taxes that support your work, and the people who you will want to use your inventions. It's always worthwhile."

So the more people know, the more accepting or well-informed they'll be?
"That's not entirely true, and it's one of the frustrating things about this topic. Look at the vaccination debate: the anti-vaxxers are not the people who know nothing about it. Instead, they are people who have read a lot but interpret the information entirely differently than we do. You

CV

Ionica Smeets (1979) earned her Master's degree in applied mathematics from TU Delft in 2005. She planned to become a science journalist but, on the advice of her supervisor, decided to pursue a PhD. She earned it from Leiden University in 2010. She later investigated science communication with philosopher Bas Haring. In 2015, she was appointed Professor of Science Communication in Leiden. Smeets has also worked as a science journalist for 14 years. She has written four books, as well as columns for publications such as the de Volkskrant newspaper, New Scientist NL, Kek Mama magazine and, until 2014, Delta Magazine. With Jeanine Daems, she co-wrote the blog wiskundemeisjes.nl. In addition, she was involved in TV programmes such as Factcheckers, Eureka, De Slimste Mens and Zomergasten.

also see that in discussions about climate change. In a fantastic study, two groups of people who disagreed about the severity and consequences of climate change both received the same solid, scientifically reliable information. Then they disagreed with each other even more! They extracted precisely that information from the text that suited their existing point of view."

What can you do then?

"The first thing – which also applies to engineers – is to be more proactive. It's much easier to be the first person who reports something than someone who has to discuss an idea that another person has expressed. Furthermore, a lot of science communication is not focused on a target group. The tone in the vaccination debate often suggests that you are an idiot if you don't vaccinate your child. But it's not effective to paint people as idiots and then try to convince them. The third point is related: it's important to communicate more from an attitude of trust. I think that frequently applies to many engineers. Engineers at large organisations often play a sort of expert role but fail to communicate their message because their attempts are so awkward."

'As a scientist, you try to prove things and make them work, but then you mess up your communication'

Do engineers communicate more awkwardly?

"I don't know. I do think they're at a disadvantage because they're taught to explain things rationally and step by step. Often that doesn't help to convince people. I think people's minds can be changed faster with an anecdote or a story, but it has to be substantiated with facts."

Do you have more tips for engineers?

" A while ago, I attended two conferences in one week: one for civil engineers and one for oral surgeons. At the oral surgery conference, you heard fantastic stories about new treatments. They failed in 80% of patients, but the surgeons spoke enthusiastically about the other 20%. The civil engineers had created amazing buildings, but they spent the entire day discussing what was wrong with them: concrete decay and pillars that were not quite right. Discussing mistakes among yourselves is part of the engineering mentality, but it's not always the smartest approach with the outside world. A general tip is to ask for a little more feedback. A friend who is a physicist asked a random person from the audience about what he remembered from the lecture he had just heard. The answer was very disappointing."

Do you ever visit Delft?

"I sometimes give a guest lecture and recently gave one for my old study association. I just did a study with someone from Delft: Rolf Hut. We investigated hydrology jargon: how experts interpret frequently used terms in public texts and how lay people do that. Experts turned out to have a different idea about what the word "river" means than the general public, but the groups strongly agreed when shown pictures of one. If you want to warn to people about a flood, you'd better make sure they understand it correctly. A picture is often useful for that."

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TEXT: JOS WASSINK PHOTOS: SAM RENTMEESTER

Cuneiform in a scanner

Beads, bones and arrowheads. Plenty of odd objects have found their way into the micro CT scanner at the Faculty of Civil Engineering and Geosciences (CEG), but the clay tablet scanned this spring topped the lot. It revealed 4,000-year-old fraud prevention.

The freezer-sized micro CT scanner is housed in the glass building at CEG. The device was originally purchased to examine soil samples, but Dr Dominique Ngan-Tillard is receiving an increasing number of requests from archaeologists hoping to unveil hidden aspects of ancient items.

The first thing that will strike you is the highly detailed finishing of the clay tablet. The tablet, the size of a bar of soap, bears writing in an exquisitely refined and measured hand.

Cuneiform was used in the Middle East region from 3300 BC to 300 AD. Dr Rients de Boer curates 3,000 clay tablets at the Netherlands Institute for the Near East in Leiden. With a degree in Assyriology and now working as an assistant professor at the VU Amsterdam, he is able to read cuneiform. De Boer stores the so-called Böhl collection in the safe at NINO. This collection is housed in two man-sized metal cabinets packed with clay tablets. The largest tablets are the size of a potato, the smallest are only as small as a walnut. Here again, the refined quality of the artefacts is plain to see - there's nothing primitive about them.

The tablet about to be scanned is special: it is contained in an envelope also made of clay. Before, a curator would simply open the envelope to read the tablet inside – there are examples of this in the Böhl collection. This destructive method is no longer being used. The hope is that the micro CT scanner will reveal the cuneiform hidden on the inside.

>> Read more on page 26

The clay tablet in the scanner at the Faculty of Civil Engineering.

The scan takes 90 minutes to complete. The object slowly revolves inside the scanner while 1,140 X-ray recordings are made. The result is a 3D, 8.2 GB data set with a resolution of 30 micrometres.

The initial cross sections confirm that the researchers are indeed dealing with a separate clay object, encased in a layer of clay. Incidentally, it is still unclear how the Mesopotamians managed to envelop a wet tablet of clay with a layer of clay without everything sticking together. They may have used sand, straw or flour to separate the layers. The crystal-clear scanner images may well provide an answer to questions such as this.

Dr Ngan-Tillard spent a day reconstructing the inner tablet based on the scanning data. She started by marking the (minimal) free space between the tablet and envelope in all the cross sections, thus selecting the surface of the encased clay tablet. Subsequently, the clay tablet could be reconstructed in 3D. This resulted in a first-class, flawless reconstruction. In order to avoid the reconstruction being mistaken for an actual tablet, Ngan-Tillard rendered the calculated surface in an abstract blue colour.

De Boer identifies the tablet as a receipt for a delivery of fresh sesame.

De Boer identifies the tablet as a receipt for a delivery of fresh sesame. The tablet is from the Girsu region in Southern Iraq, and is written in Sumerian cuneiform. The envelope reports the delivery of 15,280 litres of fresh sesame from Lu-Ningirsu to his brother Ur-Abba. De Boer notes that the enclosed tablet specifies an initial delivery of 11,050 litres followed by a second of 4,230 litres. This nicely adds up to 15,280 litres.

The curator explains that it was very easy to make changes to the cuneiform in the wet clay. This gave people creative, and potentially lucrative, ideas. Stating the same amount on both

The reconstruction of the scan data of the clay tablet in progress.

the envelope and the encased tablet made it a lot harder to commit fraud. By using the 3D data sets to create 3D prints, the researchers can produce replicas of clay tablets for students,

Thus, the lost tablets of Raqqa can be brought back to life

without risking damage to the originals. Similar pieces that have somehow ended up in Berlin, London, Paris or Leiden in the course of history can now be compared without the need for the originals to travel. A recent example is the Scanning for Syria project, with which Ngan-Tillard is also involved. The project concerns 400 clay tablets that were discovered in Northern Syria between 1985 and 2010, and had been stored in the museum in Raqqa. Following the devastation caused by IS, it is feared that the finds were lost. At the time, synthetic moulds of 20 tablets were produced. By scanning these moulds, researchers can create a 3D data set which can then be printed. Thus, the lost tablets can be brought back to life, including the letters, contracts, lists and the names of the people who lived and worked there 1,400 years ago. <<

The pop-up exhibition Scanning for Syria will be on display at the National Museum of Antiquities in Leiden until 28 October. The exhibition is part of Archaeology of the Future, a symposium addressing a number of techniques that could potentially protect the heritage and support the archaeology. Exact chocolate copies of a small clay tablet are on sale at the exhibition.

After Delft

Joachim Coens is the CEO of a 'gateway to the world', as he calls it. He deals with people from all around the world on a daily basis. About 30 years ago, he studied hydraulic engineering at TU Delft for one year.

Coens is responsible for developing the infrastructure and commercial aspects at the port. "Technical, nautical, logistics – I get to meet all sorts of people," says Coens. He truly believes that the port is a gateway to the world. "People from all around the world come to my port. This port plays a valuable role in society, this is the gateway to the rest of the industry."

While Coens spent most of his academic life in Leuven, he did study for one year at TU Delft. "Delft has always led the way in hydraulic engineering,' Coens explains. "The university was a lot more transparent and structured than the university in Belgium, wh ere things happen more organically."

Rather than live in a student house, Coens preferred the attic of a canal-side house with people who enjoyed painting. "I slept amongst the canvases.' Another big difference to studying in Belgium is the study associations. "Nightlife in Delft is fairly private, dominated by a membership system. I wasn't a member anywhere, but I did go out now and then."

Despite his integration being somewhat hampered by the membership system, he would recommend everyone to do a study abroad. "Otherwise, students will just stay in their own country, living at home. It is really important to experience another culture. You remain connected to the city: I don't have much contact with the people from back then, but I do follow the TU network and the expertise that it produces. As part of my job, I often work together with Dutch ports. And because I studied in the Netherlands, I feel a certain connection with the country."

Photo: Sam Rentmeester

'It is certainly an interesting combination: an international port and local politics'

After he graduated, Coens entered the construction industry and worked on various port projects. He became Managing Director of the port in 2001, and in 2014 he was appointed Mayor of Damme, a small municipality close to Zeebrugge. "It's a completely different thing," he explains. "It is not easy to combine the two, as your evenings and weekends are often taken up with work for the municipality, but it is certainly an interesting combination: an international port and local politics."

Coens is planning to further digitise the port. "This will make customs, imports and exports more efficient. The port is undergoing a transformation, and in the future I hope to improve how various companies and factors work together." RVT

In person

Delft alumnus and lecturer in applied mathematics at Amsterdam University of Applied Sciences Youssef El Bouhassani was elected Lecturer of the Year 2018 by the Interstedelijk Studenten Overleg (ISO). The jury praised his use of creative modes of instruction. For example, he used Tinder to teach statistics, asking: how great is the chance of a match? TU lecturer Giulia Calabretta was also nominated.

Three Delft professors received a royal honour this year: Professor of Climate Design & Sustainability (A+BE) Andy van den Dobbelsteen, for his research that contributes to maintaining quality of life in our environment despite climate change; Jenny Dankelman, Professor of Minimally Invasive Surgery and Intervention Techniques (3mE), for developing medical instruments and linking the technical and medical worlds; and Isabel Arends, Professor of Biotechnology (Applied Sciences), for the social relevance of her work and her commitment to women in science.

Anton Akhmerov (nanoscience), Joris Bierkens (applied mathematics), Frans van der Meer (computational mechanics), Amir Zadpoor (biomechanics) and Andrea Caviglia (designer of quantum materials) each received Vidi grants worth €800,000 from the Netherlands Organisation for Scientific Research. Their research proposals were selected based on their originality, their expected scientific impact and the possibilities for applying that knowledge.

Professor Bert Geerken has been appointed as acting Dean of the Faculty of Architecture and the Built Environment. He succeeds Peter Russell who will continu working on research at the faculty. Geerken just retired from the Faculty of Civil Engineering and Geosciences in May and will take on the job until April 2019 at the latest.

COLUMN

CO_2 at sea

If all goes well, we should have a climate agreement by mid-July. Or rather, a broad outline of a climate agreement that will be further fleshed out over the next six months and that ultimately should help the Netherlands reduce CO_2 emissions by 49% by 2030. In other words, an almost 50% reduction compared to 1990 levels. Considering that the reduction was only up to 12% in 2016 and 13% last year, that will be a huge task.

Truly achieving that goal involves a crucial role for the bottom of the North Sea, one that was already included in the energy agreement that was signed in 2013: building five enormous offshore wind farms. Given the Netherlands' lack of mountains (for hydroelectric energy) or vast forests (for large-scale biomass), we mainly rely on the wind, especially wind at sea.

The bottom of the North Sea will literally and figuratively be the new, stable, reliable foundation for our energy system in the coming decades. Although the five wind farms that are being built are currently the largest in the world – at 700 MW apiece – their size will pale next to the total number of wind turbines that will be installed in the North Sea after 2023, when the five wind farms are due to be completed. Undoubtedly there will be protests.

There are already protests against another role the sea bed will play: host to CO_2 storage. Carbon capture and storage (CCS) is a hot topic in the negotiations about the new climate agreement. Although parties like the Intergovernmental Panel on Climate Change agree that CCS is essential to keeping global warming below 2 degrees Celsius, not everyone is enthusiastic about it.

It became clear in June that industry and environmental organisations have fundamental differences of opinion regarding CCS. If you cut through the rhetoric and big words, you come to a fundamental question: is CCS truly indispensable to reducing net emissions in the Netherlands quickly enough, or is CCS another term for 'sweeping it under the rug' and thus a nice way to avoid having to limit emissions? The Dutch cabinet has already stated that we will not meet our very ambitious goal of reducing emissions by 49% in 2030 without CCS. And so there will likely be a compromise, as there often ends up being in the Netherlands: capture and storage of CO_2 and financial support – but not too much of either. What is certain is that the wind farms will be offshore; putting them on land is certainly not an option, after the earlier attempt in Barendrecht and the PR drama that followed.

Remco de Boer is a technology & science communication specialist.

TEXT: TOMAS VAN DIJK PHOTO: SAM RENTMEESTER

Kick starting artificial life

In the quest to create artificial life, TU Delft researchers have taken an important step. They designed a strand of artificial DNA that is capable of copying itself.

Pauline van Nies and Christophe Danelon speak of a breakthrough..

The DNA strand only contains a couple of genes, just enough to kick-start the DNA replication process. Lacking the genes that regulate cell division and survival, talking about artificial life is an overstatement. But the replication takes place in a simple cell model, a liposome.

"It is certainly a breakthrough," says Dr Pauline van Nies, who until recently worked at the bionanoscience department in Delft, in the group of Prof. Christophe Danelon. Van Nies is the first author of a paper, Self-replication of DNA by its encoded proteins in liposome-based synthetic cells, describing this feat. It was published earlier this year in Nature Communications. The Delft research builds in part on the work of a group of Japanese scientists who, about 15 years ago, assembled a cocktail of enzymes that can transcribe DNA and translate messenger RNA, the process that ultimately leads to the production of new proteins. Feed these enzymes a strand of DNA with gene encoding for proteins that orchestrate DNA replication, and Bob's your uncle: the DNA will self-replicate. Or will it?

DNA replication: inspired by viruses

This sounds simpler than it is. DNA replication is an extremely complicated process in living cells as it is entangled

with many other functions. Van Nies thought of using the DNA replication machinery of a virus called Φ29. "Viruses are extremely efficient in encoding proteins in a small genome and in robustly replicating their genetic information."

Unique blueprint

In human cells, DNA replication is managed by hundreds of proteins. Φ29 only needs four. The Delft researchers joined forces with microbiologist Margarita Salas and a couple of her colleagues at the Autonomous University of Madrid. Salas has been working with Φ29 for almost half a century. She discovered the DNA replication mechanism of the Φ29 virus and managed to isolate it.
Van Nies composed a unique DNA blueprint that took into account a number of different factors related to the flow of genetic information, such as a suitable binding site for the ribosome, an element that is essential for the production of proteins.

Water-loving head

A goal that is now coming closer is combining the new module that regulates the flow of genetic information with other essential cellular functions such as growth and division. In 2016, Danelon's group created a way to synthesise the phospholipids that make up the cell membranes (also called liposomes), such as the ones the researchers used in this project.
The fundamental structure making up membranes is called the 'phospholipid bilayer', which is only a few nanometres thick and consists of two layers of lipid molecules. These molecules, in turn, are composed of a water-loving (or 'hydrophilic') head and a water-fearing (or 'hydrophobic') tail. When brought into contact with water, the lipids spontaneously assemble to form a closed compartment.

DNA replication is an extremely complicated process in living cells

Phospholipid molecules are created through a series of complex biochemical reactions that are set in motion by specialised proteins (enzymes). The DNA that encodes for these enzymes was originally extracted from E. coli cells, a relatively simple and well-understood class of bacteria that can be found in the human gut. The DNA was then purified, undergoing multiple molecular biological steps to end up as the final DNA template. In total, the DNA strand consists of seven or eight genes. The yield of newly synthesised phospholipids was still too small to sustain growth, but Danelon is confident his group can optimise this process. The next step is to combine this module with the four-gene long strand of DNA that encodes for the DNA replication machinery.
But there is more to cell division than just producing enough phospholipids. Modern cells require a streamlined process in which copied DNA is neatly packed and then evenly distributed towards the poles of the cell. Concurrently, specialised proteins squeeze the mother cell into two daughter cells.

Be humble

Mimicking this mechanism might prove too difficult for now. "We need to be humble," says Danelon. "Sometimes it is wise to take a step back from the complexities of nature. We will design a simpler cell division technique, a 'budding' mechanism, that could also do the trick. I think we can create liposomes that grow until they start budding. If enough DNA is produced, hopefully, enough of the generated primitive daughter cells will contain the new DNA just by chance to sustain a cell population." The researchers believe that this may well be how the very first cells self-reproduced before evolution equipped them with a more elegant and robust solution. <<

HORA EST

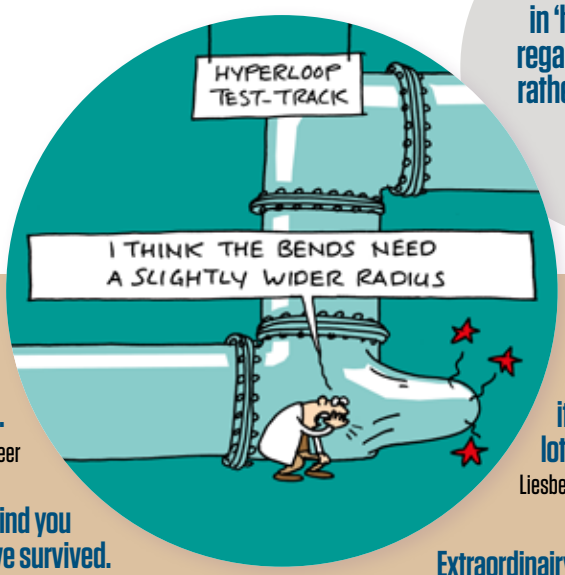
Minorities are the most innovative folks.

Sine Çelik, industrial design engineer

"This proposition is inspired by Angus Deaton. Being a minority directly relates to historical and cultural facts. It means that in a given time in history, a particular group of people was somehow surrounded by a larger group of people with different characteristics, who probably had other values, maybe they spoke another language or even looked dissimilar. All over the world, minorities suffer from the consequences that these differences bring along and they have to put up a fight to be able to survive without being assimilated. This requires them to learn solving their problems on their own. Innovation commonly develops as a response to these problems. Thus, in order to be able to coexist, minorities have to innovate."

The major challenges in 'hyperloop' design regard the tube system rather than the vehicle.

Cornelis Haringa, physics engineer



For tasks with haptic assistance, the operator is the biggest source of inaccuracies.

Jeroen van Oosterhout, mechanical engineer

A representative democracy can only be truly representative if its representatives are chosen by lottery.

Liesbeth Florentie, aerospace engineer

Don't forget to look behind you and see what you have survived.

Anuar Bin Md. Ali, water engineer

Extraordinairy results are not possible if everyone is only doing what he or she is supposed to do.

Laurens Mackay, electrical engineer

The development of Artificial Intelligence leads to a fairer society.

Wei Yu, aerospace engineer

It takes more than two Majorana bound states to detect non-Abelian exchange statistics.

Sebastian Rubbert, physics engineer

Beating the Google Maps is not that trivial.

Radan Šuba, architect

If done right, electrical engineering is rather boring: you hear no sound, feel no heat, smell no fumes and see no spark.

Gautham Ram Chandra Mouli, electrical engineer

Connecting developing countries to the internet is an act of capitalism and should not be confused with altruism.

Tom Wambeke, geoscientist

THE FIRM

Just imagine: following a leg amputation or paralysis due to spinal injury, being able to stand up again and walk away. Reboocon Bionics wants to use robotics to literally help people with a physical limitation to move forward.

"Recover capability, boost strength, connect to society." Shiqian Wang, founder of Reboocon Bionics, is keen to emphasise what his start-up is all about. Wang dedicated six years to developing and testing wearable robotics. In 2016, he decided to found his own company, establishing one branch at Yes!Delft (Reboocon Bionics) and another in Shuzhou, China: Reboocon MedTech.

No, he did not have any personal affinity with people with a limitation due to paralysis or an amputation. "But during my doctoral research, I developed a robot suit for patients who had suffered spinal injury, and I was touched by their high spirits. Their will to walk, their joy when they actually managed to walk and were able to stand up straight and look someone in the eye again – that touched me."

His goal: to make what seemed impossible, possible, by developing an exoskeleton that allows paralysed people to walk freely. "There are already three to five producers of exoskeletons around the world with this aim, but their versions still move in a relatively robot-like fashion. Reboocon wants to improve this by making its robots light, easy to control and – primarily – intelligent. You could compare it to cycling – a standard bike will get you where you need to be, but it is all a lot easier on an e-bike. "Wang recently sold some of this technology to TU Eindhoven, for use in their football robot. Interestingly, it is the start-up's robot knee that is now resulting in an actual product. Constructed from titanium, carbon composite and aluminium, this knee is designed to be more energy efficient than those of competitors, more than a kilogramme lighter and a lot cheaper, while featuring intelligent algorithms that should make it easier to walk up and down stairs and on uneven ground.

Wang is yet to earn anything with his endeavours: "We are still in the investment phase." The first prototype of his robot knee is currently undergoing testing, while the second prototype is planned to be completed by the end of January 2018. "My staff and I live off the money provided by investors. There were plenty of those from the outset, as the market for robotics for people with a physical limitation is enormous. Wang is determined to conquer this market within five years. "We already led the field in terms of prosthetics hardware, what we now need to do is take our software to the next level." JB

Photo: Sam Rentmeester

Founded:	2016
Founder:	Shiqian Wang
Degree programme:	PhD (2010-2014) in the Department of BioMechanical Engineering at TU Delft followed by postdoctoral research into exoskeletons
Employees:	7 (and 2 interns) in Delft and 6 in Suzhou, China
Turnover:	None to date
Target group:	People with a physical limitation following a leg amputation above the knee or a spinal injury
In five years' time:	wants to make Reboocon an international market leader in the field of wearable robotics.

'We are still in the investment phase'

A bridge between technology and design

It was not entirely certain that the project would succeed, but that made it especially interesting. The start-up MX3D built the first metal 3D-printed bridge in the world of 12 metres long. Now they have won the Grand Prize for innovative collaboration between technology and the arts.

TEXT: ROOS VAN TONGEREN PHOTO: SAM RENTMEESTER

The principle is simple: a robot arm moves the welding torch and creates a stainless-steel product drop by drop. MX3D could also have printed a house or a car to show the scale on which 3D printing can now occur. 'A bridge can combine the artistic side with technology, literally bridging the gap between technology and design', remarked Dr Jouke Verlinden of the faculty of Industrial Design Engineering, who was closely involved in the realisation from the 3D Building FieldLab (part of AMS, the Amsterdam Institute for Advanced Metropolitan Solutions).

The first idea was to place robots on each side of the canal that would weld toward each other. It would have been an effective way to show the process, but the welding technology would blind passers-by and was not quite good enough for it. Instead, separate parts were printed and later hand-welded together. 'We were able to work with eight printers at the same time and we were faster than we expected', says Verlinden. Actually, they were too fast: the redevelopment of the Oudezijds Achterburgwal canal in Amsterdam, where the bridge will be located, is still not complete. But when the bridge is installed there soon, it will be admired by the many tourists who visit the Red Light District and – not entirely coincidentally – by the designers who cycle past there every day.

TEXT: AGAATH DIEMEL PHOTO'S: TU DELFT

25th Best Professor Award

The Delft University Fund has been presenting the Best Professor Award to a professor from Delft since 1994; 2018 will be the 25th occasion. Three Best Professors reminisce.

Best Professors excel both in teaching and research, basing their teaching on their research. They know how to motivate students and doctoral candidates, giving inspiration to their students, but allowing themselves to be inspired too. They are not chosen because of pass-rate figures or impact scores, or selected by the Executive Board. You can only be nominated by your academic environment; by the people who see you as their teacher.
Without exception, every recipient is proud to take their place in the illustrious list of Best Professors. The University Fund honours them with a medal and a certificate, and the winner also receives two intercontinental airline tickets and a cash prize of € 15,000 intended for a sabbatical. Three Best Professors on their experiences:

PROFESSOR JACK PRONK
PROFESSOR OF INDUSTRIAL MICROBIOLOGY
2015 winner

Although Jack Pronk had already won several prizes for his work, the Best Professor Award was the icing on the cake: "This is probably the best prize I've ever been awarded. And I got it doing something I already see as a reward: teaching and supervising doctoral candidates." He hasn't had time

> 'Giving lectures and supervising young researchers is why I work at TU Delft'

for a sabbatical yet: "In 2016, I received an ERC Advanced Grant, a substantial European research grant. At the same time, a colleague left, putting 11 doctoral candidates into my care. I'm not as mobile as I was!" He's not short of ideas though: "I'd like to try teaching a new subject after my ERC project. Something outside my comfort zone; thermodynamics or ethics, perhaps. I'm basically a biologist, so these aren't particularly obvious subjects for me. I could imagine spending my sabbatical devising a course like this, in a peaceful location like a Norwegian fjord." Despite the current pressures of work, teaching is still in his blood: "Giving lectures and supervising young researchers is why I work at TU Delft."

PROFESSOR JACOB FOKKEMA
RETIRED PROFESSOR OF GEOPHYSICS AND FORMER RECTOR MAGNIFICUS
2001 winner

Jacob Fokkema is proud of his Best Professor Award: "Being a Best Professor takes more than just being a good teacher. You have to take your students on an academic adventure. It's great if your colleagues and students show their appreciation." Fokkema's sabbatical took him to New Zealand: "The soil there is perfect for research into one of my specialist subjects: georadar. I gave lectures, supervised a post-doc and made lots of unique contacts." But being a Best Professor also involves obligations: "Best Professors are among the cream of the university crop. They're the ambassadors and the conscience of the university. They must set a good example, but also have a duty to speak out if they are unhappy about the way things are going. *Noblesse*

'You have to take your students on an academic adventure'

oblige." Nowadays, Professor Fokkema conveys his passion for teaching and research to others as a coach. "You have to love what we do as a university with all your heart, without wanting to be particularly rich or important yourself. That's the bottom line."

PROFESSOR TED YOUNG
RETIRED PROFESSOR OF QUANTITATIVE MICROSCOPY
1999 winner and chair of the selection committee from 2004 to 2017

Ted Young sees the Best Professor Award as an important initiative: "There are plenty of prizes for research, up to and including the Nobel Prize. But there's very little recognition for good teaching outside your own organisation. This prize shows that teaching isn't a minor issue at TU Delft." What is expected of a true best Professor? "The rules state that they 'must prove their teaching expertise'. In this case, it

'This prize shows that teaching isn't a minor issue at TU Delft'

means having given droves of young people the knowledge, instruments and skills they need to reach the top of their field." Young was humbled by his Best Professor Award: "You choose a path in life and try to make the best of it. Your primary motive is to be the best you can in your work, and if you are, you don't really need a prize. But the Best Professor Award is a sign of recognition from the very people who stand to gain from your teaching. It means that I made the right choice. If you only want to do research, you don't need to work at a university." <<

ALUMNI NEWS

Alumni Activities

7 July
Event-in-a-box Bangalore

9 July
Shell Eco-marathon
Alumni event in London

11 July
Event-in-a-box Waterloo, Canada

20 July
Event-in-a-box Mexico

28 July
Event-in-a-box Melbourne

25 September
Alumni Backstage Tour 2

Contact:
Questions, comments or ideas?
Email: alumnirelations@tudelft.nl
Website: alumni.tudelft.nl
Community: tudelftforlife.nl

'TU Delft for Life' is the online community for all Delft alumni. Expand your network, rediscover old friends from uni and keep abreast of all the latest news and events. You can register at tudelftforlife.nl, where you can also change your address or contact details.

Shell Eco-marathon Alumni Event 9 July

In collaboration with Imperial College London, the Dutch embassy, the University of Twente and the Eco-Runner dream team, TU Delft is organising an alumni event in London on 9 July for students, alumni and people related to the organising bodies. The event celebrates the Shell Eco-marathon, which will take place in London from 5–8 July. This is a race designed for cars running on hydrogen, which are competing to complete the route as efficiently as possible. At the alumni event, the teams from Delft (Eco-Runner), Twente (Greenwheels) and Imperial (Imperial Racing Green Team) will share their experiences with alumni in a panel interview.

From Melbourne to Mexico City: Alumni Events

Twice a year, alumni communities abroad are invited to participate in the event-in-a-box campaign. Alumni around the world come together to network, share experiences and strengthen their connection to TU Delft. They receive a box from Delft with Dutch delicacies, a Delft game and an invitation to compete in a photo contest. Our alumni have once again responded positively to the summer campaign. To date, events have already been planned in India, Canada, Singapore, Turkey, Spain, Australia, Ecuador, Mexico, Italy and Sweden.

TU Delft for Life | Xperience Day

On 7 June, almost 500 alumni took part in 12 tours with various themes, attended a plenary session that included an inspiring presentation from 2018 Alumnus of the Year Ionica Smeets (see the interview on page 20) or visited one of the faculties' evening programmes! If you want to know what you missed, look back at the plenary session or see photos, go to alumni.tudelft.nl/ifot.

From Delft University Fund

Martha Deen wins Marina van Damme Grant

Geophysicist Martha Deen was awarded the Marina van Damme Grant on 16 May for her ambitious plan to combat climate change by mapping the ocean's energy potential.

'The ocean potentially contains more energy than is currently being used around the entire world', began Deen's pitch. Her project proposal for this grant concerned research into seismic data and ocean data. She wants to link these data so she can calculate the ocean's energy potential on a regional scale.
The Marina van Damme Grant will help Martha organise a research stay at Geomar in Kiel. "I want to become a specialist so I can contribute to the energy transition. Eventually, I see myself being an advisor for the energy transition on a technical level."
The other three nominees – Gianna Bottema (A+BE), Preethi Ramamurthy (EEMCS) and Rianne Houba (IDE) – each won a runner-up prize of €2,500, which was provided by the Fortuna Fund.

About the Marina van Damme Grant

The Marina van Damme Grant is awarded annually to talented female alumni who earned a degree or PhD from TU Delft. This special €9,000 grant is made possible by a donation from Dr Marina van Damme. She graduated from TU Delft in 1953 as a chemical technologist and obtained her doctorate in 1965 as the first female engineer from the University of Twente. Marina van Damme wants this grant to enable young female engineers to further develop their talents and increase their opportunities in the job market.

Read more about Martha Deen and the other nominees at: universiteitsfondsdelft.nl

The lab of...

Architecture

Masters student Surbhi Singal is working on a volumetric model of a concert hall, that is proposed at the site of Museum of London, near Barbican estate. The project stems out a real-life competition brief that asked for a musical avenue to be added to the so-called - culture mile in the city of London. The studio that she is part of, called 'Interiors, buildings and cities', relies quite a lot on making maquettes as a method to articulate spatial arrangements, architectural decisions and language. Her project looks at the concert hall as an avenue that anchors onto the festivities of London city and extends onto the image of Barbican estate. It is designed for 2000 spectators as well as with other allied public programs.

PHOTO: SAM RENTMEESTER