DELFT OUTLOOK
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TU Delft

ALLARD VAN HOEKEN
'I hope to make tidal energy a success'

THORIUM REACTOR
THE FUTURE OF NUCLEAR ENERGY

IMPROVING DRUG RESEARCH
Hart cells on a chip

THEME
Floating

Cover photo:
Balance d'eau builds floating houses with a basement of high tech composite material instead of concrete, which makes it possible to build on every location and water depth. Due to this, multiple use of space is possible, by combining water storage and living. The house floats in Delft as a pilot case. (balancedeau.nl).
Photo: Sam Rentmeester

EDITORIAL
Frank Nuijens

Floating

Hunched up under the worktop trying to fix a clogged drain reminds me of the theme of this issue of *Delft Outlook*: floating. Water is a powerful molecule that makes its presence known when it cannot make its way to the sewer. The Netherlands has learned that it is better to allow space for water than it is to fight against it. Rising sea levels are urging us to develop innovative solutions. Building on water is one of them. Rutger de Graaf, a TU Delft alumnus and founder of the YesDelft company DeltaSync, has identified important reasons for doing so: worldwide problems including deforestation, urbanisation and an increasing demand for food, fuel and other raw materials. These demands are laying claim to the increasingly scarcer space available on land. This major problem calls for vision. De Graaf's vision is known as Blue Revolution and would enable most coastal cities to expand on water while also providing floating facilities for the production of food and fuel. In this issue, we are also looking at ways of alleviating localised social suffering. For example, the instant coffee that needs less stirring, the safer transfer of workers to drilling platforms, the Fleetcleaner that reduces ships' fuel consumption, and 3D grids that increase the safety of construction in ports. And now, if we could just have a self-unclogging drain for my kitchen.

Frank Nuijens,
Editor-in-chief

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Theme Floating

PHOTO: SAM RENTMEESTER

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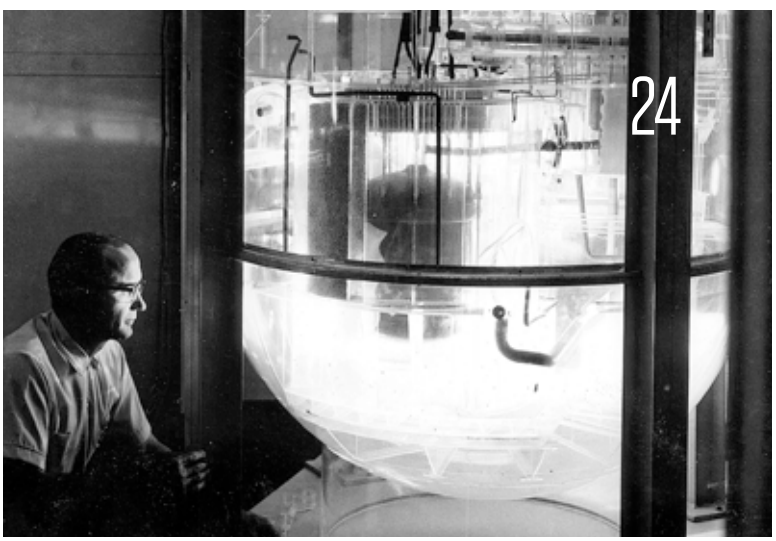
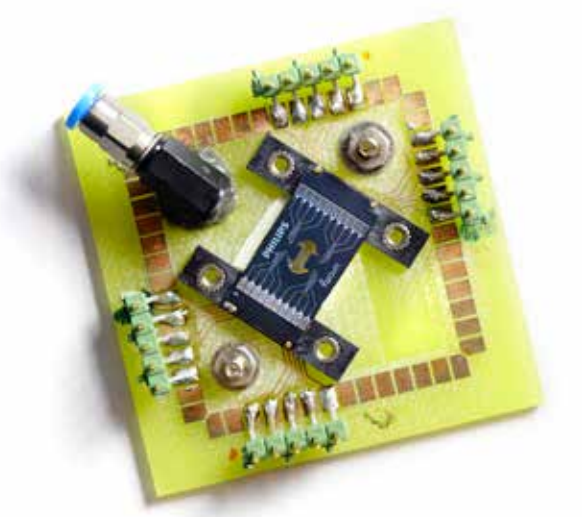




DELFT IN BRIEF

IceCubes

The days of the highly toxic rocket fuel hydrazine are numbered – at least if Angelo Cervone and Barry Zandbergen from the space systems engineering research group (AE) have their way. They have developed an idea for a propulsion system that operates using ice. They have described their invention, which could be particularly interesting with regard to the mobility of nanosatellites, in a recent publication in Acta Astronautica. Once in space, ice sublimates. The water vapour molecules emerging from this process collide with a heated plate, thus being expelled at high speed from the nanosatellite and generating several milli-Newtons of propulsion. That is enough to steer nanosatellites once they are in orbit around the earth.
delta.tudelft.nl/29803

Roboots

Researchers Wietse van Dijk and Cor Meijneke from biomechanical engineering (3mE) have created robot boots, which provide an additional boost when the wearer steps down on the heel, making it easier to walk. The Achilles walking boot, as the invention has been named, contains a spring system and a small electro-motor. The device could be useful for people with muscle disease or for those in rehabilitation. The technique does not yet work perfectly. The movement still feels unnatural, causing users to adopt another walking posture – putting more weight on their toes – thereby failing to reduce the amount of energy used. By improving the mathematical models of human walking dynamics, the researchers hope that they will ultimately be able to improve their robot boots.
delta.tudelft.nl/29878

€135 million for QuTech

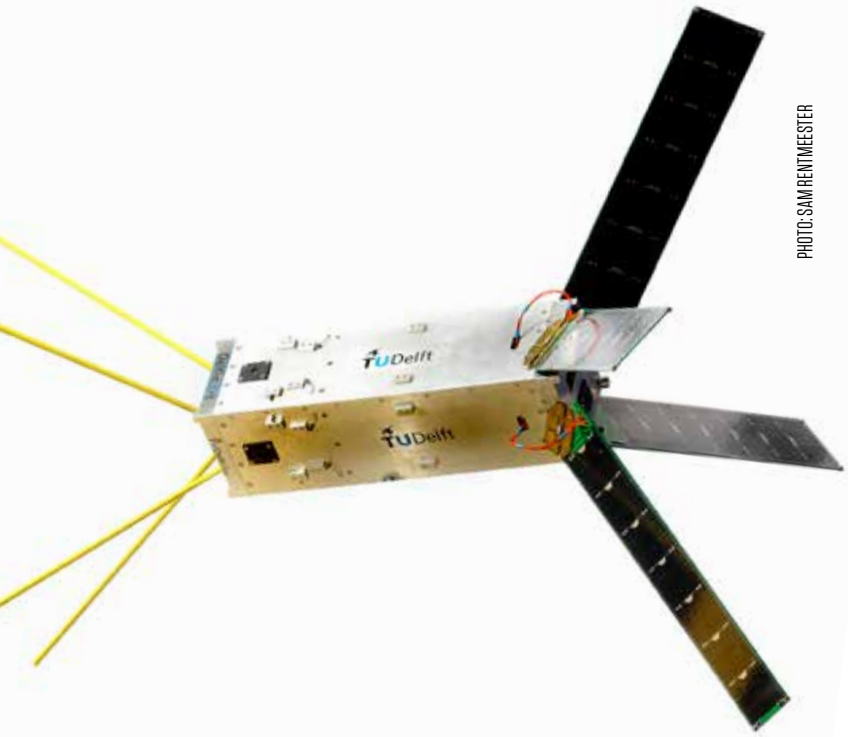


PHOTO: SAM RENTMEESTER

In the coming 10 years, the TU Delft institute for quantum technology, QuTech, will receive €135 million for the further development of the elements of the first quantum computer. The funds are from six parties: the founding partners TU Delft and TNO, the Ministry of Economic Affairs, the Ministry of Education, Culture & Science, the Netherlands Organisation for Scientific Research (NWO/STW/FOM) and the top sector High Tech Systems and Materials (HTSM). The number of staff members in the research institute is expected to double (from 100 to 200) in the coming five years.
Throughout the world, researchers are racing to be the first to achieve a breakthrough in quantum technology. With QuTech, TU Delft is taking a leading position.
delta.tudelft.nl/30005

PHOTO: SAM RENTMEESTER

Road construction with telephones

It is not easy to travel around Senegal by car. The population of the African country is increasing rapidly, but the roads are not keeping pace. The World Bank would like to know the lines along which new roads would yield the greatest economic returns. Researchers in transport and planning (CEG) have developed a smart way to do this: by analysing a mountain of data from telephone calls. The presence of telephone traffic between certain cities indicates a connection between these locations, and thus the importance of good road connections. With their study, the TU Delft researchers won the D4D Challenge, the Transport Prize in the Data for Development Challenge, conceived by the telecom company Orange.
delta.tudelft.nl/29801

Flexible electronics

Watching a video on paper or having electronics processed into clothing: these are amongst the promises of of flexible electronics. Researchers in the micro-electronics research group (EEMCS) at TU Delft have developed a technique that has brought these applications a step closer. They have made chips from silicon ink. Liquid silicon has been around for decades, but making transistors from it requires heating the ink to a temperature of 350 degrees Celsius. Few flexible bases are able to withstand such temperatures. The silicon ink that the TU Delft researchers have developed, in collaboration with colleagues at the technical university of Nomi in Japan, can be processed at room temperature. Although the process does require firing the material with ultraviolet laser light, this takes so little time – only a few nanoseconds – that the underlying substrate does not become any hotter than 150 degrees Celsius.

Synthetic cell division

Within five years, Professor of Bionanoscience Cees Dekker (Applied Sciences) hopes to have made it possible for artificial cells to divide. This spring, he received an ERC grant from the EU worth € 2.5 million for his ground-breaking research on cell division. The tiny cells that Dekker is developing replicate natural cells in their most basic form. They are cell membranes of soap-like molecules, containing a watery substance of DNA and proteins.
delta.tudelft.nl/29967

Gas production with soap

Gas production can be increased by injecting soap into the ground. This is the conclusion of Dr ir. Dries van Nimwegen (Applied Sciences), who defended his dissertation entitled The Effect of Surfactants on Gas-Liquid Pipe Flows on 15 June. The research has not gone unnoticed. Effective immediately, the Nederlandse Aardolie Maatschappij BV (NAM) is planning to inject soap into the gas-production wells in the North Sea. They hope that this will increase production by between 5% and 15%. These wells have produced less than expected, as the pressure has decreased over the years. Injecting soap will make the water effervescent, bringing gas along with it as it rises to the surface.
delta.tudelft.nl/30004

4500 Solar panels

In the hope of generating one million kilowatt-hours per year, TU Delft is going to cover nearly half of the total roof surface of its campus with a total of 4500 solar panels. The installation of the panels is expected to be completed in September. The solar park fits within the green ambitions of TU Delft. By 2020, the university hopes to be generating 25% of its current demand for energy through sustainable methods. It still has a long way to go. One million kWh per year amounts to about 2% of the energy used by TU Delft. Chris Hellinga of the Delft Energy Initiative is one of the initiators. 'To be sure, 2% is not very much', he admits. 'Nevertheless, every per cent of sustainably produced energy requires considerable investment, and it should be taken seriously. Moreover, once half of the university's usable roof surface has been covered in solar panels, this will send a message. It will encourage people to be more sustainable in their use of energy'.
delta.tudelft.nl/30015

Ecorunner wins the Shell Eco-marathon

The weekend of Pentecost, TU Delft Eco-Runner Team ended in first place in the hydrogen class of the Shell Eco-marathon in Rotterdam. The Eco-marathon is an annual competition in which secondary and university students attempt to achieve the greatest possible fuel efficiency with their self-developed vehicles. The hydrogen-driven Eco-Runner V has a fuel-efficiency level of 1227.5 kilometres to one cubic metre of hydrogen. This translates into 3653 kilometres to one litre of petrol. A small tank filled with 2.9 kilograms of hydrogen would be enough to drive the car right around the world.
The students from TU Delft can also race on hydrogen, as proven by another team: the Forze student racing team. In early May, the students drove around the German Nürburgring race circuit in just 11 minutes. This was a record for a team of students in a self-made hydrogen racing car. On the track, the car reached a top speed of 170 kilometres per hour.
delta.tudelft.nl/29963 and 29903

PHOTO: SAM RENTMEESTER

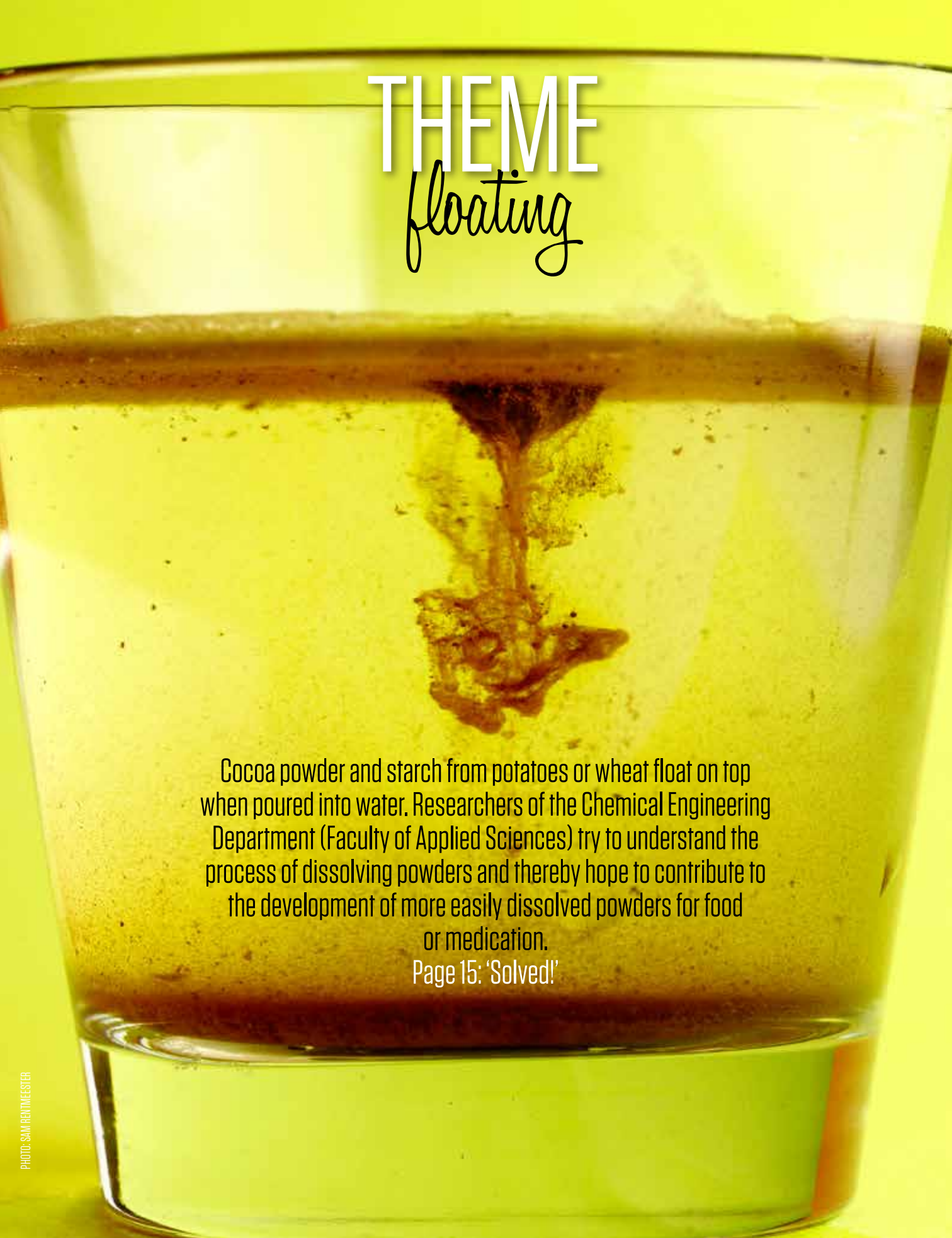
Spot on the horizon

In 2050, the provision of energy in Europe will be more sustainable and also more complex than it is now. This will call for direction, and the Netherlands is particularly well suited to take on this task. This is a proposition of the 'Delft Plan: Nederland als Energy Gateway' (Delft Plan: The Netherlands as an Energy Gateway), which was published earlier this year by the university's Delft Energy Initiative. The plan outlines a spot on the horizon, a future in which the Netherlands has affordable, clean and reliable energy facilities and in which the Netherlands is a centre of European trade for energy, where flows of energy and raw materials enter and are processed, stored and traded.
delta.tudelft.nl/29926

Fishing in governmental data

In the first issue of Delft Outlook in 2015, on the theme of Big Data, the article 'Fishing in governmental data' stated that Stefan de Konink's initiative was supported financially by PlatformTransparant Nederland. This was a misunderstanding. In the online version (delftoutlook.tudelft.nl), the final paragraph of the article has been revised accordingly. delftoutlook.tudelft.nl

THEME
floating



Cocoa powder and starch from potatoes or wheat float on top when poured into water. Researchers of the Chemical Engineering Department (Faculty of Applied Sciences) try to understand the process of dissolving powders and thereby hope to contribute to the development of more easily dissolved powders for food or medication.

Page 15: 'Solved!'

PHOTO: SAM RENTMEESTER

AUTHOR: CONNIE VAN UFFELEN
PHOTO: SAM RENTMEESTER

The floating city as an ecosystem

Floating construction: several municipalities in the Netherlands are working with it on a small scale. TU Delft alumnus Rutger de Graaf of the YesDelft company DeltaSync would like to speed things up with his Blue Revolution.

His floating pavilion for meetings and events has been bobbing around in Rotterdam's Rijnhaven for five years now. Closer to home, five water villas have been floating in the Delft Harnaschpolder since last year, as part of an innovative project initiated by the City of Delft and DeltaSync. Residents purchased water lots and worked with their own architects to develop floating homes. One of these residents, Olaf Janssen, even developed a new floating system based on composites. A true world first!
Similar projects are gradually popping up throughout the Netherlands. Some are on a larger scale. One obvious example is the IJburg in Amsterdam, with around 100 homes. Others are smaller, as in Lelystad and Woerden, with ten homes at the most. Last October, Dordrecht offered five water lots for sale on a 'first come, first served' basis. Interested parties waited in line in campers for weeks.
Just last month, the Aqua Dock was officially opened in the Dokhaven in Rotterdam. The Aqua Dock is an RDM Campus project intended to be a test environment for floating construction. There will be a floating road and companies will be able to lease water lots for testing their innovations. It was there that De Graaf presented the Community of Practice for Floating Construction – a cooperative partnership between education, industry and government – and he hopes to open a new, floating office for DeltaSync there in 2016.
The fact that floating construction is possible and that people like it are obviously reason enough to do it. In De Graaf's opinion, however, there are even more important reasons: worldwide problems including deforestation, urbanisation and the growing need for food, biofuels and other raw materials. He estimates that the space shortage in 2050 will amount to approximately 22 million square metres: equivalent to the total land surface area of North America.

Shortage of land

He explains how urbanisation has increased the need for biofuels and food, even as the amount of desert has increased. 'In theory, we could use the remaining bit of nature to resolve the major shortage of land that this has created. This is exactly what is happening now: in Indonesia, tropical rainforests are being cleared away on a large scale to make room for palm oil plantations. In Brazil and Argentina, they are being cleared to grow the soya beans that we feed to our pigs'.
Could floating construction be an alternative for converting nature into agricultural acreage? Only in part, according to De Graaf. Although the amount of agricultural land could be maintained by expanding cities on water, these expansions will require additional food.

'In addition to resolving the shortage of land, floating construction could be used to create ecosystems that filter nutrients out of the water'

With DeltaSync, De Graaf has developed what he describes as a total solution: Blue Revolution. According to this vision, most coastal cities should be able

The floating pavillion in the Rotterdam Rijnhaven.

to expand on water, in combination with floating food and biofuel production. 'You could make livestock feed from seaweed. Biofuels could be produced from algae on the water. One square metre of algae could produce much more biofuel than a sugar cane plant, for example. Algae need CO_2, of which we have a surplus. They also need nutrients that are present in waste water released by coastal cities'.
Wouldn't large-scale construction on water be harmful to nature? In order to investigate this, DeltaSync collaborated with a large number of partners to develop an underwater drone to take measurements beneath all floating construction projects in the Netherlands. Students from TU Delft and various institutes of higher education also took part. The drone took images and measured oxygen content, temperature, nutrients and other substances. De Graaf was unable to demonstrate any significant effects on water quality.

Ecosystem

However, he did observe the emergence of interesting ecological systems beneath the floating pavilion and in Lelystad. Lots of fish were swimming there and seaweed and mussels were attached to the seabed. 'In addition to resolving the shortage of land, floating construction could thus be used to create ecosystems that filter nutrients out of the water. Then we would have a floating city that could serve as a water-purification and ecological system. The floating cities could use waste from land to complete cycles. Symbiosis between cities on land and water.
De Graaf also sees his Blue Revolution as a way of reducing flood risk, since floating cities would be able to protect cities on land against waves. 'Researchers are working with 3D-printed coral reefs that could protect floating cities from waves'.
The technology already exists – algae cultivation, artificial reefs, floating technology, composites – though fragmented. De Graaf would like to connect these fields. He is already collaborating with the American Seasteading Institute, which also regards floating cities as an experimental space for self-government.
In the Netherlands, nothing as large as the floating pavilion has been realised in the past five years. De Graaf attributes this to the crisis and to delays caused by consensus-seeking. 'A floating city requires political leadership, vision and courage. I would like to present innovative projects here in the Netherlands that could subsequently be exported all around the world. Twenty years from now, we can't still be showing the Delta Works to foreign delegations'. <<

Floating islands

In the 1930s, Professor Vening Meinesz performed highly precise measurements of gravity around the world while floating in a submarine. These measurements contained the seeds of his explanation for how volcanic islands float on the earth's mantle.

Not many people were amazed by this, but geologists were: how does the earth's crust, including high mountains in some places, stay floating on the malleable upper part of the earth's mantle (the asthenosphere)? There is apparently a balance between the weight of the earth's crust and the upward force that the crust experiences from the mantle on which it floats. This 'isostasy' is comparable to the way in which the peak of an iceberg protrudes above the water due to the large mass under the water, which produces upward pressure – according to Archimedes' principle.

At that time, two explanations were in circulation. One assumed the existance of columns of rock floating on a higher density mantle. Beneath a rock mountain, there should be a particularly deep root buried in the earth's mantle to produce the additional upward pressure needed. This was the model developed by British geologist Georgy Airy in 1855.

The other theory, which had been developed a year earlier by John Henry Pratt, assumed that differences in the density of rock columns would lead to higher or lower elevations and that all columns must be buried in the earth's mantle to approximately the same depth. A comparison could be drawn with rising dough: the lower the density, the higher the mass rises.

Slightly less than 80 years later (1931), Vening Meinesz presented his contrasting model, which corresponds better to modern satellite measurements. He was particularly fascinated by volcanic islands, because the earth's crust is so thin in these areas. The notion of deep roots of rock did not fit.

Vening Meinesz's gravity measurements from the submarine revealed that the distortion of the gravitational field around such islands could extend for hundreds of kilometres. This is also the basis of his explanation of isostasy: islands remain afloat not only due to upward pressure, but also because of the support of the earth's crust in the area. The crust bends downward slightly, which distributes the burden of the island.

This isostasy model provided an explanation for the characteristic course of the gravitational field around Hawaii: on approach, gravity first reduces (less mass under the boat due to the downward bend in the earth's crust), followed by a local gravitational peak (a large amount of mass at the top of the volcano).

The TU Delft Library recently published a website on Vening Meinesz's 1934 expedition with the submarine KXVII from Den Helder to Surabaya. JW

expeditiewikipedia.nl

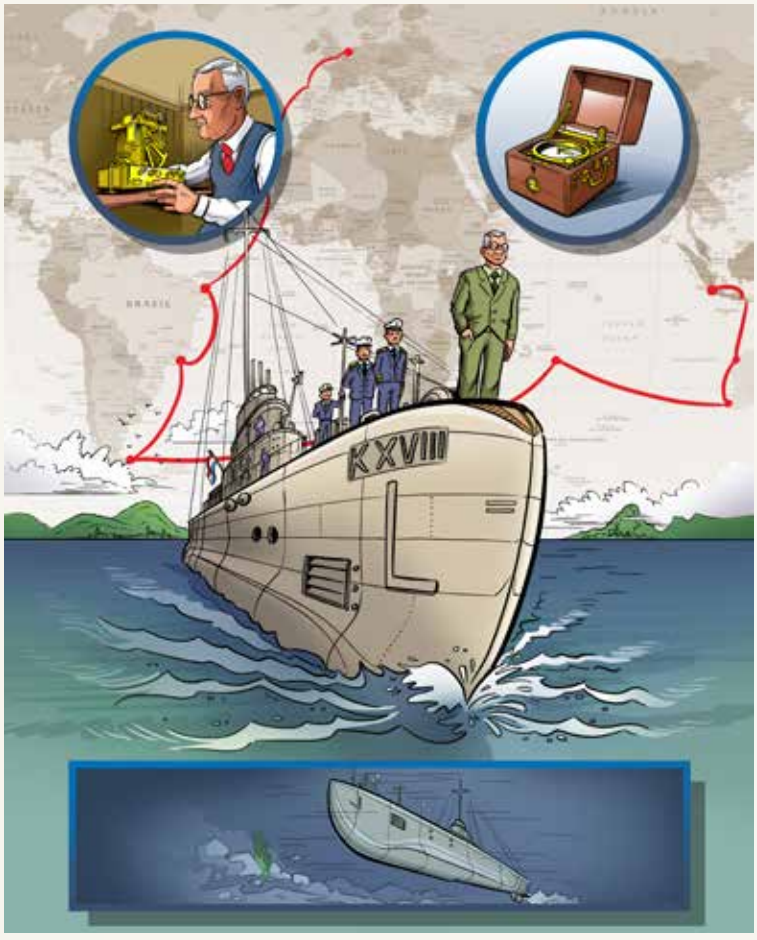


ILLUSTRATION: STEPHAN TIMMERS

Ship shape

After years of development, two graduates and a contribution from STW, the Fleet Cleaner is complete. The remote-controlled robot runs over the hulls of ships, both under and above water, in order to remove deposits. A clean hull can improve fuel efficiency by 5%. For 250m long container ships, this amounts to savings of €30,000 per year.

This scrubbing robot has turned out to be an impressive device. With a diameter of 1.80m and a sturdy steel frame, it can stand up to the heavy work for which it was designed. The star-shaped frame supports three domes with rotating water jets, which spray the deposits away from the underside, while powerful magnets hold the machine against the hull. An operator controls the robot from the shore or from another ship, which also collects and purifies the dirty water.

The TU Delft start-up Fleet Cleaner will lease the robot to a service company in the port (probably starting in the Eemshaven), which will offer cleaning services to incoming ships.

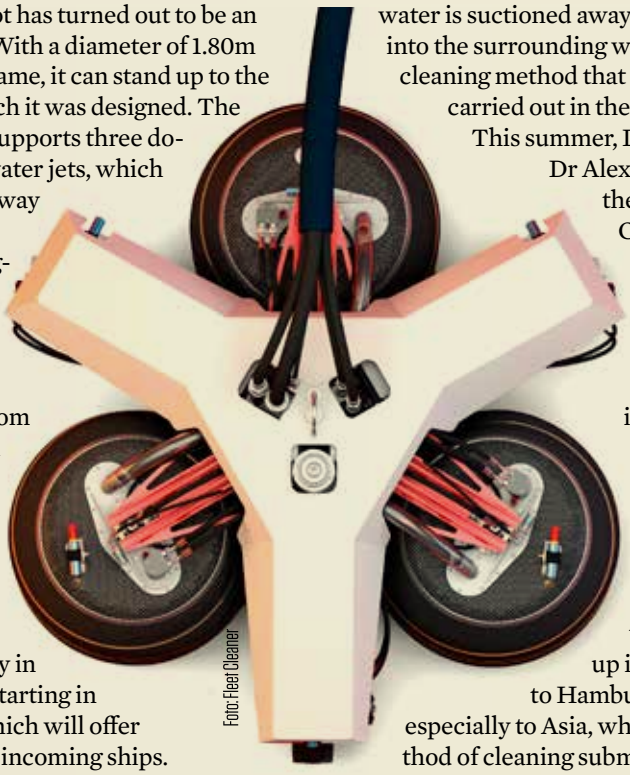


Foto: Fleet Cleaner

> The Fleet Cleaner can clean ships in the port while floating at the wharf for loading or unloading

Although shipowners are interested in this type of cleaning service, they often decide not to use it, due to certain limitations. The Fleet Cleaner can clean ships in the port while floating at the wharf for loading or unloading. Because the dirty water is suctioned away and not released into the surrounding water, this is the only cleaning method that is allowed to be carried out in the port.

This summer, Dr Cornelis de Vet, Dr Alex Noordstrand and their colleagues at Fleet Cleaner will launch the first full-sized cleaning robot in the seaport of Groningen. Further technical developments in the areas of localisation, process automation and hull inspection are expected to increase the benefits of cleaning ships with the robot. The start-up is planning to expand to Hamburg, Antwerp and especially to Asia, where the standard method of cleaning submerged parts of ships still involves divers off the coast.

The young entrepreneurs are proud to give credit to their academic supervisors, Dr Martijn Wisse and Prof. Robert Babuska (3mE, Delft Robotics Institute), without whom the Fleet Cleaner would never have been developed. JW

fleetcleaner.com

Measuring the turning of the tide

At what point does the current change direction in an estuary? Research conducted within the Chair in Hydrology, in collaboration with the department of remote sensing (both in the Faculty of Civil Engineering and Geosciences) has demonstrated that the position of a buoy in relation to the direction of a river current can provide a clear image of this change in direction.

In an estuary, the change of current direction takes place twice daily: at ebb and flood. During the approximately 15-minute period when the shift is taking place, there is almost no current in the area. According to the hydrology researcher ir. Wim Luxemburg, it is helpful to know when this period of slack water occurs. 'For example, this could be useful for towing companies trying to release a stranded ship. That can best be done when there is no current. The point at which the shift occurs is also an important parameter for models describing the change in salt content during a tide'.

The period of slack water doesn't correspond to the highest and lowest water levels

Businesses, shipping companies and scientists are now only able to estimate when the shift in current will take place. 'Based on models, it is harder to make an accurate prediction of the current than it is to predict water levels. This is because the period of slack water does not correspond to the highest and lowest water levels. In the Westerschelde, it can occur up to an hour later'. Simple GPS devices on buoys that are already in the water can be used to follow the change in current direction as it takes place. The buoys float along with the current. Taking their position as a starting point, it is possible to calculate when the shift will occur. Luxemburg notes that further research is needed on the operationalisation of the method. Time will tell whether a commercial funding source will see any profit in the idea. SB

Simple GPS devices on buoys that are already in the water can be used to follow the change in current direction as it takes place.

Cracks

Oil tankers and floating oil platforms are robust constructions, or so you might think. In fact, they are riddled with cracks and ruptures. Fortunately, they do not often occur in the skin of the tankers, but in the internal structures that ensure their solidity. For his doctoral research in the Ship Hydromechanics and Structures research group (3mE), Menno van der Horst MSc is testing an instrument that can monitor the formation of cracks in metal and send a signal when they reach a critical state. The project is called Crackguard. 'The instrument consists of countless sensors that detect disturbances in the metal's magnetic field,' explains Van der Horst. 'Every five years, ships are inspected for metal fatigue. The idea is to place instruments on top of cracks that are identified during these inspections'. However, the instrument must first undergo extensive testing, which can only be performed on cracks that are growing. Van der Horst is therefore replicating metal fatigue in the laboratory by exposing metal plates to tensile forces for days at a time. 'In two days, I can replicate the 25-year life expectancy of a piece of metal from an oil tanker'. IVD

Boat Bible

After more than 40 years of research on the hulls of sailing yachts in the towing tank at Delft, boat expert Dr Lex Keuning bade farewell to TU Delft in June. His life's work, the Delft Systematic Yacht Hull Series, is online.

Keuning (65) witnessed the start of the series as a student. That was in 1973, when Professor of Marine Hydrodynamics Jelle Gerritsma wanted to start taking comparative measurements of the hulls of sailing yachts. He collaborated with two colleagues from the Massachusetts Institute of Technology, with whom he shared a passion for sailing and sail boats: Professor of Marine Hydrodynamics Nick Newman and Professor of Hydraulic Engineering Justin Kerwin. Their work had two objectives: (1) to create a simple calculation aid with which yacht designers could determine the nautical properties of their designs and (2) to develop a tool for identifying the weaknesses of various boats in sailing races. 'For sailing yachts, it is much more difficult to calculate the expected speed than for motor yachts', explains Keuning (3mE faculty) in his office next to the towing tank. 'There are forces above and below the water that together create a complicated balance. This is difficult to calculate by hand. A programme was needed that could estimate a ship's performance based on its length, breadth, depth and water displacement'.

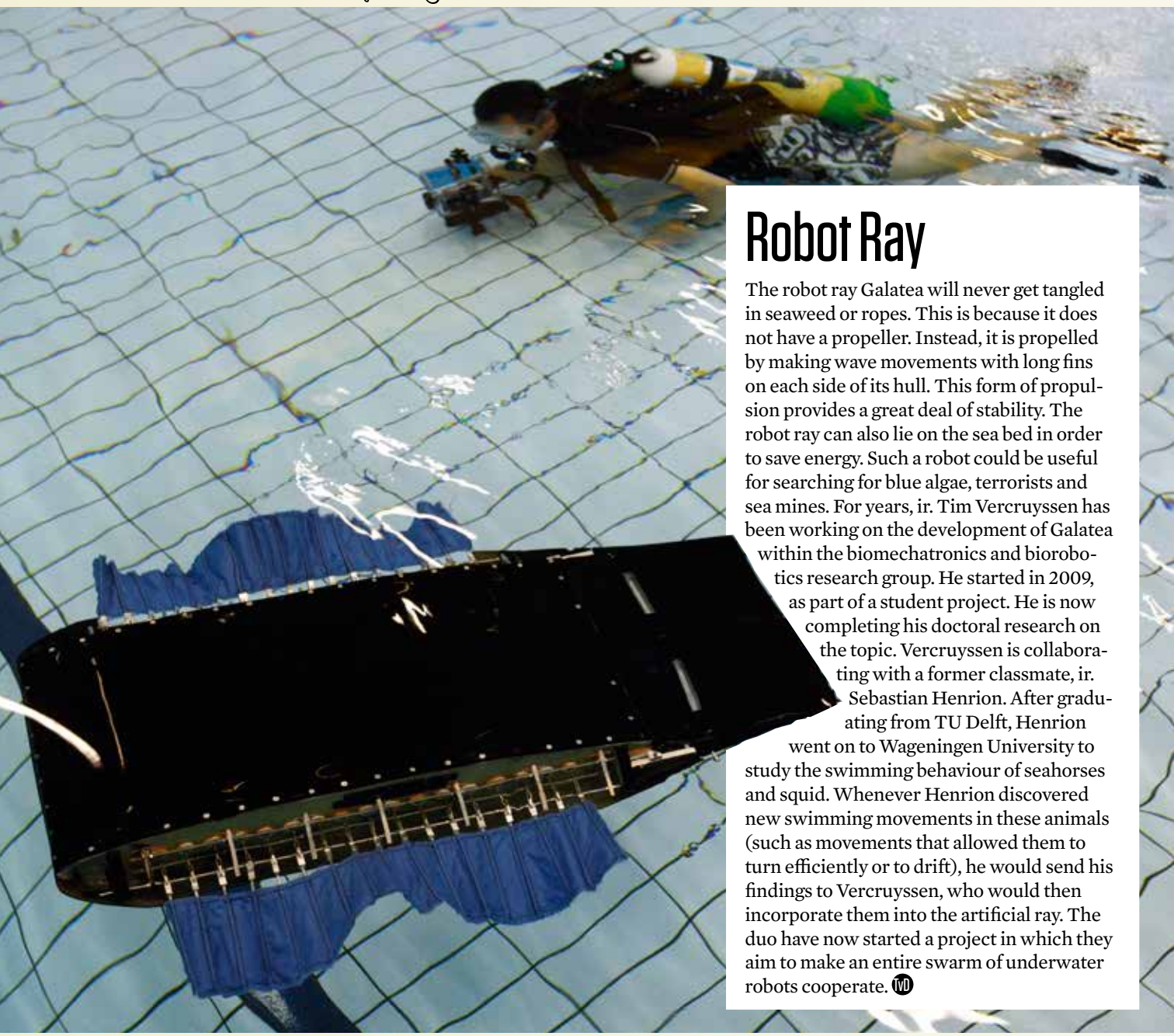
The research had to be systematic. In other words, it required variations on a standard ship. The choice at that time was the 'Standfast 43' by Frans Maas – a 13-metre long sailing yacht – for which a 1:6.25 scale model was made.
Keuning explains how the variations worked: 'From the template of the mother ship, we made three models with slight increases and decreases in the breadth, each of which we then towed. Any differences that we measured would thus be due to the differences in breadth. This could also be done with length, depth and water displacement. It sounds simple, but when you change the breadth, water displacement changes as well. There are many mutual dependencies'. The first systematic series consisted of nine models.

Dr Lex Keuning: 'For sailing yachts, it is much more difficult to calculate the expected speed than for motor yachts'.

The data from TU Delft form the foundation for performance prediction programs (PPPs), which yacht designers use during the design phase. One such designer is yacht builder Gerard Dijkstra, known for the clipper Stad Amsterdam from the VPRO TV programme 'In het kielzog van Darwin' (In the wake of Darwin). 'The nice thing about the systematic series is that you don't have to design based on a towable model', explains Dijkstra. 'You can create your own design according to your experience and your customer's preferences in terms of length, breadth and depth. This forms the yacht's operational profile. With WinDesign (one of the PPPs, ed.), you use this information to iteratively calculate the performance and adjust the design until you reach the best compromise that meets the client's requirements. If you calculate the performance based on the series, you know that the ship will at least sail well'.
Keuning has devoted the last two years to ensuring a smooth hand over of the project to his successor, Jasper den Ouden. Now he will have time to sail with his twin brother and others – not around the world, but to England and the Baltic Sea. That's fine with him.
JW

dsyhs.tudelft.nl

 PHOTO: SAM RENTMEESTER



Robot Ray

The robot ray Galatea will never get tangled in seaweed or ropes. This is because it does not have a propeller. Instead, it is propelled by making wave movements with long fins on each side of its hull. This form of propulsion provides a great deal of stability. The robot ray can also lie on the sea bed in order to save energy. Such a robot could be useful for searching for blue algae, terrorists and sea mines. For years, ir. Tim Vercruyssen has been working on the development of Galatea within the biomechatronics and biorobotics research group. He started in 2009, as part of a student project. He is now completing his doctoral research on the topic. Vercruyssen is collaborating with a former classmate, ir. Sebastian Henrion. After graduating from TU Delft, Henrion went on to Wageningen University to study the swimming behaviour of seahorses and squid. Whenever Henrion discovered new swimming movements in these animals (such as movements that allowed them to turn efficiently or to drift), he would send his findings to Vercruyssen, who would then incorporate them into the artificial ray. The duo have now started a project in which they aim to make an entire swarm of underwater robots cooperate. TVD

Safe landing

Landing a helicopter is difficult enough, not to mention landing one on a ship that is swaying atop the waves. Dr Alrik Hoencamp has developed a computer programme that calculates how well certain types of helicopters can land on marine ships. On 16 March, he defended his doctoral dissertation on this topic in the 3mE faculty. The army can use Hoencamp's programme to evaluate helicopters under various conditions, including wind speed, wind direction and the state of the sea. 'The most important advantage of the testing methodology is that the operator can evaluate safety limits for helicopters on random ships in advance', explains Hoencamp. His technique has been applied successfully since 2012 in the 'helicopter-ship qualification' for the NH90 military helicopter. TVD

Solved

When you pour a spoonful of cocoa powder in a cup of water, it always floats on top. And that's no way to make hot chocolate. In the Chemical Engineering department (TNW), researchers have been investigating how powders dissolve in order to avoid the minor nuisance of excessive stirring. They are also interested in understanding what actually happens.

'Consider instant soup, powdered milk and cocoa powder', explains Dr Ruud van Ommen in his office in the old test factory at TU Delft. Instant coffee and Nesquik have been pre-treated to dissolve easily. In order to improve their understanding of the process, the researchers preferred to start with simpler powders, like starch from potatoes, wheat or corn.

If you watch closely as a scoop of powder gradually dissolves in water, you can distinguish four phases. First, the water must penetrate the powder (which is difficult with cocoa, due to its fat content). The wet powder then sinks into the liquid, after which the powder particles disintegrate into smaller granules, which subsequently dissolve in the liquid. Further investigation into these steps will enhance our understanding of this process, and it could eventually lead to the development of more easily dissolved powders for food or medication.

For example, the first graduate, Merel Oostveen MSc, discovered that when she poured a drop of water onto a layer of starch, the drop was absorbed into the powder ten times faster than predicted by the theory, based on the size and shape of the granules. Microscopic examination of the starch revealed considerable variation in the open space between the powder particles, such that the large pores accelerated the humidification process by a factor of ten. Oostveen published this finding, which led to an invitation to present at a conference in Beijing.

When she heard that the founder of the theory of dissolution would also be in the hall, she began to worry. How would Professor Karen Hapgood from Monash University in Australia react? Van Ommen explained that refuting and refining theories through experimentation is the essence of science. Fortunately, Hapgood held the same view.

Microscopic examination of the starch revealed considerable variation in the open space between the powder particles

The team consisting of Van Ommen, Dr Gabrie Meesters and Dr Sheila Khodadadi expects to supervise several more final-year students on this topic in the future. For example, final-year student Erik Bosma is using laser diffraction to investigate how granules disintegrate while sinking. This method has already proved useful for water soluble substances. He is now trying it with fatty substances, which do not disintegrate as easily. JW

Air lubrication

Ships can save a great deal of energy by sailing on large air bubbles. Some inland waterway vessels have special installations on board that pump air under the hull (see the rubric 'Patent' in Delft Outlook 1-2014). This principle is known as air lubrication. When air bubbles are located exactly at the interface between the hull and the water's surface, ships have no friction resistance. Researchers from TU Delft are hoping to provide more insight into this principle. PhD candidate Gem Rotte MSc of the Ships, Hydromechanics and Structures research group (3mE) will start a research project in September. She will be collaborating with researchers from the University of Twente, using flow software to calculate the effect of air bubbles on ships' total resistance. PhD candidate Florian Charruault MSc of the Fluid Mechanics research group (CiTG) will be focusing on the physics of air leakage at the rear of ships that use air lubrication. IVD

The one millionth Ampelmann

For years, the problem of how to move safely from a ship onto a floating wind turbine appeared to stand in the way of the development of offshore wind farms. However, in 2002, TU Delft alumnus Dr Jan van der Tempel came up with a smart solution. His invention, the Ampelmann, is a platform that corrects for the movement of waves. It is a type of flight simulator atop six cylinders, which can be mounted behind a ship. Measuring devices and control software in the Ampelmann guide the cylinders and ensure that the swaying of the ship does not carry over to the platform. The platform thus remains still. This makes it possible to repair offshore wind turbines, as well as to drop personnel off safely from oil and gas platforms. The Ampelmann is extremely popular and last year, the platform was used for the one millionth time. IVD

View

'The days of flat maps are over; everything is moving to 3D', according to Dr Sisi Zlatanova. She has developed a 3D data infrastructure for the Port of Rotterdam.

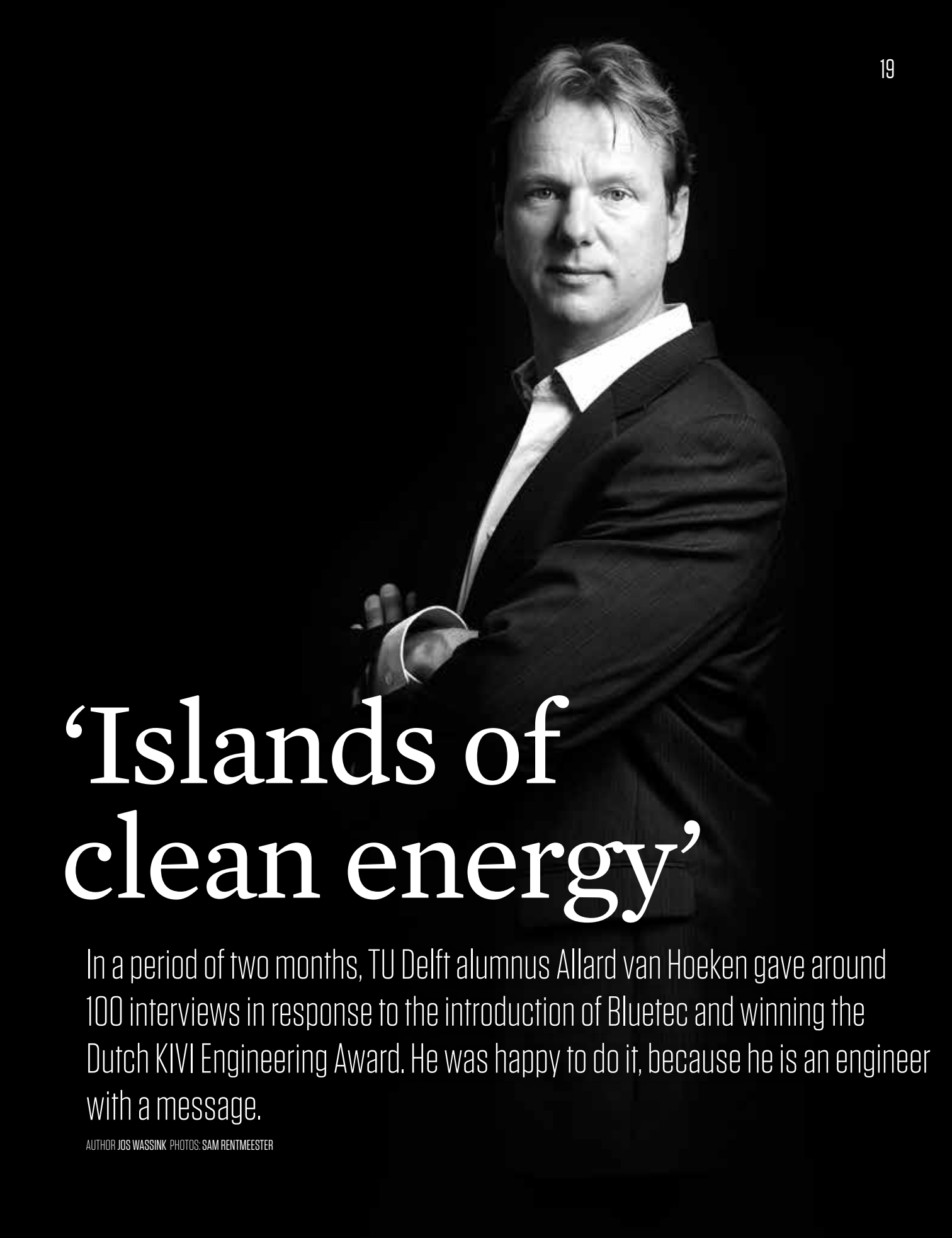
There will obviously always be maps, but in the future, they will be compiled from a personal selection of 3D information. If Sisi Zlatanova has anything to do with it, such 3D geo-information systems (GIS) will show the interior and exterior of buildings, as well as the location of underground cables and pipes. As an associate professor in the GIS technology department of the Faculty of Architecture and the Built Environment, she has spent recent years leading the 3D SDI (Special Data Infrastructures) project that TU Delft has been conducting in collaboration with TU Eindhoven, the City of Rotterdam and the Port of Rotterdam, within the Next Generation Infrastructures project for Maasvlakte 2. The plans call for managing all of the information in 3D. For demonstration purposes, a design firm developed a system in which the wall of a quay was designed as a part of the Maasvlakte. As a special feature, the designers also received spatial information on the surrounding area. This was possible because the Port of Rotterdam made all information about the port (including the underground cables and pipes) available in a 3D database. The design firm delivered a 'Building Information Model (BIM)' containing spatial information about the quay wall that had been designed.

On her laptop, Zlatanova shows how the design of the wall fits into place, as well as where problems are located. Under the wall, the software uses a red symbol to indicate conflicts in several places. Closer examination reveals that ground anchors for the quay wall are cutting into the foundations of the silos to the rear. It is much better to discover this during the design phase than during the construction phase.

The result is refreshingly simple, although it required considerable effort to reach this point. It is not easy to incorporate information from different sources under the same denominator. For example, in the Netherlands, geological information is based on 'tiles' measuring 100 by 100 metres, with a depth of 0.5 metre. This is difficult to relate to above-ground information on streets, houses and canals, which occur at a much smaller scale. Another issue concerns meanings: a property can be identified according to its usage (e.g. parking areas, brownfield sites or industrial areas).

'There are problems with semantics, geometry and resolution', summarises Zlatanova enthusiastically. 'So we have many problems, and we're going to solve them. In the future, all information will be 3D'.

The Port is a pioneer in the use of 3D geo-information. In addition to preventing accidents by making contractors aware of the exact location of existing cables and pipes, the 3D information is playing an important role in the Port' ambition to become the most automated port in the world. Because when we get rolling robots to do the work, they really need to know exactly where they are. JW



‘Islands of clean energy’

In a period of two months, TU Delft alumnus Allard van Hoeken gave around 100 interviews in response to the introduction of Bluetec and winning the Dutch KIVI Engineering Award. He was happy to do it, because he is an engineer with a message.

AUTHOR JOS WASSINK PHOTOS: SAM RENTMEESTER

Last spring, you were in the news because of Bluetec, the floating tidal turbine. How is it coming along?
'It's really taking off. In March, we presented the platform at Damen Ship Repairs in Amsterdam. On 11 May, we witnessed the launch in Den Helder. After years of preparation, the installation will be anchored and start producing energy before the summer. We will be setting more and progressively larger turbines in motion beneath the same platform. Moreover, we are offering the 200-kilowatt version for sale as a ready-to-use product. This is another breakthrough in tidal energy. Isolated turbines are being offered, but no complete systems. The larger turbines are only prototypes.'

This spring, you received the Prins Friso Engineering Award from the KIVI Engineering Society. What kind of impact did this have?
'Although we'll have to wait and see what effect it's going to have this year, the number of interviews has increased dramatically. Because of Bluetec and the Engineering Award, we've had more than 100 publications in a two-month period.'

What do you tell people in these interviews?
'My message is about deploying engineers for clean energy. For secondary-school students, engineering is a rather obscure career choice. People can remember the Delta Works as an engineering feat, but apart from that they come up empty-handed. Then again, everything we see around us was designed by engineers. How can such an important profession remain in the shadows for so long?'

Perhaps they are just too modest.
'Yes, that's a possibility. They don't seek attention, but I think that positive attention for the profession is a good thing. Without it, we'll never get young people excited about engineering, because they are not even aware it exists.'

Now you're a leader in your profession. What will you do to get this attention?
'My research priority is clean energy, because it offers an excellent opportunity for the profession to do something good for the community. Our current system of generating energy is hopelessly outdated. We're still doing the same things we were doing more than a century ago: burning coal, oil and gas. Our technology has advanced quite a bit beyond that. One hour of solar radiation is enough to provide the entire planet with a year's worth of energy. Other sources of energy include wind and tidal power. New energy is clean, local and never runs out. That last feature is the best of all. Engineers can make clean energy feasible, both technically and economically.'

And what about climate change?
'I do use the word 'clean': clean, local and inexhaustible. Clean isn't about CO_2 emissions only. It also refers to air quality and water quality.'

With regard to feasibility, we're now being told oil and gas prices are so low that clean energy has become too expensive by comparison.
'First of all, these low oil prices are only temporary and notoriously hard to predict. The fact is that there will be less and less of it, while clean energy is inexhaustible. According to the newspapers, the United States has granted permission to Shell to start drilling in the North Pole region. It's not cheap to work there. The very fact that people want to do it anyway is a sign that inexpensive sources are being exhausted. I also have another answer: if you want to make clean, non-polluting sources compete with dirty energy sources, you need to assess them in the same way.'

Do you mean that no charge for environmental impact is included in the consumption of fossil fuels?
'Yes, for example. There have been attempts to adopt emission rights that could be traded, but they've not been successful. What I mean is that it doesn't make sense to require clean energy to be less expensive than polluting energy. At home, it's also cheaper to throw your rubbish in the back yard than to have it disposed of. Alternatively, you might include clean-up costs in the price of polluting energy sources, or ensure that there are no emissions at all. That would make clean energy less expensive: there's nothing to clean up because there were never any emissions in the first place. In my opinion, a healthy society should be willing to invest more in clean forms of energy than in polluting energy.'

The jury report for the Engineering Award hails you as 'a source of inspiration for sustainable energy in a conservative world.' This is because Bluewater primarily serves the oil and gas industry, and you are trying to achieve sustainability within this company. How are you doing this?
'It's a lot of fun and very challenging. It's simply

CV

Allard van Hoeken (1969, Groningen) graduated from TU Delft in 1994 with a degree in mechanical engineering. After a brief stint at Heerema, he worked for the offshore company Bluewater between 1995 and 1999. In 2000, he completed his MBA in France. Between 2001 and 2004, he ran his own market research company in Barcelona, but he missed the offshore work. For this reason, he returned to Bluewater in 2004, with the idea of developing new energy technologies. Between 2005 and 2009, he worked for Bluewater in Houston. In 2010, he returned to the Netherlands to develop tidal energy with the Bluetec floating generator. This spring, KIVI presented him with the Engineering Award. Van Hoeken was married in June, and he has a daughter.

a matter of persistence and perseverance. In my previous job at Bluewater, I was responsible for Latin-America. There, I learned about the three P's: paciencia, persistencia and perseverencia (patience, persistence and perseverance). These traits are indispensable. I'm not opposed to fossil fuels - I use them just like anyone else. Nevertheless, I would like to see us use only a small portion of this type of fuel to develop something that will eventually be inexhaustible. That's what I'm doing at Bluewater.'

Did it take a long time to achieve recognition for that?
'Not really. In 2005, I suggested doing something with wave energy, floating wind turbines and tidal energy. When I was in Houston, one employee was playing around with the idea. He believed that the tidal turbine would be the most promising option. In 2009, they invited me back to set it up. I found that a corporate restructuring was underway because several customers had been lost due to the crisis. Bluewater had to make budget cuts, and my renewable energy group was at the top of the list. At that time, I had to engage in intensive discussions with consultants and banks to keep my promising little group on board. It was a difficult period.'

Even though it could be argued that clean energy is the most promising route to growth?
'That is absolutely true, but if bankers only want to see their loans repaid, they will care little about the distant future. That's the way things are.'

Did your MBA help you in these discussions?
'Without my MBA, I wouldn't have been able to carry on those discussions. They asked for discounted cash flow and details on future implications. I was able to use models to show them the potential. I wouldn't have been able to do this without my MBA.'

What made you decide to take this degree programme?
'That had always been my idea. I'm a commercially oriented person. At TU Delft, I was keenly interested in technology, but I lacked the financial-economic knowledge required. I wanted to master that as well. On the advice of my thesis supervisor in Norway, I started in technology – first at Heerema and then at Bluewater. After four years, I started the MBA programme at Insead in France.'

Would you recommend engineers to pursue an MBA?
'Yes. Absolutely. I really liked the dynamics of the programme. It wasn't just the knowledge, but also the people you met there: a lot of consultants, bankers and lawyers - and each of them brings a different perspective.'

'My research priority is clean energy, because it offers an excellent opportunity for our profession to do something good for the community'

Did the results meet your expectations?
'Yes. Absolutely. At Bluetec, we bring technology and sales under the same umbrella. I'm comfortable with that, because now I can take on the challenge. I know about finance, marketing, market knowledge and market data interpretation. I'm not sure if I would have felt so comfortable without an MBA. With any new development, it's essential to stay in touch with both market contacts and technological developments. If you separate them, sales and technology will take on lives of their own, and then you're bound to fall behind in the market.'

Based on your age, you're about halfway through your career. What are your plans for the latter half?
'I want to stay committed to clean energy. Right now, I hope to make tidal energy a technological and economic success. My dream is to expand it to include storage. Because tides are predictable, you don't need much storage. I could use this to help small, remote Pacific islands with their energy supply, like those of Indonesia and the Philippines. My speciality is ocean energy, supplemented by storage and solar and wind energy to create a clean-energy portfolio for those regions. As a sailor, I've visited these places. And then you hear the generator start up at six in the morning, even though they have an abundance of sunlight, and often waves and currents as well. It seems to me that this would be a fantastic place to start. And if it works on an island, it could be applied in a village too.' <<

HORA EST

The two most important days in the lives of doctoral candidates are the days on which they start their research and the days on which they find out exactly why they started their doctoral research.

Zhang Li, expert in image analysis

'I was inspired by a statement made by Mark Twain: "The two most important days in your life are the day you are born and the day you find out why". When I came to the Netherlands from China in order to do my doctoral research, I embarked upon a four-year adventure, a new life. I had to leave my family, my girlfriend (who is now fortunately my wife), my dog and my friends behind. I wanted to solve complicated problems and publish. That was my reason for doing doctoral research, at least that's what I thought. I spent thousands of hours in the laboratory, but things just weren't happening; I was rejected by leading journals. Suddenly, it dawned on me that my reason for doing research is curiosity. From that point on, this became my guide. And it worked; I have published, and I will soon be defending my dissertation'.

Climate deniers are to climate science what creationists are to biology.

Wouter Edeling, aerospace engineer

Interest is the best motivation.

Changlin Chen, computer scientist

The use of moral dilemmas in engineering ethics education evokes the perception among students that ethics is ineffectual for engineering practice.

Johannes Franciscus Jacobs, biochemical engineer

On balance patent rights nowadays have an inhibitory effect on innovation and economic growth.

Cornelis van Dorsser, civil engineer

The argument that motorcycles do not, or hardly, contribute to congestion is false.

Wouter Schakel, transport engineer

It is easier for robots to communicate with each other than for humans

Changyun Wei, computer scientist

What makes an engineer outstanding is not his (her) knowledge but his (her) design intuition, experience and soft skills.

Yi Wang, electrical engineer

Answering the question of who is to blame, does not solve the problem.

Paul van Drunen, biomechanical engineer

ILLUSTRATION: AUKE HERREMA

After Delft

How does a civil engineer become editor-in-chief of the feminist magazine *Opzij*? This question is often posed to Irene de Bel (37). The groundwork for her remarkable career shift was laid during her university days.

One factor that undoubtedly played a role in this shift is the fact that Irene de Bel comes from a 'female home'. After her divorce, De Bel's mother raised her three daughters by herself, with the most important lesson being how to become financially independent. Despite high marks in science subjects and a father who had studied mining, De Bel wasn't sure she was ready for TU Delft. 'My mother told me, 'if you can't do it, nobody can'. I thought there would only be people with thick glasses at the university, and that I would not find any fun friends.'

Although she chose to study industrial design, 'playing with clay under the table and creating weird shapes' simply proved too woolly for her taste. Just not enough technology. She changed to civil engineering and graduated with a project on vertical drainage in the catchment of the Aral Sea in Uzbekistan. She worked there for Royal HaskoningDHV for a while, but working abroad did little to help her relationship.

She started working for an engineering firm in Amsterdam, conducting research for municipalities, water boards and provinces. 'Definitely not the place for me. Those senior officials adding awkwardly phrased sentences to my reports
really ticked me off.' No, if she could do it all over again, she would become a journalist.

Wondering how she should approach this, she called Simon Rozendaal, a scientific journalist for the news weekly Elsevier. 'He was on the editorial staff forTU Delft university magazine *Delta*.' De Bel started a course in journalism. 'It was great: learning a new profession in familiar territory.'

'I thought there would only be people with thick glasses at TU Delft'

After nearly six months with Delta, she started working for the magazine *Cobouw*, writing about national topics in the construction industry. When newspaper *de Volkskrant* and telecommunications company KPN started the free newspaper *DAG*, she was selected out of 1500 applicants.

'I'm certain that my degree programme at TU Delft helped. In a sense it's a certificate of intelligence.'

In the wake of the demise of *DAG*, the editor-in-chief of *Cobouw* called her to ask if she would be interested in creating a new magazine for architects, property developers and contractors. For the first time, she was making a monthly magazine, and she became the editor-in-chief. Several years later, *New Scientist* asked her to publish a Dutch-language version of the science magazine. She merged NWT Magazine into the effort, departing three years later to join its neighbours in the same building: *Opzij*. 'In this magazine, I want to highlight the qualities of women, rather than their struggles. To me as a reader, this is essential.'

The future of nuclear energy

Cheap electricity, no plutonium and no meltdowns. This is what the thorium molten salt reactor is promising. TU Delft has been given a grant to research this almost utopian reactor.

AUTHOR: TOMAS VAN DIJK PHOTO: OAK RIDGE NATIONAL LABORATORIUM

'Just tell me: what do we have to do to convince people that this is a different type of nuclear energy, that this technology has a real future? Whenever I mention nuclear energy in Parliament, people immediately think of Fukushima.'

This plea came from the floor during a symposium on thorium molten salt reactors on 17 April. It came from André Bosman, MP for the VVD and advocate of the thorium reactor. So how can you generate enthusiasm for nuclear energy among politicians and voters in the wake of the Fukushima nuclear disaster?

'Your task is much more difficult than mine as a researcher', replied American Kirk Sorensen from the stage. Sorensen has a healthy sense of irony and is one of the keenest supporters of thorium reactors. In 2005, when working for NASA, he came up with the idea of designing an energy plant for the moon. He decided that a thorium-based reactor would be the best option. But, he thought, this type of reactor is also perfect for Earth. The American hopes that his own start-up company, Flibe Energy, will be the first to bring these reactors onto the market. But he will have to work fast. During the symposium, Canadian Dave Leblanc explained that his company, Terrestrial Energy, hoped to have a fully operational reactor by 2024. And then there's Leslie Dewan, the 29-year-old alumnus from Massachusetts Institute of Technology, who launched the company Transatomic Power four years ago and acquired several million in funding from investers to build a thorium reactor.

Pioneers

Startups that think uranium is a thing of the past are springing up like mushrooms, particularly in the United States, Canada, England, Scandinavia and Germany. In their eyes, thorium is the future. A handful of these pioneers unveiled their plans at the symposium.

Researchers from Delft were among those who took the stage. Last month, it was announced that scientists from TU Delft will be heading a European thorium research project worth €3.5 million. The partners include research institutes from Germany, France, Italy and Switzerland – among others.

Like the start-up companies mentioned above, this European project will focus specifically on the thorium molten salt reactor or MSR. In this type of reactor, the fuel (thorium) is dissolved in molten salt of lithium fluoride or beryllium fluoride, which also serves as a coolant. The pressure inside the reactor is low, making the risk of explosion negligible. If a leak occurs, the fuel flows out of the reactor along with the coolant and the reactions inside the reactor cease. The salt solution clots and all the radioactive material is trapped in the salt. At least that's the theory.

Grand dream

Dr Jan Leen Kloosterman from the Reactor Institute Delft initiated the project and organised the symposium. He is keen to add to his list of advantages of the Thorium MSR.

>>

Molten salt reactor technology is nothing new. Its inventor, Alvin Weinberg, had a working MSR at the Oak Ridge National Laboratory in the United States from 1965 to 1969.

'Thorium is an extremely common natural resource on Earth. It is four times more plentiful than uranium. What's more, we only use one percent of the uranium found on Earth. So a thorium reactor can generate hundreds of times more energy from thorium than we currently generate from uranium. There are beaches in India where a kilo of sand contains fifty grams of thorium. This will generate as much electricity as 100,000 litres of petrol. My grand dream is to extract this energy from thorium.'

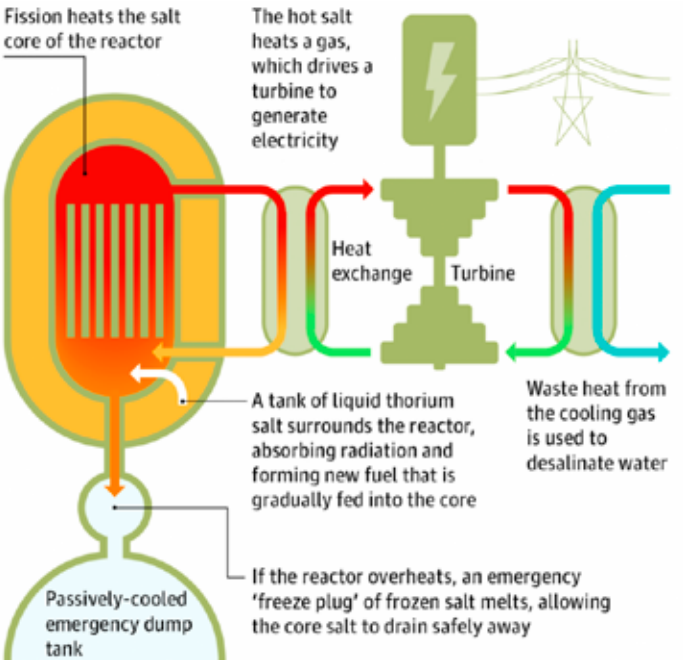
'But the best part is that a thorium MSR does not produce long-lived radioactive waste – and no plutonium. It is also an efficient way of clearing existing waste out of nuclear energy plants and nuclear weapons and transforming it into energy.' (see box)

Molten salt reactor technology is nothing new. Its inventor, Alvin Weinberg, had a working MSR at the Oak Ridge National Laboratory in the United States from 1965 to 1969. Although the Weinberg reactor seemed to be a promising development, the project was stopped. One of the explanations given was that countries needed nuclear reactors that ran on uranium to produce the huge amounts of plutonium required to make nuclear bombs.

Lifespan

So although the thorium reactor is a development an earlier invention, a huge amount of research is still needed. Too little is known about the lifespan of the materials used in the reactor, for example. And the chemistry of the salt must be scrutinised more closely. Prof. Jilt Sietsma (3mE), materials researcher and speaker at the symposium, was crystal clear about the extent of the research remit. 'Just look at this devastation', he said, pointing to a photo of a pockmarked metal sheet made from a nickel alloy. Nickel is one of the materials that may well be used for the pipe network in the reactor. 'It has been totally blitzed by radioactive radiation.'

Thorium reactor



A huge amount of research is still needed. Too little is known about the lifespan of the materials used in the reactor, for example

According to the materials researcher, the inside of a thorium MSR is about as dangerous as it gets in this respect. 'The material is subjected to very high temperatures. The salt is 700 degrees Celsius, which is half the melting temperature for nickel. The lithium fluoride causes corrosion and then there's the continual bombardment from radioactive particles. It would be difficult to imagine worse conditions.'

Having said this, Sietsma is by no means sceptical about thorium. 'I think we'll be able to solve the material problems as long as we do enough research.' To Sietsma's mind, the thorium reactor could bridge the gap between sustainable and fossil energy. 'Solar panels and wind turbines are great, but progress in these fields is too slow. And the other alternative, nuclear fusion, is still too far away.'

A billion euros

Sietsma and several colleagues from TU Delft went to the Energy Committee of the Dutch House of Representatives a few days before the symposium to promote thorium research. The few million euros being offered by the European Union is merely a drop in the ocean, according to the scientists from Delft. 'We need a billion euros over a period of 20 years,' says Sietsma. As yet, only Asia is seriously investing in MSR technology, say the researchers. China started a research programme involving hundreds of researchers a few years ago. In 2012, Kloosterman told Delta: 'The next generation of thorium reactors will come from China unless Europe really gets a move on.'

What's the difference?

In existing light water reactors (LWR), the nuclear fuel consists of uranium-dioxide tablets enclosed in an elongated, gas-proof metal casing made of zirconium alloy. These fuel rods are bundled into nuclear fuel elements, several hundred of which together form the reactor core.
The waste products from nuclear fission are radioactive and generate heat, even when the nuclear fuel reaction is halted. If this decay heat is not removed – for example, in the event of significant damage to the cooling system after an earthquake, as was the case at Fukushima – the fuel rods can overheat. Ultimately, the fuel rods themselves can melt, which releases radioactive substances.
In addition, this type of reactor only uses one percent of the available uranium and irradiating the non-fissile type of uranium in the nuclear fuel elements produces dangerous plutonium. Although this plutonium can certainly be recycled, full recycling requires a new type of nuclear plant (a sodium-cooled fast breeder reactor), which does not yet exist. If it is developed, it will carry a small risk of a major incident.
The molten salt reactor does not have these problems. Since the fuel is dissolved in molten salt, there is no temperature difference between fuel and cooling. The nuclear reaction stops automatically if the temperature becomes too high. There is therefore no danger of over-heating, volatile nitrogen cannot be formed and no meltdown can occur.
However, the Delft researchers think that the best thing about the MSR is that all the fuel undergoes fission and is converted into electricity. This is not only true of thorium, but also of the hazardous nuclear waste that has already been produced. This can be gradually fired in the reactor.
The remaining nuclear products will have lost practically all their radioactivity within 300 years, which simplifies the geological storage process. And last but not least, the residual waste would be unsuitable for producing nuclear weapons.

The behaviour of fluoride salt is another major point of concern within the European project. The initiator of this line of research is Prof. Rudy Konings, professor of nuclear fuel cycle chemistry (Applied Sciences), who also works for the Institute for Transuranium Elements in Karlsruhe. He explained that an experiment involving irradiating fluoride salt is due to take place at the NRG High Flux Reactor in Petten later this year.
Konings hopes to discover whether the theory that radioactive material (including caesium and iodine) becomes trapped in the salt in the event of a leak is really true.

Opponents

Although a number of people voiced reservations during the symposium, most people seemed to embrace the general concept of the thorium molten salt reactor. It was largely preaching to the converted, but there are still plenty of fervent opponents in the world.
One of them is Arjun Makhijani, chair of the Institute for Energy and Environmental Research, an American think-tank and lobby club opposed to nuclear energy. Makhijani disputes the notion that thorium reactors are safe from a terrorism point of view because they do not produce plutonium. According to him, the reactors produce a substance that is much more dangerous than plutonium: uranium-233.
A thorium MSR is fuelled by thorium. As this element is non-fissile, it must first undergo a neutron bombardment in the reactor to turn it into fissile uranium-233. A terrorist or rogue state could have a field day simply by draining salt from the reactor and extracting the uranium-233. It is even easier to develop dirty bombs with uranium-233 than plutonium, argues Makhijani on his website.
This actually increases the risk, he says, because draining the salt will be a standard procedure with MSR reactors. The salt needs to be cleansed in order to keep the nuclear reaction going. Small amounts of the salt mixture flow through a processing tank to remove nuclear fuels and other unwanted by-products.
According to Jan Leen Kloosterman, extraction of uranium-233 does not pose a huge threat. Or maybe it does, depending on your point of view. He believes that we shouldn't be too concerned about bombs. 'The salt mixture does also contain uranium-232, which is a highly dangerous substance. It emits enormous doses of gamma radiation, which would very quickly do away with the terrorists.' <<

R PATENT

Exoskeleton for stroke patients

Inventor:
Ir. Johannes Luijten

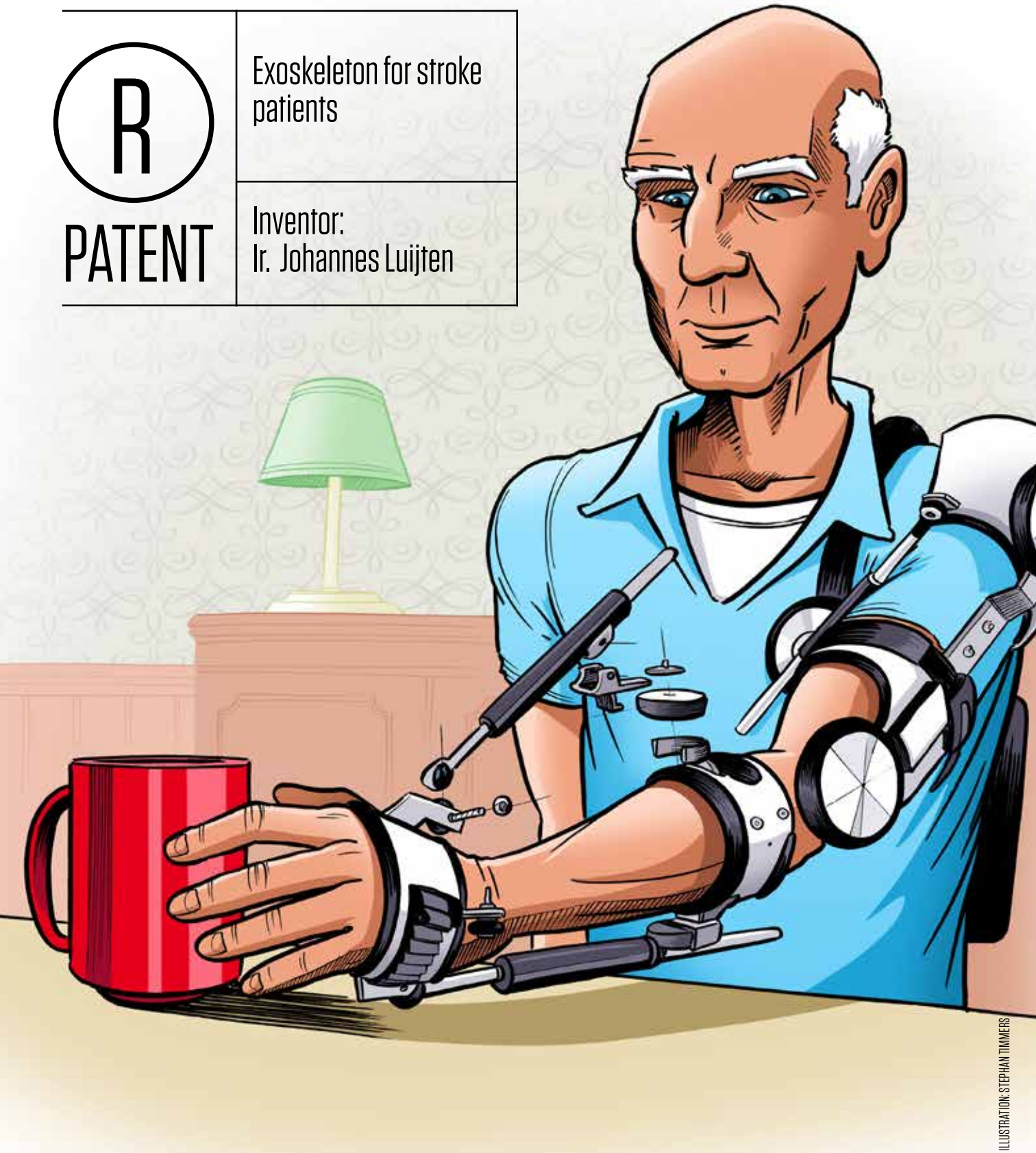


ILLUSTRATION: STEPHAN TIMMERS

Of the 44,000 people suffering a stroke in the Netherlands each year, 70% are left with permanent unilateral paralysis of the arm. Some will go to a clinic for rehabilitation, while others will make daily visits to an outpatient treatment centre. For his graduation project in the cyber-physical systems research group (Faculty of Industrial Design Engineering), Johannes Luijten designed an exoskeleton that enables patients to do exercises on their own. Built-in software allows the physical therapist to change the settings by simply demonstrating the correct movements to the exoskeleton. Seven small motors – 'actuators' – are distributed across the shoulder. They support the patient's movements. This makes it possible for the shoulder, one of the body's most complex joints, to rotate almost completely. The movements stimulate the brain, helping patients to learn how to use their arms again. Luijten's design is modular. The arm can be removed to train just the elbow, wrist or hand. Together with Luijten, TU Delft student Gijs den Butter set up the company Adjuvo Motion. They expect to complete their second prototype by September. They are now looking for development and distribution partners, as well as investors. In 2019, they hope to bring the exoskeleton to the market for rehabilitation clinics and, later, for individual patients. The design focuses on rehabilitation. In the future, it may also be used to assist with daily tasks. 'It will be important to reduce the weight. The total weight of the first prototype was 12 kilograms, while the arm itself weighed 1.5 kilograms. The next prototype will be much lighter,' Luijten promises. Adjuvo Motion received a grant from the STW Technology Foundation and is finalist in the startup competition of New Venture. SB

Bureaucrats and fools

Forget about subsidence, rising sea levels and flash flooding. An even greater danger is now threatening the dikes in the Netherlands: Dutch Celebrities. Four of them recently voiced their dissent against the work being done on the Markermeer Dike in Noord-Holland. This primary flood defence protects 1.2 million people in the Netherlands from getting their feet wet feet, or worse. Since 2006, however, almost 50 kilometres of the dike have been officially declared unsafe. More than half of this length (33 km) must be strengthened before 2021. The plans are not yet definitive. Still it is very likely that the 800-year-old barrier will be undergoing major work.
Weak peat soil, listed villages and Natura 2000 are not making the job any easier. Another challenge of a perhaps even greater magnitude is overcoming opposition against the procedure. Project leader Fons Elders, Professor Emeritus in philosophy, found four residents of the dike area who are willing to lend a mediagenic face to his endeavour: astronaut André Kuipers, actress Katja Schuurman, actor Michiel Huisman and the charming professional blowhard Jort Kelder.
Schuurman and Huisman are easily brought to tears: wearing a gaze that would be perfect for a fund-raising spot for three-legged puppies with cataracts, they plead to leave the dike alone: 'Once we tear it down, the dike will be destroyed irreparably.' Kelder and Elders like to play on people's sentiments. Kelder refers to the planners as 'a bunch of bureaucrats'. Elders censures their approach: residents are being 'misled and cheated' with 'fallacies' and 'half truths that add up to lies'. Kuipers adds a bit of scientific flavour to the effort. He has studied the TU Delft satellite images. They allegedly prove that the dike is extremely stable. According to Kuipers, the data on which the plans are based – and thus the plans themselves – are outdated. He argues that other solutions are much better, smarter and less expensive.
Moreover, he considers the thousand-year storm scenario against which the dike must legally be calculated is highly improbable and a gross exaggeration: 'No scenario can eliminate every single risk. A rock might fall out of space.'
In summary, for anyone wishing to start an opposition group: deny the problem, reject solutions as old hat and demand 'new' technology that is much less expensive and that – presto – has no disadvantages. Don't forget to discredit your opponents. Argue that engineers keep resorting to old, expensive and outdated technology, even though new, inexpensive options are there for the taking. This will implicitly disqualify them as a bunch of fools. God help us if the debate on dike safety gets hijacked by celebrities – whom I seriously would expect to see in the telephone panel for a television fund-raiser 'Help Noord-Holland' if, as a result of their lobbying efforts, the dike is not strengthened and eventually succumbs in a most picturesque manner. So let's kneel down and thank our Lord for graciously giving us these 'bureaucrats' and 'fools' as well.

Ir. Remco de Boer is a technology & science communication specialist

In the pit

A capital of €60 billion in sewer drains lies buried in the Netherlands. These drains must gradually be replaced, but where to start? New inspection techniques may provide the answer.

AUTHOR JOS WASSINK PHOTOS MARCEL KRIJGER

Nikola Stanić is convinced that the laser has the potential to become the new standard in sewer inspection.

Almost 100,000 kilometres of pipes buried under the streets of the Netherlands carry dirty water from households and rainwater from street drains to waste water treatment plants. The self-evident presence of this system is fairly recent. Until the 1930s, most people in the Netherlands still relieved themselves in buckets. City canals served as open sewers, which remained the case for houseboats in Amsterdam until 2013.

A sewer is likely to go unnoticed until it stops working – when the toilet overflows, or when the streets are flooded after heavy rainfall.

One of the topics addressed in the TISCA (Technological Innovation for Measuring the Strength and Condition of Wastewater Drains) sewage research programme, for which the STW doubled the allocation last spring to reach an amount of €1.5 million, focuses on the replacement of sewage systems. How is this done? Municipalities are responsible for sewer maintenance. They contract with sewer-service companies, who bring in a high-pressure sprayer and a moving camera to flush out and inspect the sewers. The company submits an inspection report to the municipality, in accordance with European standards. Damage, cracks, in-growth and residues are coded and graded (with 5 representing the highest level of contamination). The municipality uses this information to identify the most urgent problems. Unfortunately, blockage and collapse occur regularly (12 repairs per 100 kilometres), despite reassuring video inspections.

The human factor is part of the problem. In a comparative study of different inspectors, Dr ir. Jojanneke Dirksen (Waternet) showed there is confusion about cracks and fractures, as well as with regard to distinguishing between residue and sand washed into the system. Moreover, the inspectors often overlooked certain details (e.g. mechanical damage or protruding washers). Dirksen concluded that the coding system should be simplified considerably in order to produce unequivocal reports.

Laser scanner

In addition, video inspection has several inherent deficiencies, as explained by doctoral candidate ir. Nikola Stanić. Video images tell us little about pipe thickness or about the surrounding soil package. Moreover, information on the damage location is not specific (with a one-metre margin of error), as the video carriage is capable of little more than wiggling back and forth on the round base of the pipe.

‘Concrete sewer pipes become thinner over time’

Now, laser scanners offer a promising alternative. Stanić has worked in the laboratory on a prototype of a laser scanner assembled from a common video tractor with a protruding rod. A laser ray that is deflected by a rotating mirror on the end of the rod rapidly scans the interior of the sewer pipe. A lot of information can be derived from the position of the light circle - much more than is possible with a regular video image. One key measurement is the diameter of the pipe, which serves as a measure of thickness.

‘Concrete sewer pipes become thinner over time,’ explains Stanić. The bacteria inside excrements produce sulphur dioxide. In a watery environment, it forms an acid that dissolves the calcium in the pipe. The cement becomes brittle and, in some places, may be washed away when a cleaning water jet is forced through the pipe. ‘You can hear the pebbles that came loose when they are suctioning out the water,’ says Stanić. The pipe diameter can be used to determine the thickness that the pipe wall has lost. ‘Once it reaches 15–20 millimetres (of the total wall thickness of about 60 mm), there is a substantial loss of thickness, and thus of strength,’ Stanić comments.

>>

Sewer research for dummies

TISCA
stands for (in Dutch) Technological Innovation for Measuring the Strength and Condition of Waste Water Drains

95,000 km
Length of the sewer network in the Netherlands not including pressure lines

€ 60 billion
Capital invested

€ 1,5 billion
Maintenance costs per year

3 million
Scope of the TISCA research programme

75 km
per year renovated (new inner lining)

12/100 km
Number of repairs in 2012

0,7 %
(650 kilometres per year)
Number of kilometres replaced in 2012

Number of doctoral candidates **10** in the past **20** years, **10** currently active doctoral candidates and **9** others in TISCA

Increasing pressure

In a laboratory at TU Eindhoven, he conducted strength measurements on old concrete sewer pipes from The Hague and Breda. He measured the diameter with the laser scanner, took core samples from around the pipe to test the strength of the material and compressed the pipe (from above and bilaterally) until the first cracks appeared. This occurred at a pressure of 20 tons. Stanić increased the pressure to find out when the pipe would collapse. The pressure was increased to 30 tons, until large, cracking fractures appeared and the test leader called out, 'Stop, stop!' fearing that the compression-test machine would fail.

The idea is to use a combination of geometry, material properties (derived from the core samples) and mechanical strain to develop a mathematical model of the sewer pipe. This model is expected to identify those factors that have the greatest impact on the strength and life expectancy of a pipe: internal environment, remaining wall thickness or, perhaps, external forces. Moreover, the strain to which sewer pipes are exposed in the sandy conditions of The Hague differs from that in the sagging subsoil of Amsterdam or Rotterdam.

> A mathematical model is expected to identify those factors that have the greatest impact on the strength and life expectancy of a pipe

Although the laser scanner will not be able to address all the problems related to the ageing of sewer pipes, Stanić is convinced that the laser has the potential to become the new standard in sewer inspection, given the wealth of information produced by laser inspection. In addition to diameter, the system measures the coarseness of the pipe (with a resolution of 1 mm). Sludge and waste are localised precisely, and the depth of cracks and damages is recorded with great accuracy, as are their locations. This high degree of accuracy in localization is made possible by using the three-dimensional position of the video tractor to correct the images.

According to Stanić, the next step will involve developing a robust prototype video scanner and testing it in a sewer, but that will be after he has received his PhD. <<

Invitation to innovation

'Sometimes, you have to lose something to become aware of its value,' concludes the head of the research project, Dr ir. Jeroen Langeveld (CEG and research consultancy firm Urban Water). It was not until the sewer and urban water chair was facing elimination from the healthcare technology research group (Department of Water Management in the CEG faculty) that the industry came into action. The RIONED Foundation, the umbrella organisation for urban water management, raised funding to support the chair with a research programme (Prof. ir. François Clemens). In 2010, this resulted in the Urban Drainage knowledge programme, for which Jeroen Langeveld (associate professor at Clemens) is the head of the research project. When the first PhD candidates submitted their dissertations, Langeveld took the initiative to launch a supplementary programme entitled TISCA (Technological Innovation for Measuring the Strength and Condition of Waste water Drains). Last spring, the STW allocated €3 million to fund this programme for the next four years.

'Video inspection is the current market standard, and the pricing pressure is making it difficult to develop anything new, even though it is sorely needed,' says Langeveld. 'The research programme aims to break this deadlock by developing new technologies that will allow us to take sewer inspections to the next level.'

Laser, acoustic, optical, radar - many technologies have the potential to predict sewer-pipe failure better than the current video inspection methods.

'Now it's up to the universities to present technologies that they would like to investigate further,' explains RIONED director Hugo Gastkemper on the telephone. 'The ultimate aim of this STW programme is to develop a broader range of inspection tools.'

If this succeeds, Langeveld also believes that the technology may have export value: 'The entire EU is facing the same challenge: making the most efficient use of an outdated infrastructure. Everyone is currently using video inspection, but it is clearly inadequate.'

THE FIRM

Automated container terminals can process greater volumes, in addition to causing less damage to machines and containers, while being quieter, emission-free and safer for personnel. The TBA company, owned by TU Delft alumnus Yvo Saanen, will supply the operating software.

'The port industry is conservative.' Sitting in his office in Delft, Yvo Saanen knows this from experience. His company, TBA, supplies simulation and operating software to automated container terminals in ports including Rotterdam, Los Angeles and New York.

Business is thriving, and more and more terminals are seeing the advantages of automation, but there is still much ground to be gained. This is hardly surprising. 'Many leading positions are now held by former dockworkers. These are people who once hauled, manned cranes or captained a ship. They have less affinity with technology and computers.' Change is in the air, however, and TBA is moving with the times. 'More and more highly educated people are entering the ranks of management. This is an irreversible trend.'

These people are more inclined to see the advantages of automation, in terms of efficiency, sustainability and lower wage costs, not to mention safety. 'Worldwide, each year there are hundreds of casualties in container terminals, most of them run over by lorries. Remove your employees from the shop floor and the risks will be reduced dramatically.'

Saanen established his company TBA in 1996, together with classmate Klaas Pieter van Til. They started with logistics consultancy. 'We visited ministries and a number of stakeholders in the Port of Rotterdam. This led to a wide range of small projects. We'd take on anything.'

PHOTO: SAM RENTMEESTER

The two alumni got support from TU Delft with finding assignments: 'contract funding research they couldn't handle.' 'This was how we got involved in simulation. Mechanical Engineering professor Joan Rijsenbrij used to work for the German company Gottwald, which supplied automated guided vehicles for Maasvlakte. Gottwald needed simulation software and noticed this was something I was good at. That's how things got started with the port. We began developing a library of simulation models. It became the basis for much of our work worldwide.'

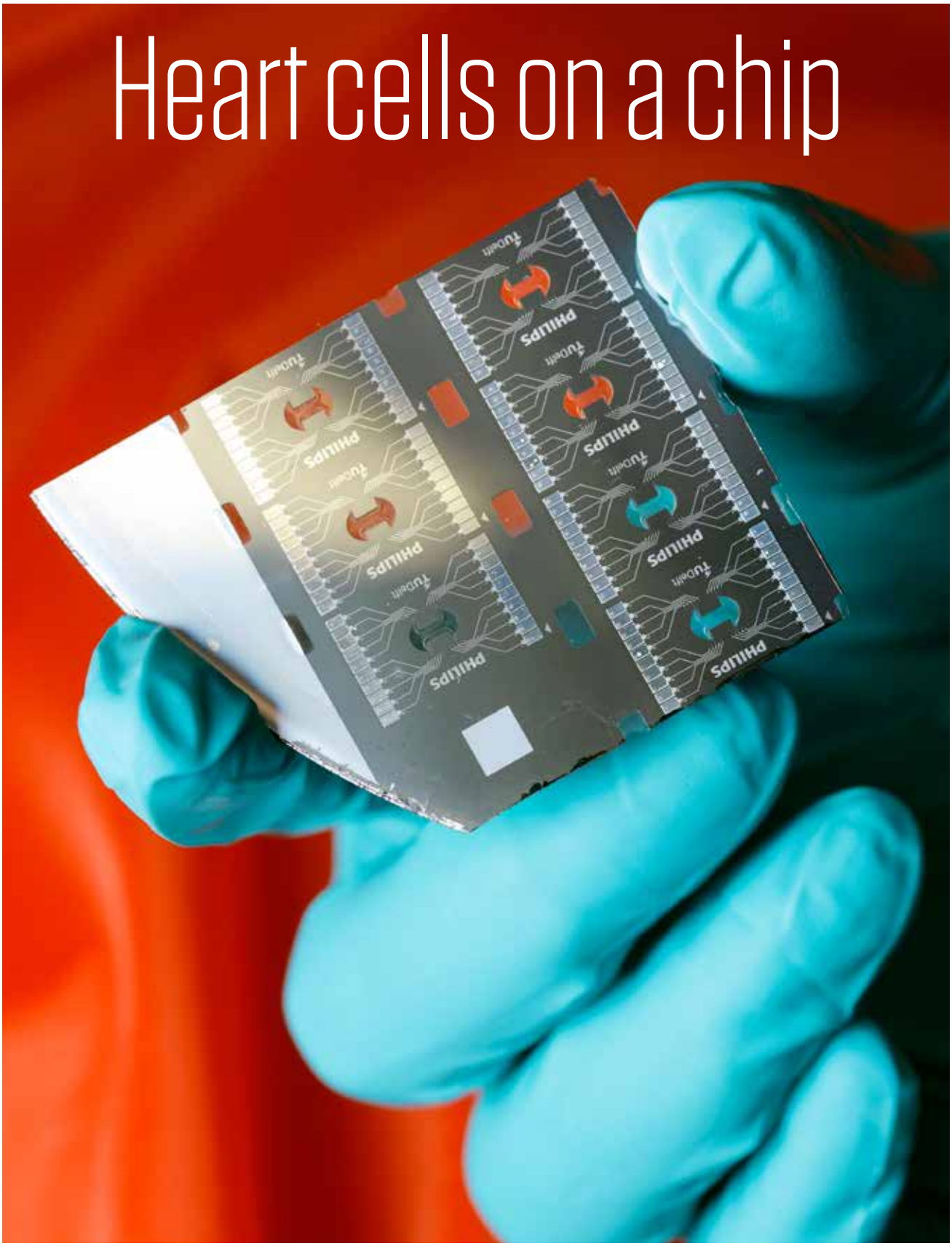
The company has offices in Germany and Romania, and it has purchased two companies in the last three years, bringing the total number of employees to 200. This allows TBA to continue developing new products. To make this happen, the company is shifting to virtual reality. 'For example, consider someone who performs repairs in the container terminal. He puts on goggles that make him feel like he's in a 3D environment that simulates everything: vehicles driving around, ships being processed. He can walk around and practise carrying out his tasks in complete safety.'

Saanen is optimistic about the future. 'I expect the number of automatic terminals to quadruple within a decade. We will have contributed to this in a major way.' SB

Name:	Yvo Saanen
Degree programme:	Systems Engineering, Policy Analysis & Management
Company:	TBA (in Dutch, Technisch Bestuurskundige Adviesgroep: Consultancy on Systems Engineering, Policy Analysis & Management)
Established:	1996
Product:	Operating software for automated container terminals
Mission:	To make ports safer, cleaner and more efficient
Turnover:	€20 million
In five years:	€40 million

AUTHOR: TOMAS VAN DIJK
PHOTOS: SAM RENTMEESTER

Heart cells on a chip



Beating human heart cells are expected to give a significant boost to drug research. Researchers at TU Delft are working to develop such a chip: an electronically readable mini-organ.

It is a strange sight. At first glance, the invention of ir. Saeed Khoshfetrat Pakazad looks like the type of bone dogs gnaw on in cartoons and comics. It is tiny, however, only three millimetres in length, and it beats like a heart – literally. The PhD candidate plays a video clip showing human heart cells going up and down in a synchronised fashion. They form a thin layer of tissue on a rubber membrane shaped like a bone. In turn, the membrane is mounted on a silicon chip.

The tissue is attached to electrodes in dozens of places. With this miniature organ, all sides of which can be measured, Pakazad hopes to identify adverse side effects of drugs in an early stage. Drugs are regularly taken off the market after having been found to cause cardiac arrhythmia or even cardiac arrest in a few cases.

A thorough investigation of the side effects of new medication requires experimenting with living and beating human heart cells. This makes it possible to establish whether individuals with certain genetic traits are more sensitive to side effects than others. This is the idea behind the research programme on human organ and disease model technologies (HDMT). Pakazad's chip is the first tangible outcome of this project. Apart from TU Delft, project partners include Philips, the other two universities of technology, VU University and the universities of Utrecht and Leiden.

Euphoric

Pakazad conducted most of his work at Philips, under the supervision of Professor of Electronics ir. Ronald Dekker. Dekker also holds a part-time position in the faculty of Electrical Engineering, Mathematics and Computer Sciences. He conducted the experiments with heart cells in collaboration with the Leiden-based biotechnology company Pluriomics.

The high point of his research was when Pakazad recorded the first electrical signals from the heart cells. 'I was euphoric. I had temporarily transferred to the research group of stem cell biologist Christine Mummery at Utrecht University, to measure a special signal amplifier attached to my cells. After a long period of experimentation, a mini-electrocardiogram finally emerged from the computer. It showed the same pattern as the ECG of an actual heart.'

The next step will be to apply medication to the cells with a pipette to see how they react. If the shape of the electrical signals changes, this could indicate cardiotoxicity. Pakazad will no longer have time to do these tests. He defended his dissertation on 15 June.

'After a long period of experimentation, a mini-electrocardiogram emerged from the computer'

Professor of Micro-Electronics ir. Lina Sarro (EEMCS) will be continuing his work at TU Delft. 'We would like to further improve the readout of the electrical signals,' she notes. 'And we'll start developing a range of miniaturised sensors. Examples include sensors for measuring the force with which the cells contract and sensors for measuring the presence of certain ions. The more we can measure electronically, the easier it will be to analyse the data.'

Reliable measurements require replicating all of the forces to which heart cells are normally exposed as accurately as possible. A tiny pump underneath the cells inflates the membrane, causing the cells to rise, fall and stretch, just like in a real heart.

Stretchable wiring

It took considerable effort to create this chip. Pakazad built on research work done by Ronald Dekker and Nikolai Böker, whose 2009 graduation projects dealt with this topic and who had also developed a prototype. What the chip lacked was the stretchable wiring.

How can you build electrodes that can be stretched? 'In the past, researchers have experimented with liquid metal alloys for use as electrode material, with elastic conductors and electrodes in the form of flexible coils (much like telephone cords). None of these methods were suitable for mass production. This is a prerequisite, however. To get the attention of the pharmaceutical industry, you need to be able to produce hundreds of thousands of chips at a low price.'

Pakazad discovered that shaping the membrane like a bone creates zones that hardly stretch at all when the membrane is inflated. Because of the characteristic shape, forces are not distributed equally. Pakazad uses this to his advantage. He installed the largest electrodes in those areas that are hardly stretched.

Stem cell technology

Many research groups around the world are working on the replication of organs on chips. The fact that this research has taken off in recent years can be put down to three factors. First, the pharmaceutical field is reaching its limits. The drug industry does not have suitable models for studying the behaviour of organs. In addition, better polymers have been developed for cells >>

Saeed Khoshfetrat Pakazad: 'I am the first to create an electronically readable heart on a chip that is also able to stretch.'

Professor of Micro-electronics ir. Ronald Dekker has been working for years to develop chips containing beating heart cells.

Professor of Micro-electronics ir. Lina Sarro (EEMCS) will be continuing the work of doctoral candidate Pakazad at TU Delft. 'We would like to further improve the readout of the electrical signals.'

to thrive on. The most important factor, however, was the 2006 breakthrough in stem cell technology.
In that year, Shinya Yamanaka from Japan and John Gurdon from the UK developed the Induced Pluripotent Stem cell (IPS) technology, which is used to reshape specialised cells back into stem cells. Until that time, it had been quite difficult to obtain human cells for experiments. Specialised cells (e.g. heart cells, lung cells and neurons) have lost their ability to divide and, in theory, cannot be cultivated. With IPS technology, however, it is possible to take a piece of skin and reprogram the skin cells to become stem cells, which can then be grown into any desired type of body cell.
As a result, experiments with human tissue became easier to reproduce. It is now possible to conduct countless experiments with tissue from a single individual, with cells that are genetically identical. Ronald Dekker sums up the power of this technology in a few words. 'In the past, we would take a biopsy of a heart, conduct an experiment, and that was the end of it. It was possible to take a biopsy from someone else as well, but that would introduce genetic differences.'
The group that created the greatest stir with its mini-organs is the Wyss Institute at Harvard University. Several years ago, researchers at this facility replicated a type of lung. On one side of the membrane, they grew lung epithelium cells, while growing blood vessel endothelial cells on the other side. With this system, they investigated the effects of fine dust on the lungs, among other things.
'Those guys are pioneers,' says Pakazad. 'What they are doing is so impressive. But an electronically readable heart on a chip, and one that can stretch, they'd not been able to produce that,' he adds with a smile.

HDMT

The official kick-off for the collaborative partnership in human organ and disease model technologies took place on 16 March. The researchers had already been working together for years in a less formal partnership. After the official launch, it is hoped that the pharmaceutical industry will join efforts, thus bringing in additional money.
In addition to cardiac research, HDMT has two other research lines. Twente University and VU University in Amsterdam are at the forefront of blood-vessel research. They will attempt to replicate vessels on chips, after which they will conduct research on such topics as thrombosis and blood vessel infections. Biochemists at TU Eindhoven are hoping to cultivate cancer cells on a chip.

Professor Lex Haak
PROFESSOR EMERITUS

For his exceptional achievements for the Diocese of Rotterdam, the Parish of St. Ursula and the community and residents of Delft, Professor of Finishing and Furnishing Buildings Lex Haak has received the high papal award Pro Ecclesia et Pontifice. From 1979 to 1991, Haak was a professor at TU Delft, and from 1960 until his retirement, he was director of an architectural firm. It was particularly through education that he played an important role in the architecture of the Netherlands.

Ir. Julia Cramer
PHYSICIST

Since recently, it has become possible for anyone to follow her work on a super computer at the Kavli Institute, thanks to a blog on facesofsciences.nl, an initiative of Kennislink and the Royal Netherlands Academy of Arts and Sciences (KNAW). This is intended to showcase young scientists and show what is involved in the life of a scientist. In particular she wants to show that she is pretty 'normal'. 'You don't have to be very special to do well here.'

Prof. Marileen Dogterom
PHYSICIST

'A world-class expert in experimental cellular biophysics' and 'a pioneer who has earned a high international reputation for the research in single molecule physics that is being conducted in the Netherlands', states the jury report by the Dutch Physics Society (NNV) about Dogterom. For this reason, the chair of the bionanoscience department (Applied Sciences) received the 2015 Physics Award. Dogterom's long-range goal is to build an artificial cell.

Thom Hoffman
ACTOR

'Kromo Blanda' is the topic chosen by the photographer and coming cultural professor Hoffman for his master class at TU Delft. With his students, he will be examining the history of the Dutch East Indies and the role of photography in the 19th and 20th centuries in colonial thought and dealings in the Netherlands. The photography project will include a film festival and a photography exhibition in a renowned museum. His inaugural lecture will be held on 11 September, and his farewell lecture will be held on 27 November.

Seven Vidi grants

Seven TU Delft researchers have received Vidi grants of up to €800,000 from the Netherlands Organisation for Scientific Research (NWO). Only 17% of the more than 500 proposals were funded. Dr **David Abbink** (3mE) hopes to save even more effort for the drivers of automatic cars. Dr **Läslo Evers** (CEG) is taking measurements of inaudible sounds of volcanoes and earthquakes, with the goal of providing insight into the temperature of the deep oceans and the higher layers of air in the atmosphere. Dr **Chirlmin Joo** (Applied Sciences) is studying how proteins that destroy the DNA of viruses in the immune systems of bacteria are able to recognise this DNA. Dr **Evert Meijers** (OTB, Architecture and the Built Environment) is investigating whether the advantages of urban agglomerations (e.g. schools, cinemas and other facilities) could be distributed over a larger area. Dr **Susan Steele-Dunne** (CEG) is working to develop a technique using satellites equipped with radar devices for the early detection of water shortages in vegetation. Dr **Stephanie Wehner** (QuTech, Applied Sciences) is attempting to construct a quantum network: an internet for quantum computers. Dr **Michael Wimmer** (quantum-nanoscience, Applied Sciences)is investigating which materials are best suited for the construction of a quantum computer.

Alumni World

Alumni continue learning at technology festival




On 4 June, more than 100 alumni visited the campus to attend lectures that the Alumni Office had organised during the International Festival of Technology. In the space of one hour, the visitors were brought up to date on a current research project or field at TU Delft. The activities included master classes on solar energy, an introduction to cyber security, and the dangers and advantages of wooden skyscrapers. 'In my field, so much has been discovered since I graduated 20 years ago. It is wonderful to come back and take a peek at what's being done now', observed one of the visiting alumni. Speakers included Alexandru Iosup, who this year was voted Netherlands' Teacher of the Year; Zaid Al-Ars, who previously won an award for his graduation research on rapid DNA analysis for diagnosing cancer; and Fedor Baart, with his research on historical reconstructions of tides, with he has used for such purposes as demonstrating the possibility of the escape from Alcatraz in 1962. The evening concluded with a social gathering in the newly renovated Henri Baudet Institute for design-history research in the Faculty of Industrial Design Engineering.

Mineralogical-Geological Museum re-opens

The grand re-opening of the Mineralogical-Geological Museum in the Science Centre on Mijnbouwstraat took place on 23 April. Sponsors, current and former professors, staff members and current and former students met in the beautifully renovated reception hall.

The foundation for the collection was laid in 1864 by Professor of Mining Herman Vogelsang. A programme in mining without a collection would have been inconceivable. In the museum's heyday, students, staff and alumni collected minerals, ores and rocks from all over the world. The mineralogical collection is unique, and it is one of the few university collections that is still intact. Many of the minerals are from mining regions that have been closed for decades.
Several years ago, when there was a good chance that the collection – which had since been gathering dust – would be dismantled, TU Delft alumnus Duco Drenth took immediate action. 'Money should not be an object', declared Drenth, who laid out plans for the Executive Board and approached sponsors. With nearly €1 million in sponsor funding, a portion of the collection is now housed on the second floor of the building on Mijnbouwstraat. The hall has been re-named the Dietsmann hall, after the chief sponsor.
'Because of the chief sponsors – Dietsmann, Shell, Fugro and Dyas – the museum will have 10 years to prove its worth, in part to the credit of TU Delft and the dissemination of knowledge about our subsurface', according to Drenth.

Alumni Activities

13 July
Summer Sports Camp at TU Delft

25 July
Alumni dinner in Taiwan

28 August
Tenth-anniversary Celebration of the Joint Master's degree programme in Geophysics

23 September
TOP meets Talent

Dutch Engineers Alumni Nordic Tour

Following their joint alumni tour of the United States, TU Delft, Twente University and TU Eindhoven visited Scandinavia in May. More than 1000 alumni of the Dutch universities of technology are living in Denmark, Finland, Sweden and Norway.

'This is why we decided to focus on the "Nordic" countries', explains Anouk Dijkstal, manager of alumni relations at TU Delft. 'Scandinavia has a lot to offer. Many of our alumni live there, and it is a highly innovative area. It also resembles the Netherlands, and the universities are of outstanding quality. During the tour, we tried to establish contact with graduates and ask our alumni if they would like to visit TU Delft whenever they are back in the Netherlands'.

Dutch Engineers Alumni in the Residence of the ambassador of Norway.

For TU Delft, it is of great importance to maintain the international network. The university has an international objective, and

Alumni form the portal for internships and work placements for the current generation of students

the alumni network plays an important role in it. Alumni of TU Delft are working in the very best and most prestigious companies in the entire world. They form the portal for internships and work placements for the current generation of students. 'In each city, we try to mobilise volunteers to continue organising activities and network events after our visit', explains Dijkstal. 'In America, this has already taken place in four of the five cities we visited'.

Nordic tour

The Dutch Engineers Alumni Nordic Tour was a success, with 4408 kilometres travelled, more than 1000 alumni, 160 participants, 14 taxis, 6 suitcases, 8 alumni lectures and 4 cities.

During one week, successive visits were paid to Stockholm, Oslo, Copenhagen and Helsinki. In each city, the alumni were welcomed by the Dutch embassy (or the Residence). Each visit included an update on the universities and two lectures by alumni on highly diverse topics. Each event was highly successful, and it went a long way towards strengthening the ties with the alumni living there.

Delft University Fund Best Professor Award goes to Jack Pronk

The Delft University Fund has presented the Best Professor Award for 2015 to Prof. Jack Pronk, a professor of industrial microbiology in the Faculty of Applied Sciences.

The Best Professor Award is presented each year to a TU Delft professor who excels in both education and research, motivates others to do the same and serves as a source of inspiration for both students and doctoral candidates.

The award, which entails a foreign sabbatical valued at €15,000, offers the winner the opportunity to acquire new knowledge, which can then be passed along to their students and doctoral candidates. Rector Magnificus Prof. ir. Karel Luyben and the chair of the Delft University Fund, ir. Michael Wisbrun will present the award during a festive meeting to be held on 31 August at 12:30, preceding the opening of the 2015-2016 Academic Year.

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

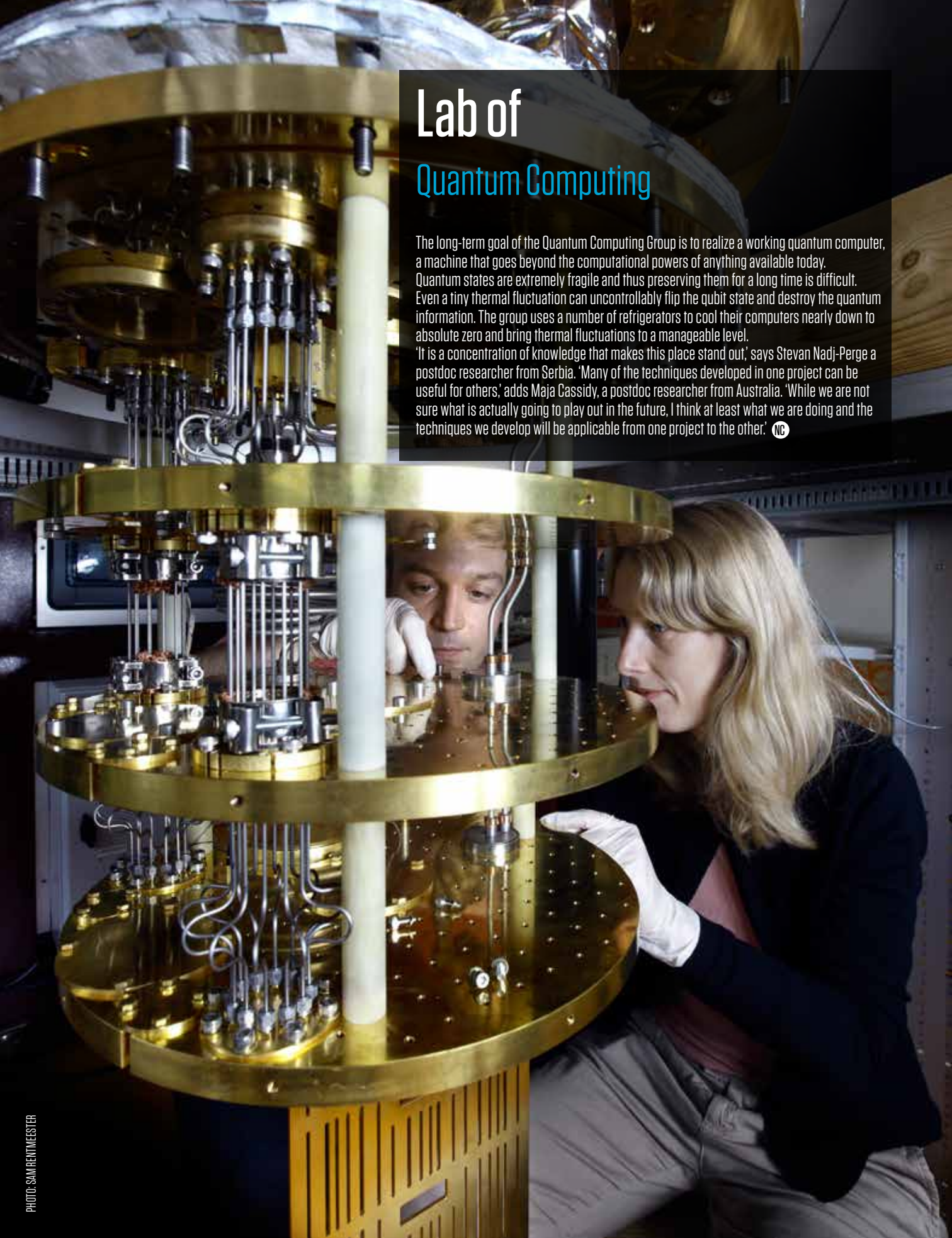
Do you want to change (alumni) information, communication preferences or sign up for alumni events? You can do that through the alumni portal www.alumniportal.tudelft.nl

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 NL19FVLB0226850471, account name 'stichting UfD', description 'friends'. universiteitsfonds.tudelft.nl



Lab of

Quantum Computing

The long-term goal of the Quantum Computing Group is to realize a working quantum computer, a machine that goes beyond the computational powers of anything available today. Quantum states are extremely fragile and thus preserving them for a long time is difficult. Even a tiny thermal fluctuation can uncontrollably flip the qubit state and destroy the quantum information. The group uses a number of refrigerators to cool their computers nearly down to absolute zero and bring thermal fluctuations to a manageable level.

'It is a concentration of knowledge that makes this place stand out,' says Stevan Nadj-Perge a postdoc researcher from Serbia. 'Many of the techniques developed in one project can be useful for others,' adds Maja Cassidy, a postdoc researcher from Australia. 'While we are not sure what is actually going to play out in the future, I think at least what we are doing and the techniques we develop will be applicable from one project to the other.' NC

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