DELFT OUTLOOK | NO. 1 | MRCH 2017 | YEAR 34 | TU Delft

STEFANIE TSEGGAI
'Africans have less, but share more'

SELF-DRIVING VEHICLES
Obedience can be dangerous

AUTONOMOUS SAILING
Roboats steaming up

THEME

Serendipity

The role of chance in science

Cover photo:
Inside the measuring room of the windtunnel it sounds as an empty meadow because the sound hardly reverberates. The room is not finished yet. As soon as all the instruments are installed, the aero acoustic measurements can get started.
Photographer: Sam Rentmeester

Editorial
Saskia Bonger

Serendipity

"Aren't all inventions the result of serendipity?" The question was put to me by a member of our scientific advisory council when I asked for examples of inven-tions made by chance. It is difficult to answer this question based on scientific publications and dissertations. The reason why is given in an article about Pek van Andel's lifelong fascination for serendipity: researchers rationalise their chance discoveries. They draw a straight line from question A to end result Z, hiding from our view the circuitous route that they actually took to get there. This is a shame for two reasons. Firstly, because stories about serendipitous discoveries appeal to the imagination. Take the history of how the microwave came about, with its Delft connection, illustrated in cartoon form by Stephan Timmers: this house hold appliance is all thanks to a bar of accidentally melted chocolate. Or what about the temperature sensor Prof. Kofi Makinwa is currently trying to sell to a chip manufacturer? If he had stuck to his original plans, it would never have existed.

A second reason why serendipity deserves our attention is to convince everyone that it's possible to exert control over chance. 'Happy accidents', as IDE students describe their chance inventions, are the result of an open mind. Or as quantum mechanic *ir.* Floris Kalff says in the 'View': "You need to be prepared to pursue 'crazy' ideas."

Saskia Bonger,
Editor-in-chief

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Theme Serendipity

PHOTO: SAM RENTMEESTER

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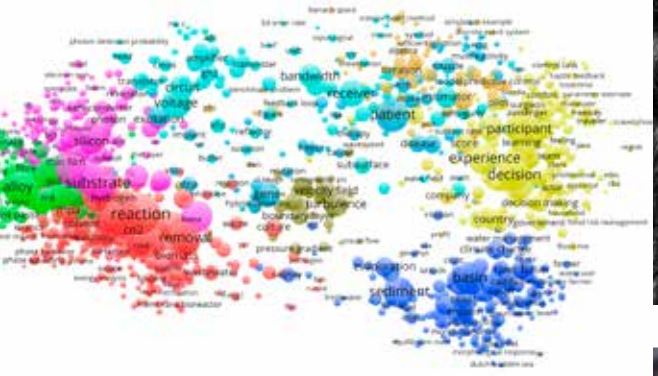

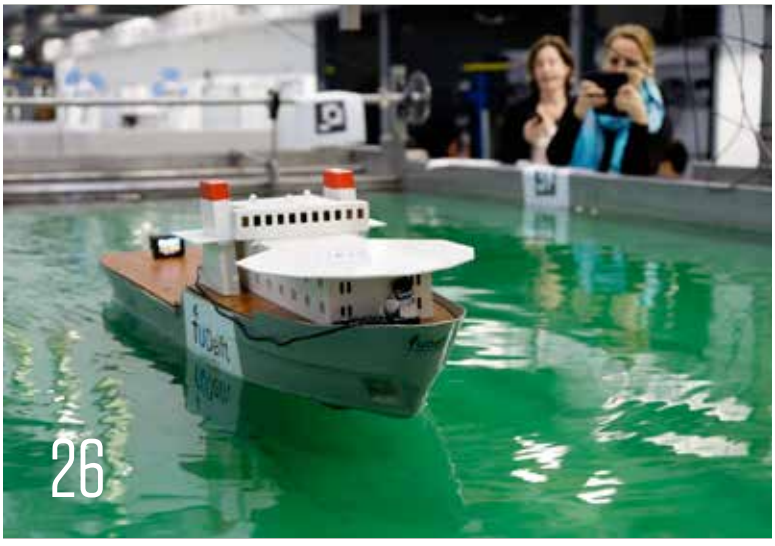

DELFT IN BRIEF

Zebra stripes

The idea that gradients in protein concentrations can lead to natural patterns was proposed as early as 1952 by the computing pioneer Alan Turing – a zebra's stripes being one example. More than 60 years later, Dr. Yaron Caspi of the Cees Dekker lab has filmed the dynamic behaviour of proteins in an enclosed space. This led to a publication by the Kavli Institute for Nanoscience in eLIFE in November 2016. For Prof. Cees Dekker, this dynamic plays an important role in his research into the artificial living cell.
delta.tudelft.nl/32503

Artificial hand

The operation of almost all arm and hand prostheses requires too much force, observed Dr. Mona Hichert during her doctoral research at the 3mE faculty. As a result, almost half of all users discard their prostheses after some time. Generally, lifelike aesthetic prostheses require more force to operate than split hook constructions. Hichert feels that engineers should be designing prostheses that require less force, and rehabilitation specialists should first measure how much force someone can routinely apply before prescribing a prosthesis.
Photo: Sam Rentmeester
delta.tudelft.nl/32822

Building with glass

'Thick glass is our baby', is how Faidra Oikonomopoulou and Telesilla Bristogianni describe building with glass in 3D. The doctoral candidates won the Innovation Prize by the Society of Façade Engineering for their glass façade for a shop on Amsterdam's P.C. Hooftstraat, designed by MRVDV Architects. Prof. Rob Nijsse and Dr. Fred Veer produced the structural design. The doctoral candidates manually inspected more than 7,000 glass bricks for the project.
delta.tudelft.nl/32760

PHOTO: MARCEL KRIJGER

Run on limited enrolment programmes

In the coming academic year, TU Delft will have to disappoint around 900 first-year students as their chosen programmes are full. Demand for the four programmes with a cap on student intake is greater than the university can handle. For Aerospace Engineering (AE), a record number of 932 people applied for 440 places. Clinical Technology had 310 applications for 100 places and Nanobiology had 159 applications for 100 places. For Industrial Design, 485 first-years wanted to get started, but only 350 will be able to.
The Director of Education at AE, Aldert Kamp, says: "Let's allow 1,000 students to come, and then we can identify the good ones using the right selection tool."
delta.tudelft.nl/32787

Funding for Kavli Institute

In the coming decade, the Kavli Institute for Nanoscience will receive an additional 200,000 dollars (190,000 euros) a year from the Kavli Foundation. This sum will be matched by TU Delft. The financial boost can be used freely for research and activities. The Kavli Institute covers the institutes for quantum nanoscience and bio-nanoscience. Its research has been supported by the American Kavli Foundation since 2004. "We can use this contribution to fund postdoctoral fellowships, particularly on the cutting edge between the bio-nanosciences and quantum nanosciences," said co-director Lieven Vandersypen.
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Investigating breath

Your breath contains materials that say something about your health. Diabetes, asthma, stomach and intestinal disorders and some forms of cancer could all be detected by analysing breath. Current gas analysis instruments are too large and expensive for this, however. Dr Adonis Reyes Reyes (Applied Sciences) has developed a prototype breath analysis instrument based on the absorption of infrared light from a broadband laser. Reyes Reyes expects to see sensitive portable breath analysis units on the market in a decade's time.
delta.tudelft.nl/32707

PHOTO: SAM RENTMEESTER

Brake light 2.0

A 'smart' brake light can increase traffic safety and traffic capacity on motorways. The brake light uses a horizontal bar to show how powerfully a car is braking (left, red) or accelerating (right, green). Vertical columns show whether the following car should increase (arrow up) or decrease (arrow down) the braking distance. Dr Mehdi Saffarian (3mE) discovered that this information helps people to maintain the ideal distance. Self-driving cars use the same technology to maintain the correct distance. Their greatest problem is the unpredictable behaviour of other traffic (people!).

See page 24: 'Autonomous crashing'

delta.tudelft.nl/32892

Steel and chocolate

On 13 March, the 4TU Research Centre High-Tech Materials held a symposium on the influence of the production process on materials. According to co-organiser Dr Marcel Sluiter (3mE), this is as true of steel as it is of chocolate: "Progress in steel production means that modern cars absorb much more energy during collisions. And controlling the crystal structure of chocolate ensures that it melts in your mouth, not in your hand."

delta.tudelft.nl/32861

Delft Blue icons

IMPRESSION VIA NIEUW DELFT

Iconic Delft Blue homes, an atrium with space for exhibitions, hotels and cafes with outdoor seating: by 2019, the station area should be a 'lively entrance' to the city. The 'House of Delft' design refers back to the homes of Delft-based pioneers such as Antoni van Leeuwenhoek and Johannes Vermeer. The other side of the former station building will see the building of the 'Antoni' project, consisting of loft apartments, studios and a hotel. A Student Hotel will be built directly opposite the station, containing 342 fully furnished rooms for students.

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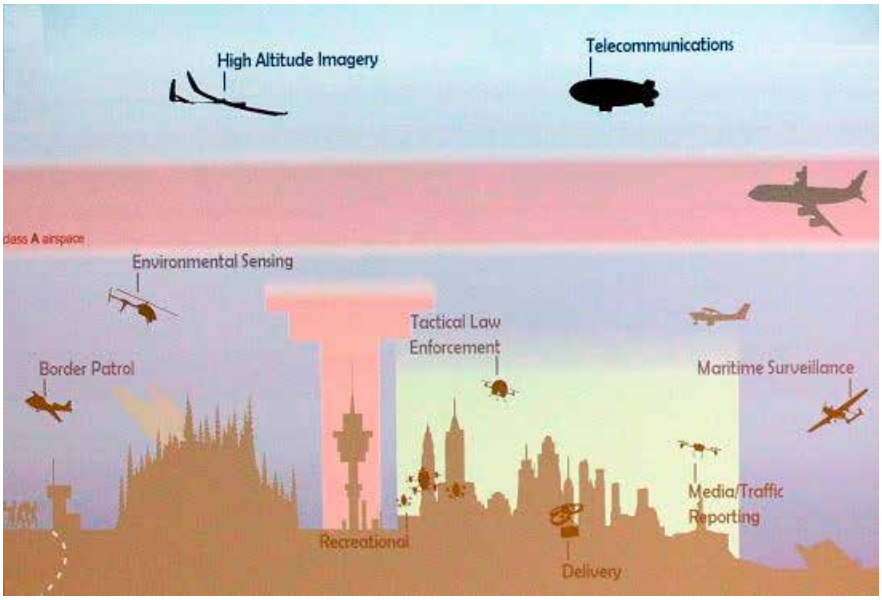

Traffic rules for drones

There are already more registered drones than aeroplanes and helicopters put together, not to mention non-registered machines. The development of civilian uses is being held up by restrictive regulations. Dr Yazdi Ibrahim Jenie at the Faculty of AE has done research into computerised safety systems for drones. Such systems (conflict detection and resolution, CD&R) provide traffic rules for drones, while also allowing for the calculation of the maximum density per layer of air.

delta.tudelft.nl/32709

THEME

Serendipity

An umbrella that lights up when wet. So when do you have water and want light? “When it rains in the dark”, says materials expert Kaspar Jansen. He explores how technological materials can be applied. He does this in brainstorming sessions with IDE students. The umbrella is the result of experiments with electroluminescence.

Page 8: ‘Happy accidents’

PHOTO: SAM RENTMEESTER

TEXT: CONNIE VAN UFFELEN PHOTO: SAM RENTMEESTER

Happy accidents

Serendipity? For researcher Elvin Karana, that's most certainly one of her goals. "I want it to happen. My students come across incredible things by pure accident."

Karana is a member of Professor Kaspar Jansen's Emerging Materials research group, and part of her work involves trying to find useful applications for new materials. That can be useful in terms of the material or technique, or useful for the user. They should enjoy touching and playing with the material. And playing is the first thing students should being doing with the materials, since that usually throws up accidental discoveries, which they call 'happy accidents'.

This is the approach that one of her groups of student has adopted for their research on recycled plastics. They melt them, let the material cool for a long time and then use it to make a kind of tile. That is, they did until it all went wrong. Students put the molten plastic in a sink, and water accidentally came into contact with it. Bubbles started to form and some parts of the hot plastic ' exploded'. "You could 'open' the plastic, which revealed a kind of shell shape," explains Karana.

The group noticed that an unusual effect had occurred: the outside of the 'shell' felt rough, but the inside was as smooth as an oyster or marble. "Fantastic," says Karana. "The students have been trying to repeat this accident for weeks now to see if they can create the same effect for larger surfaces."

In user studies in the lab, people were very surprised. They wondered what type of material it was. It had a mix of colours and people held it up to the light to see if they could see through it. This role of light gave students the idea to put a lamp inside the material, or to turn it into a bowl and pour water into it so as to emphasise the smooth texture. So the students started out wanting to make tiles, but ended up creating lamps and bowls.

Forgotten application

Serendipity plays an important role when researching designs based on the materials, says Karana. She tells her students to forget about the application of the material during the initial stages of the research. "It's very difficult for designers. They should focus on the material itself. They should also be looking at other variables such as temperature and process techniques. Once they've done that they can start to think about what people do with the material."

During an NWO project with Utrecht University, it appeared that users tended to scratch and crumble the material. What could you use this material for? One of Karana's students suggested that it could be used for packaging for a bottle of wine; to open your gift, you have to pry open the packaging.

These are just a few examples from Kaspar Jansen's group. During his own research he primarily focuses on technological materials, which he then develops to create a functional prototype or demonstration model. And he does that in a systematic way using brainstorming sessions. "Sometimes students come up with a hundred applications which we then group together. Sometimes, one of those ideas actually turns out to be a good one."

Umbrella

An example of this process is an umbrella which lights up in places that come into contact with water. Jansen asked his students to experiment with electro-luminescence. If you put an alternating electric field on phosphorus paint, it lights up. The first thing that a student made was a screen-printed circle of phosphor paint on a sheet of paper with silver electrodes. The paper lit up like a lamp. Jansen asked his students whether this would also be possible

Plastic as smoorth as an oyster was formed by accident.

using fabrics – and sure enough, it was. Then he asked them to look for electrodes that are transparent, flexible and can conduct electricity. They got the idea to use liquid and organised a brainstorming session to come up with meaningful applications for the material. “In which circumstances is there water and you need light? When it rains in the dark,” says Jansen. “And that’s how the idea for an umbrella came about.”

The students drew lightning patterns on the umbrella using phos-phor. The electrical circuit isn’t complete until drops of water fall on it, causing the umbrella to light up in those spots. People continually ask Jansen where they can buy the umbrella, but he hasn’t actively sought out companies who could continue to develop the product.

The students started out wanting to make tiles, but ended up creating lamps and bowls

Another example is a cooling jacket for women with hot flushes. RFID tags, which are often attached to clothes to prevent theft in stores, were the initial inspiration behind this idea. Jansen asked his students to think of other things that could be developed using this as a basic starting point. One student then came up with a form of cooling and a tie which acts as a USB stick. Both proved technically impossible to achieve, but immediately got Jansen thinking about the thermoelectric elements used in a camping cooler. By integrating them in a vest, complete with temperature sensors, he managed to develop a short-term cooling solution. He asked the student to come up with an application, and what followed was a eureka moment: menopausal women. Additional research still needs to be done, and Jansen was awarded funding for his STW proposal. <<

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New lab makes sound visible

Basic equations of fluid dynamics resulted in the creation of the new aeroacoustics research group.

The vertical wind tunnel in the Low Speed Laboratory on Leeghwaterstraat has been completely refurbished. All sources of sound, including electric converters, were removed and the measuring chamber is as close to total silence as you can get. The silent room is the centre of the new aeroacoustics research group, which is part of the Faculty of Aerospace Engineering. The group will use this room to carry out measurements on wind turbines and propeller blades. The lab, the group and two million euros worth of European subsidies owe their existence to a former PhD student and his highly theoretical approach some ten years ago.

Particle image velocimetry

Professor Fulvio Scarano remembers him well. At that time, Scarano was measuring air currents using theatrical smoke, fast pulsed lasers and high-speed cameras that could take five thousand shots a second of the smoke in a space the size of an iPhone. This is the particle image velocimetry (PIV) technique. Scarano was primarily concerned with increasing the volume and speeding up the reconstructions so that you could accurately calculate the local air velocity anywhere and at any time. "I was fixated on creating a detailed reconstruction of how air moves in semi-chaotic vortices," Scarano recalls. His PhD student Roy Humble was more of a theoretician with a passion for fluid mechanics. As a supervisor, Scarano found that difficult. "He came up with equations that I couldn't really do much with. It seemed like mathematical exercises without a real purpose. So I asked him what he wanted to achieve." To cut a long story short, Humble felt misunderstood and Scarano doubted the relevance of his research. Meanwhile, the pressure was mounting - the end of his PhD research was in sight.

'It seemed like mathematical exercises without a real purpose'

Pressure differences

In desperation, Humble tried again: 'Fulvio, I've taken another look at the 3D PIV formulas and, in principle, if you have all the velocities you can use them to deduce pressure differences.'

Variation in pressure means noise, thought Scarano. "I thought, wait a minute. If you can deduce local pressure from PIV measurements you will no longer need to mess around measuring pressure and force in a wind tunnel using barometers and balances. The formula you need to be able to do that is hugely complicated because it includes all the velocity elements. But with 3D PIV we can measure all of these and use them to calculate the pressure, followed by lift, drag, and sound."

In 2007, his proposal "Flow visualisation inspired aero-acoustics with time-resolved Tomographic Particle Image Velocimetry (Flovist)", was awarded €1.5 M from the European Research Council (ERC). That marked

the beginning of a five-year research project. This time, the volume used to record measurements has increased from the size of an iPhone to a beer crate.
The PIV technique is also behind the more recent research project Nioplex (Non-Intrusive Optical Pressure and Loads Extraction for Aerodynamic Analysis) which aims to further develop the simultaneous measurement of the surface pressure distribution on a model and the velocity and pressure field around it for industrial applications.
Dr Bas van Oudheusden (AE) is leading that large project, which secured funding to the tune of €2.26 M.

Capturing vortices

"It was a steep climb," says Scarano, reflecting on that time. "But now we're looking at a whole new field of research: aeroacoustics. It was difficult to develop 3D PIV and it was even more difficult to capture the development of currents over time, but now we know how it works we can use PIV to capture vortices in many applications."
What started with basic equations of fluid mechanics resulted in a new field of research that, according to Scarano, could be of strategic importance for AE and TU Delft. Since noise pollution is attracting a lot of attention from many sides, aeroacoustics is a hot & happening topic. <<

The vertical wind tunnel in the Low Speed Laboratory is as near to total silence as you can get.

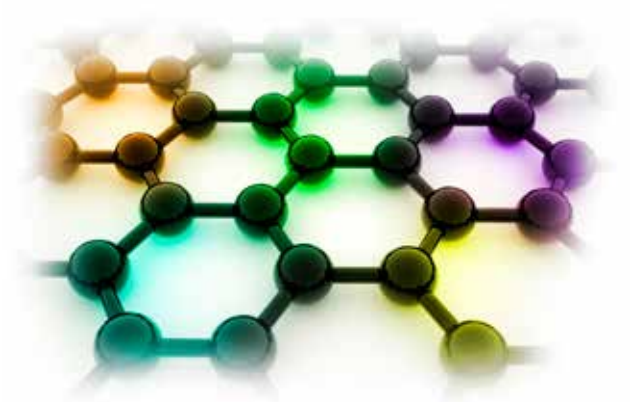
Tensile steel

Its rock hard... and elastic? That's not usually a characteristic you would associate with steel. Nevertheless, a few years ago one of Prof. Jilt Sietsma's (3mE) students conducted research into the elasticity of a piece of steel in the testing machine. She just didn't know it at the time.

"The future engineer used tensile forces to research the plastic behaviour of steel, so the extent to which you can permanently deform the material," says Sietsma. "She plotted this behaviour. The straight parts of the curve usually indicate plastic deformation. That's the interesting part of the graph and we zoom in on that. But the straight part that my student focused on concerned elasticity, not plasticity. You really don't expect to see any elasticity there."
The student presented the graphs to a number of other researchers. No one noticed the error, but it wasn't long before Sietsma realised. What was going on? "Dislocations in the crystal lattice - which disrupts the perfect arrangement of atoms - had caused the elastic behaviour. The best thing is that we can now detect similar dislocations by looking at the curves that the student researched (a world's first) and presented all those years ago. We have ended up with a whole new method of analysis. A post-doc worked on this topic for two years, and we have published three articles about it, while three others are in the pipeline."
What's the moral of the story? "Always keep an open mind. If you expect a straight line, and you find a straight line, don't immediately assume that it's the result you were looking for. You might have discovered something completely different." TVD

Fifty shades of graphene

Research into graphene didn't lead to hyper-sensitive sensors for mobile phones as expected, but energy-efficient displays.



Think of it as a nano drum: a tiny indent, a hundredth of a millimetre in diameter, covered with one or multiple layers of graphene. Back in 2014, previous research at the Kavli Institute for Nanoscience had already proved that such drums showed promising results for use as hyper-sensitive sensors in mobile phones.

But when Delft researchers, in collaboration with the Spanish company Graphenea, created a whole field of those tiny indents and PhD student Santiago Cartamil-Bueno examined it through the microscope, he was not happy. The indents had different colours. "I wanted to see if they could be used as a sensor," says Cartamil-Bueno. "The colours indicated that the indents were not homogeneous, and that's bad news for sensors."

So where did these colours come from?

As head of the research project, Dr Samer Houri (Faculty of Applied Sciences) noticed that the colours changed slowly and understood that there had been some interference. The double layer of graphene covers the silicon indent, which can cause pressure differences across the membrane. This difference in pressure pushes the graphene membrane up, or pulls it down. Interference between reflected light waves on the membrane and the bottom of the indent represses some colours and reinforces others.

Cartamil-Bueno wants to use this unexpected effect to make energy-efficient displays: so pixels instead of sensors. As little energy is required, they would be suitable for watches or eBooks. He has replaced air pressure with electrostatic force as the driving force and made a prototype display for the Mobile World Congress in Barcelona in February.

The colour change is not very significant at this stage and the pieces of graphene are not very big, but that hasn't deterred Cartamil-Bueno. "I can think of a few things we can do to enhance the effect," says the PhD student. JW

Watch the film clip: vimeo.com/190362200

Wind meter reborn as thermometer

He is in the final stages of negotiations with a chip manufacturer to get his temperature sensor incorporated into a microprocessor. A sensor that was originally intended as a wind meter.

Professor Kofi Makinwa is Antoni van Leeuwenhoek Professor in the EEMCS Faculty, specialising in smart sensor systems. He arrived at TU Delft from the Philips Research Lab to do doctoral research in 1999. The aim was to develop a wind meter (or anemometer) with no moving parts. "It's like sticking your finger in the air. A warm object cools asymmetrically in the wind. Our aim was to derive the wind direction and speed from the temperature profile," he recalls. He made three prototypes with heating elements, temperature sensors and various quantities of electronics on the chip. The idea was to balance cooling with additional heat. The power needed to achieve that could be used to derive the wind force and direction.

To his surprise, the three different prototypes behaved identically. That was strange.

Makinwa: "The electronics on the chip made no difference to how it worked. How was that possible? Unexpected results of this kind are interesting. Unlike the results you expect, which you know already."

He understood that the time it took a warm front to pass through silicon (thermal diffusivity) was very constant because the material is extremely pure and the distance between the heating element and sensor was identical in all three.

The next idea was to explore whether you could use that constant diffusivity to make a clock. The plan soon faltered because the diffusivity proved to be dependent on temperature after all.
Hang on, thought Makinwa. I can use this to make a temperature sensor. By measuring the speed of a warm front between a source and a sensor (order of magnitude 10m/s) the temperature can be extrapolated without the need for calibration.
"That's far more interesting than a wind meter. Wind measurements are rare, but there are thermometers everywhere: in the fridge, the thermostat, the car is full of them and there are dozens in a laptop."
The thermal diffusivity (TD) temperature sensor, as the invention is now known, appears perfectly suited for using microprocessors because it takes up very little space and there is no need for calibration, which Makinwa says is necessary for all transistors used so far. With twenty sensors on a microprocessor, calibration is sizeable step in the production process. The temperature sensors are used to prevent local overheating by dynamically reducing the load on various computer cores.
The TD sensor would suit a processor because they already have a clock and the additional heat from the sensor (1mW) is nothing compared to the dissipation of the processor itself (up to 100W).
Why has the sensor not yet been built in? "Industry is scared to take the plunge," says Makinwa. He quite understands this. "I play around with them, creating a hundred to check that it works. They say: 'Kofi, let's see it done with a thousand.' Of course that's impossible at a university, so it remains a risk for industry to take." Despite this, Makinwa has confidence that his modified wind meter will soon be protecting microprocessors from overheating. JW

Vibrations above **Venus**

A climate model for all the planets: that's what planet researcher Dr Daphne Stam of the astrological dynamics and space missions (AE) research group wants to see someday.

Change the parameters, such as air pressure and atmospheric composition, and your model can describe the climate on Mars. Change a few more things and you'll know what it's like on Venus, or on a newly discovered planet.
We're still a long way from achieving a universal climate model because there is a substantial lack of data about the physical processes that play a role in the atmospheres of other planets. Stam believes that she has now found another piece of that puzzle. Completely by chance, Stam, together with astronomers from Leiden and a PhD student, discovered mysterious vibrations just above the sulfuric acid clouds that obscure the surface of Venus.
"In 2014, Leiden astronomer Michiel Rodenhuis carried out tests using a large telescope, ExPo, on La Palma. This extremely accurate polarimeter measures the vibration direction of light," explains Stam. "Michiel emailed me to ask if it would be worthwhile observing Venus while he was waiting. That seemed like a good idea to me."
The circular patterns which Michiel saw in Venus' atmosphere had never been observed before. "For a long time we thought that the measurements were the result of an instrumental effect, but Michiel has tested all possible deviations and subsequent measurements of the debris disks do not reflect those patterns.
So we now assume that the measurements are correct: for Venus, this type of measurement has simply never been done before with such precision. One of my PhD students, Gourav Mahapatra, is currently analysing the data. We've probably discovered something completely new in the atmosphere." TvD

Cool magnets

Last January, Prof. Ekkes Brück celebrated his FOM valorisation prize with champagne which had been cooled in one of the world's first magnetic fridges.

Professor Ekkes Brück spent 20 years developing a magnetic refrigerator.

Magnetic cooling is a very promising technique since it doesn't require a chemical coolant; instead, heat is transported via (salt) water. According to Brück, magnetic refrigerators can be 30% more efficient than conventional models due to the simpler technology used.

Brück stumbled across magnetic cooling completely by chance about 20 years ago. At that time, he was working on reader heads for hard drives at the University of Amsterdam. For that research he used the giant magnetoresistance effect, which was discovered in 1988 (GMR, Nobel Prize in Physics 2007). Thanks to the GMR effect, the change of resistance in a magnetic field becomes ten times stronger, meaning that much smaller hard disks could be produced. No wonder that researchers the world over were looking for materials which demonstrated that effect.

Brück explains that he became curious about an article in Physical Review Letters in 1997 in which researchers Pecharsky and Gschneidner reported an extremely large entropy change (i.e., heat) due to a double structural transition in the material under the influence of a magnetic field. Brück: "My PhD student was going to make this material to see if it could be used as a sensor. It then turned out that the double phase transition was a by-product of Geschneidner and Pecharsky's preparation, and that the physics of the giant magnetocaloric effect is very different."

Brück switched his focus from the magnetic effect on resistance to the effect on heat

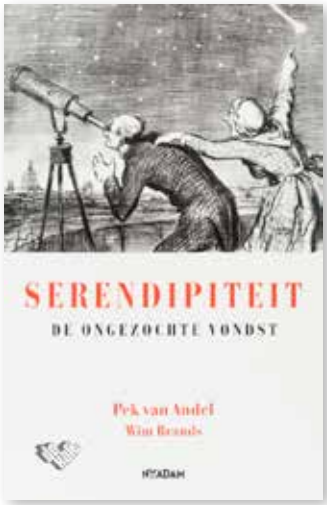
That was the beginning of his search for the giant magnetocaloric effect (GMCE) that chilled the champagne at his party. Brück switched his focus from the magnetic effect on resistance to the effect on heat. It works like this: place a piece of magnetocaloric material in a strong magnetic field, and it heats up. Remove it from the field and the temperature drops. The material then starts to absorbs heat from the surroundings (in this case the cooling water). So this technique allows you to cool using an alternating magnetic field.

Inside the material, this goes hand in hand with the double phase transition: magnetic and in the crystal structure. Brück managed to make the two transitions coincide at a suitable temperature by using sophisticated blends of different elements. This is what we call a giant magnetocaloric effect (GMCE). A mixture of manganese, iron, phosphorus and silicon was developed for the refrigerator.

Brück has been working on this research for about 20 years. "If Geschneidner and Pecharsky's preparation had not demonstrated double transition, I would never have looked into it further," he realises now. JW

Flowers along the side of the road and by-catches

Discoveries rarely start with someone shouting 'Eureka!'; you're more likely to hear 'hmm, that's strange'. In their book *'Serendipiteit, de ongezochte vondst'*, Pek van Andel and Wim Brands argue that accidental discoveries are underestimated in science and technology.



Pek van Andel, Wim Brands, 'Serendipiteit, de ongezochte vondst', Nieuw Amsterdam Uitgevers 2014, 128 pages, 13 euros
Only available in Dutch.

Research and results are rationalised and ironed out for scientific publications. 'Coincidental findings, luck, surprises, things you weren't looking for, mistakes, things that you've never even heard or dreamed of, jokes and unknown factors; all of these elements can lead to the end result, yet they are often underexposed and suppressed,' say the authors.

Television presenter Wim Brands, who died last year, interviewed Pek van Andel about his lifelong hobby and fascination for unexpected discoveries. The filing cabinets in his farmhouse in Groningen bulge with clippings and his head is an inexhaustible source of anecdotes and stories. According to Van Andel's Wikipedia page he is currently doing a PhD on the subject, something I remember him planning to do ten years ago too.

Searching for the roots of his fascination, Van Andel tells the story of him burning down his parent's farm at the age of four. He can still see it now - playing with fire between the open barn doors in the bright summer sun. That's why he didn't notice the fire, nor how quickly it spread. The fierce fire ravaged the De Keizer farm. It was never rebuilt. 'I think this trauma during my youth triggered my pet obsession with serendiptology.'

'He who does not expect will not find out the unexpected, for it is trackless and unexplored.' This Heraclitus quote, dated around 500 BC, shows that the phenomenon is as old as philosophy and thought. The Englishman Horace Walpole coined a name for it in 1754. He had read a translation of the Persian fairy tale 'The Three Princes of Serendip', which dates back to the fourteenth century. Walpole wrote: 'These princes travelled, always making discoveries, by accidents and sagacity, of things which they were not in quest of.' He called this 'serendipity'.

> 'He who does not expect will not find out the unexpected, for it is trackless and unexplored'

The list of accidental discoveries in Van Andel's archives is inexhaustible. For the book he decided to select a discovery for each letter of the alphabet; Aortic surgery, Beriberi and the discovery of vitamin B, Daguerre's discovery of photography thanks to a broken thermometer, and Enkamat - from failed mattress to turf reinforcement mat.

Serendipity exists in many different forms but it is often a combination of a hypothesis and an observation that doesn't quite fit. Do you just ignore it or let it surprise you? Who notices the flowers along the side of the road? Van Andel believes that universities should award an annual serendipity prize so as to encourage open minds and percipience, which in turn should stimulate researchers to keep one eye open for unexpected discoveries. JW

ILLUSTRATION: STEPHAN TIMMERS

From radar to magnetron

Counting cells

Purely by chance, researchers working on smart catheters discovered that silicon can be used to measure the stiffness of living cells.

Medication can affect the stiffness of a living cell, which influences the time it takes a cell to flow through a narrow channel. The stiffer the cell, the longer that takes. To measure these microfluidic measurements, glass or polymer in which tiny channels are made is used. Thanks to an accidental discovery for a completely different application, silicon appears to be perfect for studying microcurrents.

Professor of Microelectronics, Prof. Ronald Dekker (Philips and TU Delft, Faculty of EEMCS): “People often think silicon is too expensive but it has several important advantages: you can use it to integrate sensors and electronics, and there is a huge industry on hand to produce it.”

In Dekker’s Philips lab, to develop smart catheters they needed channels in silicon that were sealed from above. Some students developed a trick for that which turned out to work very well. When they looked at it through an electron microscope, they came up with the idea to develop a chip which could be used for conducting microfluidic measurements.

Dekker approached microfluidics expert Prof. Jaap den Toonder at Eindhoven University of Technology (TU/e), whose research group studied the stiffness of living cells using a polymer-based flow cell, and together they decided to develop a similar chip made from silicon. Four Master’s students from India, Zimbabwe, Belgium and Japan worked on this project in Eindhoven and Delft.

PHOTO: RONALD STOUTE

The microfluidic chips are only 3x3 mm and after being cut they are ready to be tested.

At the moment, the Japanese Master’s student Shinnosuke Kawasaki from the Faculty of EEMCS is working on integrated electronic sensors to measure the speed of passing cells. To analyse those measurements he has connected the chip to a Red Pitaya processor board (which costs around 200 euros).

For Ronald Dekker, this project is a typical example of accidentally discovering a useful application (cell analysis) while actually working on a completely different topic (smart catheters). “It was a spontaneous and fun project between TU Delft, TU/e and Philips, in which a handful of Master’s students played the leading role.” JW

Quantum behaviour without the mystique

Droplets of oil can display quantum behaviour and behave like waves rather than particles. John Bush (MIT) demonstrated this in 2014. Photo: Dan Harris, MIT

Irritation and a surprise discovery led aircraft professor Theo Van Holten to publish a book about quantum mechanics.

The irritation dates from Van Holten's initial acquaintance with quantum mechanics. Particles that are in two places at the same time, fundamental uncertainty, quantified charge and energy – all of them strange phenomena. How can they be explained? 'Then came the deep disappointment, bordering on irritation, when I was told that physicists had no explanation', Van Holten recalls in his book. On an atomic scale, quantum laws apply, but classical physics applies to macroscopic behaviour. His irritation persisted.

After retiring as professor of aircraft performance theory at the Faculty of Aerospace Engineering, Van Holten decided to apply a half-forgotten physics technique used in aerodynamics fifty years ago to describe the electromagnetic fields of a charged cloud. Initially, he just did it for fun. 'When I extrapolated the results to a total charge for the cloud equal to the charge of a single electron, I realised to my amazement that the electrons appeared to be behaving exactly as predicted by quantum mechanics – quantitatively correct, even though I was still using the classical laws of physics', Van Holten wrote.

'What I had stumbled on by chance was a replica of quantum theory in which classical laws seemingly conspire to achieve this behaviour', writes Van Holten. 'At the very least, this makes it possible to develop models of thought on how to rid the strange, magical behaviour of elementary particles of its mystique.' JW

Theo van Holten, The Atomic World Spooky? It Ain't Necessarily So!, Emergent Quantum Mechanics, How the Classical Laws of Nature Can Conspire to Cause Quantum-Like Behaviour, Springer 2017, 516 pages, EUR 103 (ebook) or EUR 133 (hardcover) from Springer.

View

PhD student and quantum mechanical engineer Floris Kalff believes in the premise that you sometimes have to dare to stray off the beaten path.

Last November Kalff wrote an editorial piece in Nature Nanotechnology: 'The value of the unforeseen'. The reason behind this publication was the discovery that Kalff and his colleagues at the Kavli Institute of Nanoscience stumbled across; an atomic memory. This discovery might even go on to cause a breakthrough in the chip industry.

The researchers built a 1kB memory by placing a layer of chlorine atoms, a bit like a blanket, over a thin layer of copper and moving the chlorine atoms around. Or rather, moving the holes, because holes had formed here and there in the one-atom-thick layer of chlorine. "We'd made some kind of slider puzzle that we could use to process information," says Kalff.

The team managed to achieve a storage capacity of 80TB per square centimetre, about 500 times better than the best commercial hard disk.

But moving holes wasn't exactly the researchers' initial plan. "Actually, those holes were incredibly irritating," says Kalff. "Our group investigates the properties and interactions of magnetic atoms, such as cobalt and iron. With the chlorine we tried to create a very flat substrate on which we could then deposit and study cobalt and iron atoms. It's fairly fundamental research. We needed a nice tablecloth, not one with holes in. "But we then realised that we could move those holes using a scanning tunnelling microscope (STM), a sharp needle which is used for atomic-level surface imagery, one atom at a time. That opened up new possibilities. We started to do some experiments with it. It was a side path, a by-product, which gradually became a main road.

"Changes in direction like this are good, you have to be open to them. It can lead to promising discoveries. You have to be willing to work out 'crazy' ideas and not be blinkered by your original research question. I think that the majority of Delft researchers have the right attitude. It's what makes you a good academic.

"Organisations which fund fundamental research are often open to serendipity, whatever form that might take. They also have to have a flexible attitude, because without flexibility, fundamental research is impossible. But it would be nice if there were a few more subsidies and grants that had not yet been earmarked - even for TU Delft- to reward serendipity.

"During your studies you only really learn how to deal with chance discoveries during your internship. Or you should do, anyway. Internship supervisors need to be aware of serendipity and transfer that mind-set to their students. I think this happens a lot at TU Delft.

"How you can encourage more serendipity? Go to a lot of cross-discipline lectures so that you get out of your own little bubble for a bit."

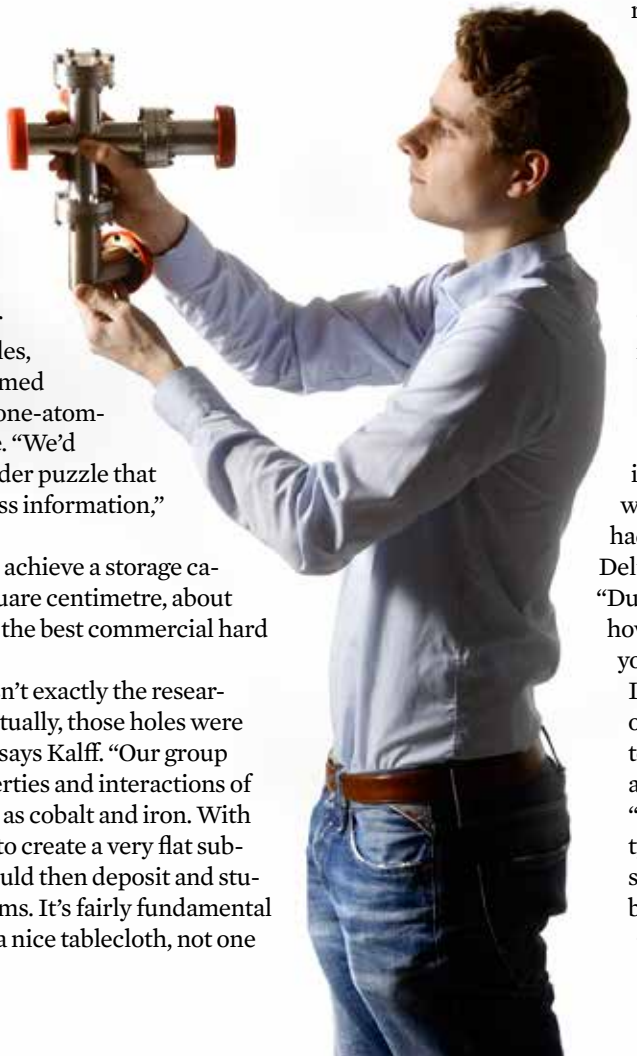


PHOTO: SAM RENTMEESTER

‘Africans have less, but share more’

Architect Stefanie Tseggai went to Kenya for a study project and found echoes of her own life at home. Five years later, the TU Delft alumna is returning with two partners to build a health centre.

TEXT JOS WASSINK PHOTOS SAM RENTMEESTER

"Africans often have less, but they share more', Stefanie Tseggai noticed when she arrived in Pokot, Western Kenya in 2011. Architecture students Stefanie Tseggai, Carlijn Kingma and Niek van Laere worked with people from the East Pokot Medical Project on the design of a medical information centre in the Pokot region. It marked the start of the Pokot Resource Centre project, which recently acquired the support of Wilde Ganzen, an organisation that combats poverty worldwide. Having graduated, the three architects are now preparing to complete the project. "Investing in Pokot enables people to make more of their lives", believes Tseggai.

You were all set to leave for Kenya to start building, but something got in the way. What was it?
"The project was delayed because of extreme drought. You need water just to be there and also for building."

Four of your people were already there. What were they able to do?
"From early November, they did research to locate water sources. They were there during the short rainy season. But there was so little rain, they had to return to the city a week early and could not stay in Barpello."

What impact is the drought having on the people?
"About 10,000 people live in and around the two villages of Barpello and Kositei, where we're building the centre. Approximately 750,000 people live in the East Pokot region as a whole. For them, water is a matter of survival. Women and girls often walk for hours to the remaining wells to return laden with water for their family. Many wells are shared with livestock, which means that the water becomes polluted and a source of infection."

With your partners Carlijn Kingma and Niek van Laere, you designed an outpatient clinic and an information centre there. What is happening with that?
"It will happen eventually, it's a question of when. Having consulted the students who were there and our Kenyan partner East Pokot Medical Project, we decided to develop a water system for the centre first. We are having geologists investigate whether a well is an option and are installing dams to collect rainwater. We will start construction after that."

You originally planned to build between April and the summer; I assume that will shift a little?
"It might. If the drought continues, we will not be able to start on time before the elections in August. It is advisable not to be in Kenya during the elections because of the chance of unrest. In 2007, there were many riots between different tribes and there were even some fatalities.

How did the idea to build there come about?
"Through the TPM faculty's minor in international entrepreneurship and development, Carlijn, Niek and I came into contact with sister Esther. She manages the East Pokot Medical Project and explained that many health problems are due to ignorance – about HIV/AIDS and FGM, for example. FGM may be a ritual part of traditional culture, but it entails numerous health risks. We went there to see what the organisation needed to provide information about these issues. We concluded that a new centre was needed, because not everyone felt welcome in the places currently used for this, such as a church."

'Investing in Pokot enables people to make more of their lives'

Will there be a clinic in that centre?
"Yes, the organisation already has a clinic, but it is in a sorry state and too small. A new clinic will be built next to the information centre. Niek, Carlijn and I are designing the information centre and the Kenyan architect we work with is designing the clinic."

How long have you been working on this?
"In 2011 and 2012, we spent six months working on the project and raising some of the funding. We decided that we had too little experience to do the actual building. We then agreed with the people there that we would do the building after our Master's."

How did you remain in contact over the years?
"Things were put on hold. We congratulated each other on birthdays, etc. When there was something to report, we did so. Or just asked how things were going, mostly via Whatsapp or Skype. Whatsapp is used for nearly everything there."

CV

/r. Stefanie Tseggai (Amsterdam, 1987) has an Eritrean father and a Dutch mother. She began studying medicine at the University of Amsterdam. Unable to express her creativity she switched to Architecture at TU Delft, "because, for me, it combines art and science". During her Master's degree, she spent an exchange year at the Art Academy in Copenhagen, becoming proficient in furniture making and interiors. She graduated in 2016, specialising in the development of construction materials from the by-products of water treatment in her thesis 'Infinite Mining for Structural Composites'.

Did the choice of Africa have something to do with your roots?

"I feel an affinity with East Africa because my father is Eritrean. My mother is from the Netherlands. I feel at home in Kenya because of the way people treat each other."

Did Africa play a role in your upbringing, in shaping who you are?

"In my family and the Eritrean community, respect for others is very important. You treat other people as you would like to be treated. That's how we see things. Also: other people have just as much right to food, drink and shelter as you have. Sharing and helping others are therefore important values for us. I notice that, although they have very little, people in East Africa still share a lot. In a community like that, I often feel more at ease than in a more individualistic society. But I grew up in Amsterdam, so I guess I'm a product of both."

Projects like this can often go wrong just at the point that the building is complete and is being handed over. How do you intend to prevent that?

"I am fully behind this project because it is the result of collaboration rather than one-sided development work. It is the initiative of the local community and the local NGO, the East Pokot Medical Project that has been active for 36 years.

'Clay walls with steel rafters'

They have the greatest stake in it because they raised funds and commissioned the building. We see ourselves as advisers and facilitators. We conduct research and provide drawings, but rely on the skills of the local population. During construction, we will be working with the Kenyan contractor to train builders, and they will tell us which type of clay is most suitable."

What materials will you use for construction?

"We want to take existing local techniques and materials as a basis, but the Pokot see a grass roof and clay as old-fashioned, so we will be combining clay blocks for the walls and floors with a steel roof structure. We hope they will see the building as modern and accept it. We are also using steel-reinforced concrete for the foundations."

How do you see your future as an architect?

"After this project in Kenya, I intend to qualify under the supervision of a registered architect. It is a two-year process. I want to specialise in the efficient use of materials in production and design. I intend to use that knowledge to work on projects in East Africa for an NGO, an architects firm or UN Habitat (the United Nations construction programme). I can do that based here or by heading off again." <<

pokotresourcecentre.nl

POSTSCRIPT

After the interview, the drought continued relentlessly. 'The drought has descended into a mad cycle of violence and retaliation', wrote Koert Lindijer in the NRC newspaper (21 February 2017) about disagreements between nomads travelling with their livestock. The Red Cross predicts that three million people in Kenya will need urgent food aid. If the surrounding countries are included, more than 16 million people face famine.

TEXT: TOMAS VAN DIJK ILLUSTRATION: AUKE HERREMA

Autonomous crashing

Happily reading the paper while your self-driving vehicle guides you through the busy city traffic? That's something for the future.

In Silicon Valley, smart vehicles from Google, Uber, Ford and Nissan are already on the road. Although they still have a steering wheel, no one has to sit at it – except in emergencies. Tesla director Elon Musk believes that cars will be driving fully independently in five years, even in busy cities. Ford has announced plans to sell cars without steering wheels by 2022.

Maarten Sierhuis is in no hurry to buy one. An expert in artificial intelligence, he is head of a Nissan self-driving car lab in Silicon Valley. He did not mince words about these rolling robots at the symposium 'The Future of Driving', organised by students of the Electrotechnology Association(EEMCS faculty).

"Anyone who says that you will no longer need to sit behind a steering wheel in a few years is lying. We're making an autonomous car that will be able to drive in cities by 2020. But it's very much an eyes-on vehicle." Don't imagine that completely autonomous vehicles will be driving round the city in 5 to 10 years' time."

According to the man from Nissan, cities are a nightmare, with all their pedestrians, cyclists and badly-parked cars. "Autonomous vehicles can still barely recognise a pedestrian if he is standing next to a tree. The sensor technology is not yet sufficiently developed."

RULES OF THE ROAD

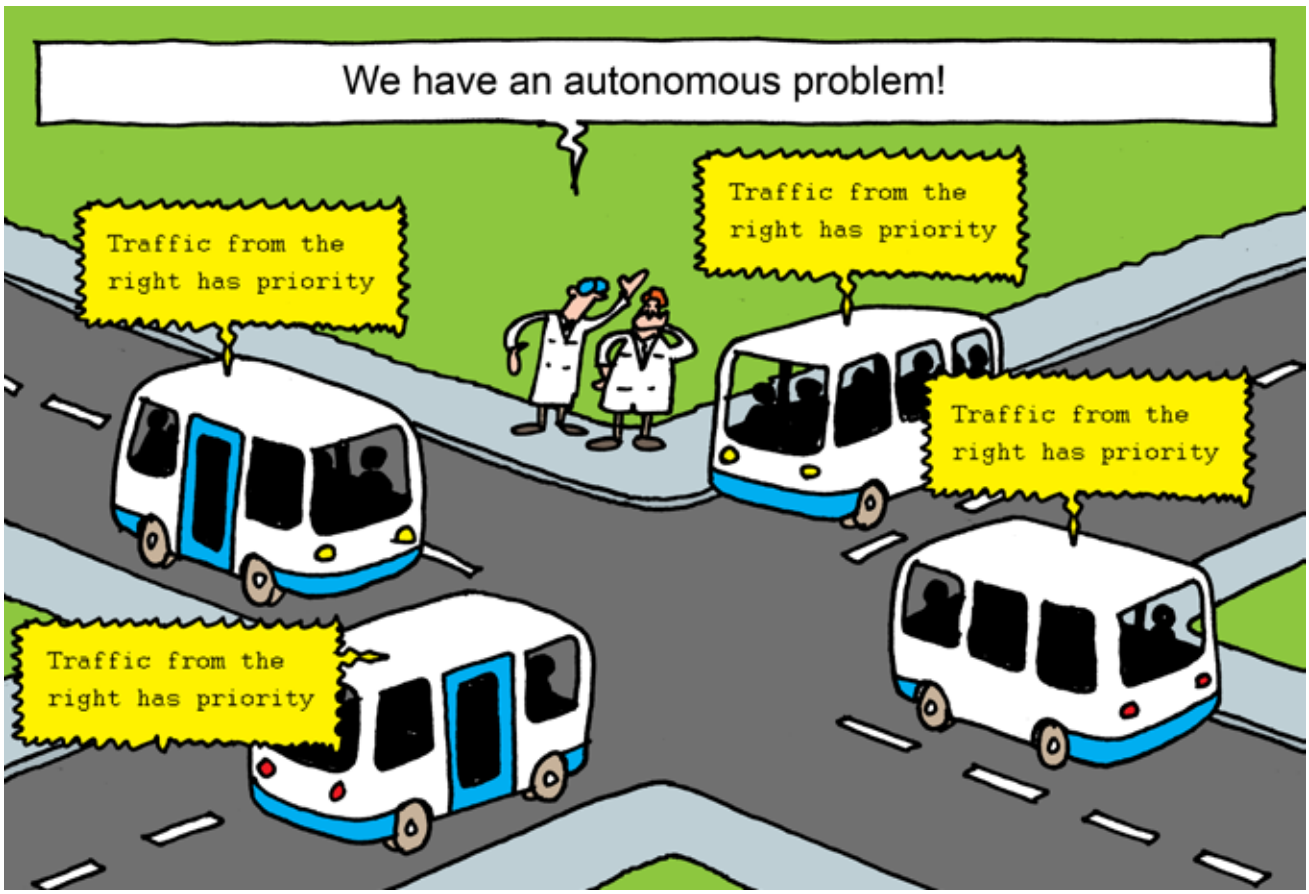
The greatest challenge is in the field of artificial intelligence. No one sticks strictly to traffic rules. People negotiate a route through the city through body language and gestures. "The software must learn to understand people."

Autonomous cars have to change gear quickly, within a fraction of a second. "That calls for enormous computer power and electricity."

DANGEROUS SITUATIONS

And there is the further problem of social acceptance. "Autonomous vehicles are a pain. Recently, I was driving home late at night. Three Google vehicles were driving in front of me at 25 mph. "Get out of my way", I thought. But I guess they have to stick to the rules of the road."

Such obedience is not only annoying, it can even be dangerous. What happens if four autonomous vehicles meet at a junction where each has priority from the right? It creates an impasse, and all cars come to a standstill. People behind will get impatient and engage in dangerous takeover manoeuvres. Autonomous vehicles need to be flexi-



ble regarding traffic rules. This was also the message from Serge Lambermont, head of autonomous driving at car component manufacturer Delphi. He is working on a trial in Singapore. The city state aims to have a completely autonomous vehicle system on call, a kind of robotised car2go.
Lambermont: "People drive aggressively in Singapore. As soon as you start indicating, they accelerate to close the gap. We need to tweak the car to make it drive more aggressively."
But that could mean that the car does not always maintain the legally required distance from the car in front.
Lambermont: "I don't know if it's possible to have a car drive autonomously according to the traffic rules."

CREATIVE WITH RULES

Professor of autonomous cars and artificial intelligence, prof. Pieter Jonker, believes that cars can learn to be creative in dealing with the rules and also to behave socially, including making eye contact.
"Through deep learning, cars will learn to respond adequately in all kinds of traffic scenarios. And they will need to be able to simulate eye contact with human road users. An autonomous car can use a LED light that goes green to indicate it has seen you. That's clearly the direction developments are taking."
Jonker knows only too well that human interaction can be tricky. He is closely involved in the development of the WEpod, a small semi-autonomous bus that transported people between Ede and Wageningen this year. "The WEpod drives along a set route, a kind of virtual tramline, and has someone on board who can intervene if necessary. We tested it last September in Amsterdam on a route full of taxis, pedestrians and cyclists. It was extremely difficult. We often had to use the joystick to adjust the steering."
Jonker believes that the first autonomous driving in the city will be in such vehicles as the WEpod. "They drive very carefully. If they come across something, they stop. They will never hit anyone, but can only be hit by other vehicles." <<

'An autonomous car can use a LED light to indicate that it has seen you'

TEXT: JOS WASSINK PHOTO: MARCEL KRIJGER

Roboat ahoy

As the development of self-driving cars advances, the shipping sector cannot lag behind. Ships are getting smarter and autonomous 'roboats' are on the horizon.

The Faculty of 3mE's press afternoon drew a crowd. Journalists scurried around the huge water basins. They watched a model boat as it manoeuvred back and forth between cryptic signs with black & white patterns. Head of the research project Dr Rudy Negenborn spoke to reporter Marc-Robin Visscher from Radio 1. "Soon the best navigating officers will all be ashore," was the message.

Although fully autonomous 'roboats' do not exist yet, it does not put a damper on high expectations. Some believe that ocean crossings will be roboticised first. Others have ferries or container transport between various terminals in ports in mind. Autonomous patrol boats are candidates, too. Whether a conveyance flies, sails or drives does not really matter to Dr Rudy Negenborn. As an expert in artificial intelligence at 3mE, his mission is to make means of transport smarter. "Just look at how much a car already controls itself." He understood that as part of a global logistics system there is still much to gain in shipping.

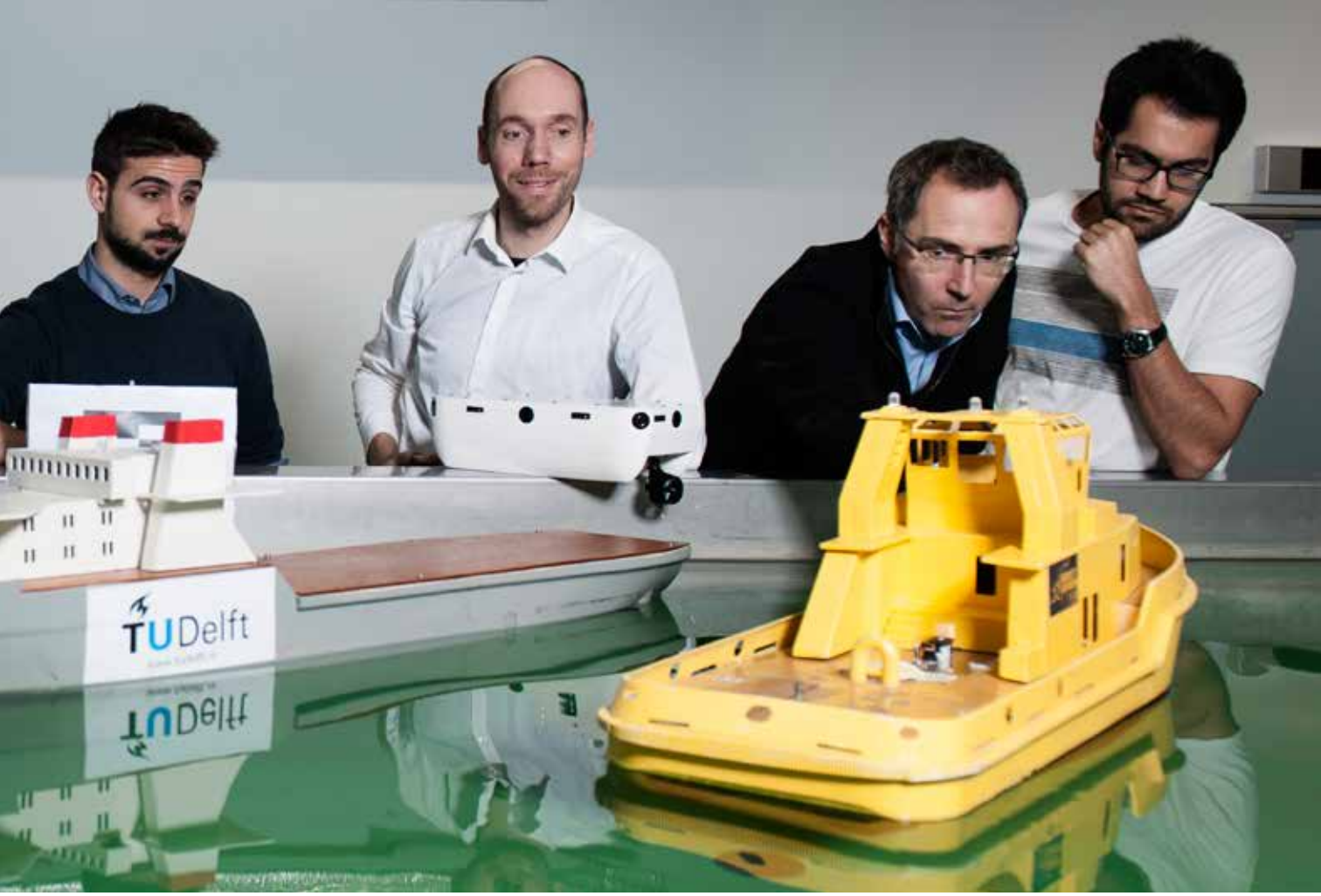
In 2010, he received a Veni grant from research funding organisation NWO for his proposal to coordinate transport flows. 'This study allows local transport hubs to independently interact and negotiate on a continuous basis. The result is more effectively coordinated and more efficient transport management,' he wrote at the time. After receiving the grant, Negenborn recruited five PhD students, the first of whom had already defended their theses.

SENSORS

Making ships intelligent starts with installing sensors to allow them to detect their surroundings. The second step involves using this information. A navigating officer can do that, but so can an operating system that processes sensor data into usable information and controls engines and rudders on the basis of it.

An example is 'dynamic positioning', which ensures that a ship stays on course regardless of wind and current. "More and more intelligence is coming on board," said Negenborn. "This is true in inland shipping now, too. Barge captains are receiving increasingly better information such as adaptive route planners and arrival time estimates. Although this is currently still in the ship, it would be interesting for terminal operators if this information is exchanged."

As more intelligence is introduced on board, the role of humans in the chain of activation, monitoring and supervision moves to the next level. In other words, when ships are able to sail themselves, humans must contemplate



From left to right: Vittorio Garafano, Rudy Negenborn, Milinko Godjevac and Ali Haseltalab.

the where and the why. The strategic choices.
But is autonomous shipping safe in busy ports? "Much is possible technically. Legally not very much," said Jan Willem Verkiel from the Port of Rotterdam, summarising the situation. The former Navy officer is the project leader for Rotterdam's port director.

'Much is possible technically. Legally not very much'

He pointed out that all legislation assumes that a ship is navigated by a ship's master or captain who is responsible for the craft. Who is the responsible party in the case of an autonomous vessel? To avoid getting tangled up in legal quibbling, the port director has designated two testing areas for autonomous ships: in the Rijnhaven and next to the RDM site.
"Autonomous sailing is a long way off for us," said Verkiel. "Still, the path leading to it can encourage technical developments." As an example he mentioned navigation advice from the computer, which sometimes has a better overview of what awaits the ship up ahead than a human navigating officer.

SAFETY

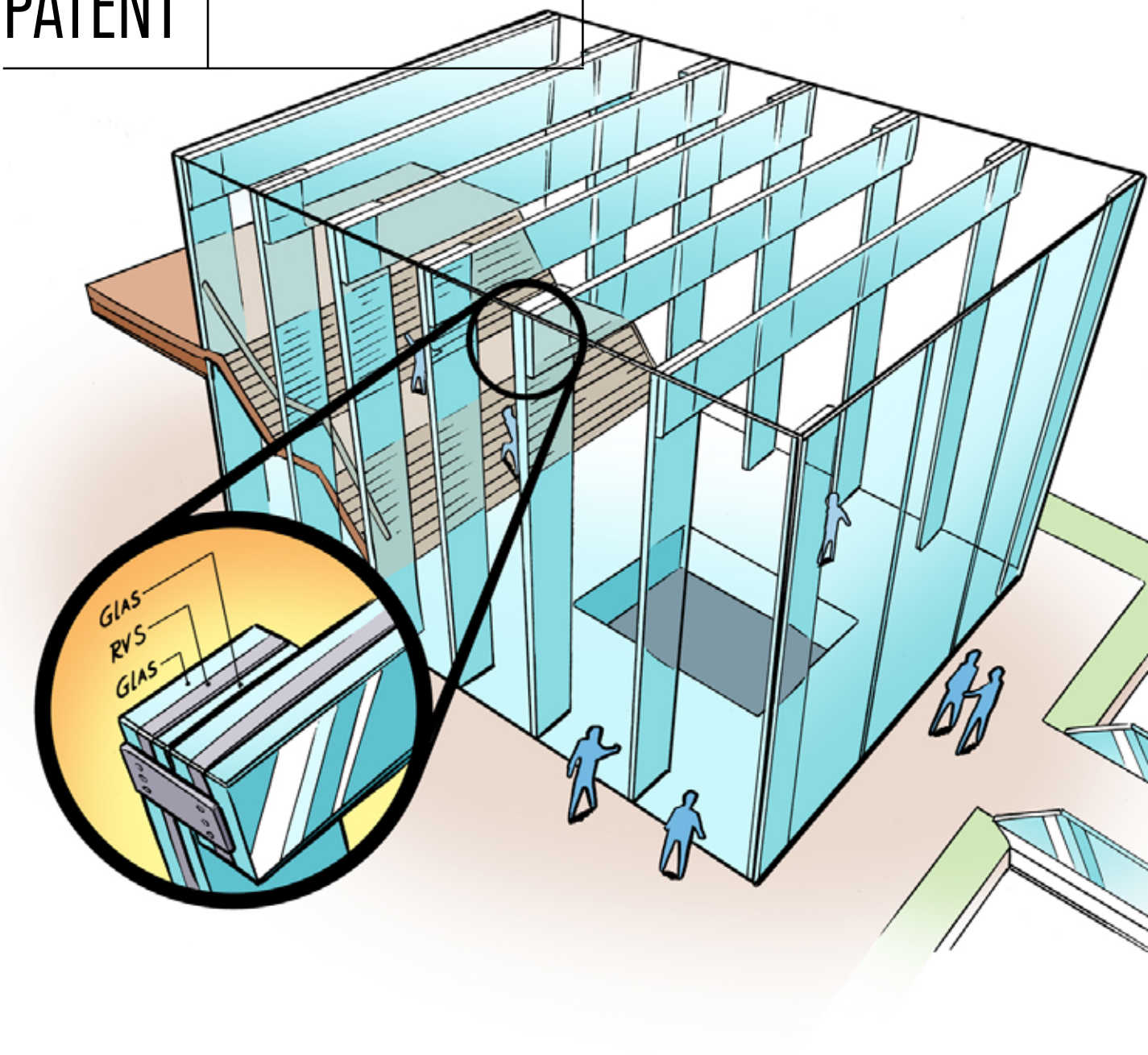
There is still a great deal of uncertainty regarding safety, said Verkiel. "Obviously, the identity of the ship's owner must be known and there is a need for rules regarding liability. But consideration must also be given to practical matters such as the option to tow a stalled vessel or some kind of emergency button to disable systems remotely."
"That has to work," said Negenborn with a laugh. He and his PhD students are working on two different types of ships. The Seabax looks most like a model freighter. The other type, the Delfia, is a sailing platform that can move in every direction. In the future, clusters of these could transport containers between terminals.
What will be the first robot ships? Negenborn is thinking ferries between two fixed points, or sailing robots that take samples to test water quality. Patrol ships present opportunities, too. At sea, huge offshore wind farms tend to be guarded by multiple patrol ships, some of which could effectively operate independently. He expects this will take 10 to 20 years. Meanwhile, all sorts of parties are calling to find out what more floating intelligence can do for them. The vanguard of the 'roboat' is an armada of increasingly smarter ships. <<

R PATENT

A safe joint configuration for glass structures

Inventor:
Fred Veer

ILLUSTRATION: STEPHAN TIMMERS



The most famous example of an entirely glass structure is the Apple Cube 2 in New York. There is one problem, however: it cannot be used as a building because it fails to meet statutory safety regulations, says associate professor Fred Veer. A glass supporting structure must be properly safeguarded against collapse, which according to Veer is exactly the problem. The glass columns and beams must be fastened together with steel armature, but you do not want to make holes in glass. Veer had already spent a considerable amount of time looking for a way to connect the reinforced elements to one another. One night, he woke up and envisioned the solution: the armatures would be bolted together using a stainless steel (rvs) hollow cylinder that would be bonded to the glass element. "In other words, we never make a hole in the glass. The glass is connected to metal using only adhesive."
The advantage according to Veer is that less steel is required and can be connected to non-glass elements using the same method. "The glass walls can be produced prefab and subsequently bolted down at the building site." Veer tested the load capacity for stresses up to 8 metres; 12 metres will be tested next. If it holds, the world's largest glass hall – 12 metres high, 30 metres long and spanning 12 metres – will open next spring in the Green Village on the former Architecture grounds. A beautiful exhibition space. GVD

COLUMN

Time for tinkering

One of my favourite inventor stories is about the American Spencer Silver. He was working for technology company 3M and wanted to develop a superglue but came up with the weakest adhesive ever. If you spread it on to a piece of paper, the paper will stick to a wall, but is just as easy to remove. It was 1968 and Silver had no idea what to do with his weak glue. It was only years later that he spoke to someone who showed interest in his invention: a colleague who sang in a church choir and was irritated by bookmarks falling out of his book. And so the idea of the post-it was born and it made millions.
The theme of this Delft Outlook is serendipity: discovering something useful by chance. A great theme – from the discovery of America to that of penicillin; in each case, they were actually looking for something else. It seems to me that one of the preconditions for making chance discoveries is a lot of time for tinkering: hours in the week not driven by the need to deliver a product according to a list of functional requirements negotiated to the final detail. Hours in the week when you can take your time and look at your work from all angles and wonder: what else can I do with this, who else should I show this to and share ideas with?
Spencer Silver, the post-it man, worked at a company that encouraged its staff to spend 15% of their time on their own projects. No managers demanding results, no customers on the line: just give a shout if you think you're onto something.
Other famous technology companies apply a similar philosophy. In a memorandum, the founders of Google wrote: 'We invite our employees to spend 20% of their time on projects alongside their regular projects that they believe would benefit Google the most. This policy makes employees more creative and innovative.'
Sounds fantastic, until you read the revelation by ex-Google boss Marissa Mayer on Business Insider. Anyone who is so keen to work on their own projects, she said, does that on top of their regular contract at Google. 'I'll let you into the secret of Google's 20% time. In reality, it's 120% time.'
At the start of this column, I had no idea it would end here: in an ugly dark chasm between corporate policy and business practice. Tinkering time that is actually unpaid overtime for your boss. Maybe we should see it as serendipity's nasty brother: when you discover something that you weren't looking for, but would perhaps prefer not to have found.

Tonie Mudde (1978) is the Head of Scientific News at *de Volkskrant* newspaper. In Delft, he studied Aerospace Engineering.

IN PERSON

PHOTOS: SAM RENTMEESTER

Prof. Pieter Desmet (IDE)

has been awarded a Vici grant to explore why certain products make some people, but not others, feel good. With his 'From gloomy to cheerful' research project, the Professor of Design for Experience wants to find out why some products have a positive or negative effect on a person's mood. He ultimately wants to be able to design spaces that 'actively contribute to a positive mood.'

Prof.Carola Hein (A+BE)

and colleague Juliette Bekkering (TUE) have been granted a subsidy by 4TU (the four technical universities in Delft, Eindhoven, Twente and Wageningen) to print objects of historical value in plaster. They will copy architectural and decorative elements from the 15th-century Gothic St Hippolytus church in Middelstum. Should the church suffer earthquake damage, the team will be able to repair it quickly.

Prof. Isabel Arends (AS)

is playing an important role in the newly reorganised Netherlands Organisation for Scientific Research (NWO). She is vice-chair of the Applied and Engineering Sciences department. The STW funding organisation used to cover applied research, but this body has been disbanded. At the same time as the abolition of the STW, the NWO was reorganised and is now divides into four departments.

Dr. Arjan Houtepen (AS)

has become a member of the Young Academy, a group of 50 young scientists who are committed to the popularisation of science. Houtepen investigates how lamps, screens and solar cells can be made more efficient using nanotechnology. He focuses on colloidal nano-materials, materials that develop different properties when the form of the molecules changes.

New honorary doctors building on life

During the January Foundation Day, three scientists and one non-academic expert were awarded honorary doctorates by TU Delft. Their expertise reflects the anniversary theme of 'technology for life'.

Drew Endy, Associate Professor of Bio-engineering at Stanford University, is one of the builders of the biological equivalent of the transistor, the so-called transcriptor.

The Harvard professor of chemistry and chemical biology **Xiaowei Zhuang** is best known for her 'Storm' technique, with which she introduced nanoscopy.

Professor **Alessandro Vespignani** of Northeastern University, Boston, is an expert in viruses and the founder of a new field of research, network epidemiology. Civil engineer **Manuel Alvarinho** is the founder and chair of the Water Regulatory Council in Mozambique.

PHOTO: ROY BORGHOUTS

The four honorary doctors of 2017 (from left to right): Drew Endy, Xiaowei Zhuang, Alessandro Vespignani and Manuel Alvarinho.

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After Delft

His grandfather was a pilot. His father flew F-16s, was an air force commander and chair of the Netherlands Agency for Aerospace Programmes. Allard Droste was also destined to fly, until he had to wear glasses.

But still, in 1990, Droste opted to study Aerospace Engineering at the faculty where his father would later become Dean. He graduated in 1997, specialising in Glare floor panels for the Airbus. Fokker had just been taken over by Stork. After a two-year traineeship, he secured a management position there. He did marketing and sales and spent a year at Insead on a management programme in Fontainebleau and Singapore.

Back in the Netherlands, he became director of a Stork operating company until, ten years later, he got the entrepreneurship bug. He wanted to work on lean management, developed at Toyota after World War II. That manufacturer started making one car at a time, on customer demand. "That means you have to be extremely lean to be capable of making a car at lightning speed", he explains. "What you make is finished in one go and slightly better each time." Droste hired himself out as a consultant. Fun, but lonely. So he decided to buy an existing company with no successors: Aldowa, a supplier of metal, aluminium and stainless steel. "Very hierarchical, there was no room for staff input." Self-management was his answer: everyone the boss, contributing ideas. "We have no departments, managers, authorisation schedule, job descriptions, working hours, organisational chart or fixed structure." The magic word is trust. Trust combined with personal responsibility. It's going 'amazingly' well, says Droste. "We have increased turnover by a factor of five, sick leave is down by a third and we have won some prestigious awards." Aldowa focused on construction projects, and its work has included the inside of Rotterdam's Markthal and the facades of

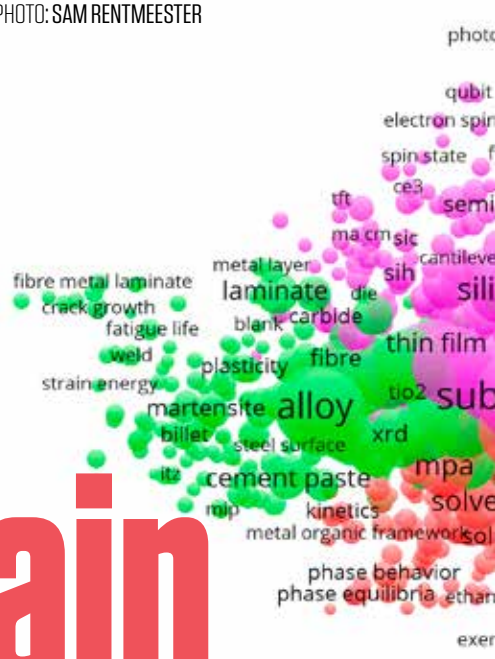
PHOTO: SAM RENTMEESTER

Professional dreamer with structure

Rotterdam and Utrecht central stations and the new student accommodation in Stieltjesweg in Delft. Droste has taken to calling himself a 'professional dreamer' because he finds it cold and business-like to talk in terms of targets. A large dream board hangs in his open-plan office. It once said 'do the Markthal'. He then acts as if the dream is already reality. "Then magical things start to happen: people become more enthusiastic, start believing in it, search for solutions rather than excuses. That's what gives us structure."

And now? "I'm now facing the greatest experiment of my life: I'm letting go of Aldowa somewhat." He invested in two start-ups: Shake-on in Delft and StartMonday in Amsterdam. He is a supervisory director at online learning platform Squla and has also published a book about his experiences. "It's already a bestseller, only ten thousand people still need to read it." CWD

TEXT: TOMAS VAN DIJK IMAGE: BIJAN RANJBAR-SAHRAEI/VOSVIEWER PHOTO: SAM RENTMEESTER



TU Delft's brain

What's hot and who's working together? Data expert Dr Bijan Ranjbar-Sahraei (3mE) visually rendered the most important keywords in tens of thousands of TU Delft publications. Clusters and buttons illuminate his images like functional MRIs of a brain.

With a little imagination you can see a cerebral cortex light up in blue at the lower right. With words like basin, erosion and sediment, this is the domain of hydrology. Researchers from the CEG Faculty rule the roost here. It is far removed from the world of electron spins and semiconductors in the 'frontal lobe' in pink at the upper left. That's primarily Faculty of Applied Sciences territory.

Neurologists create atlases of the brain; Dr Bijan Ranjbar-Sahraei did something similar for the University with the help of keywords. Using the Web of Science database, he collected the titles and abstracts of all scientific articles on which TU Delft researchers collaborated between 2003 and 2015: some 20,000.

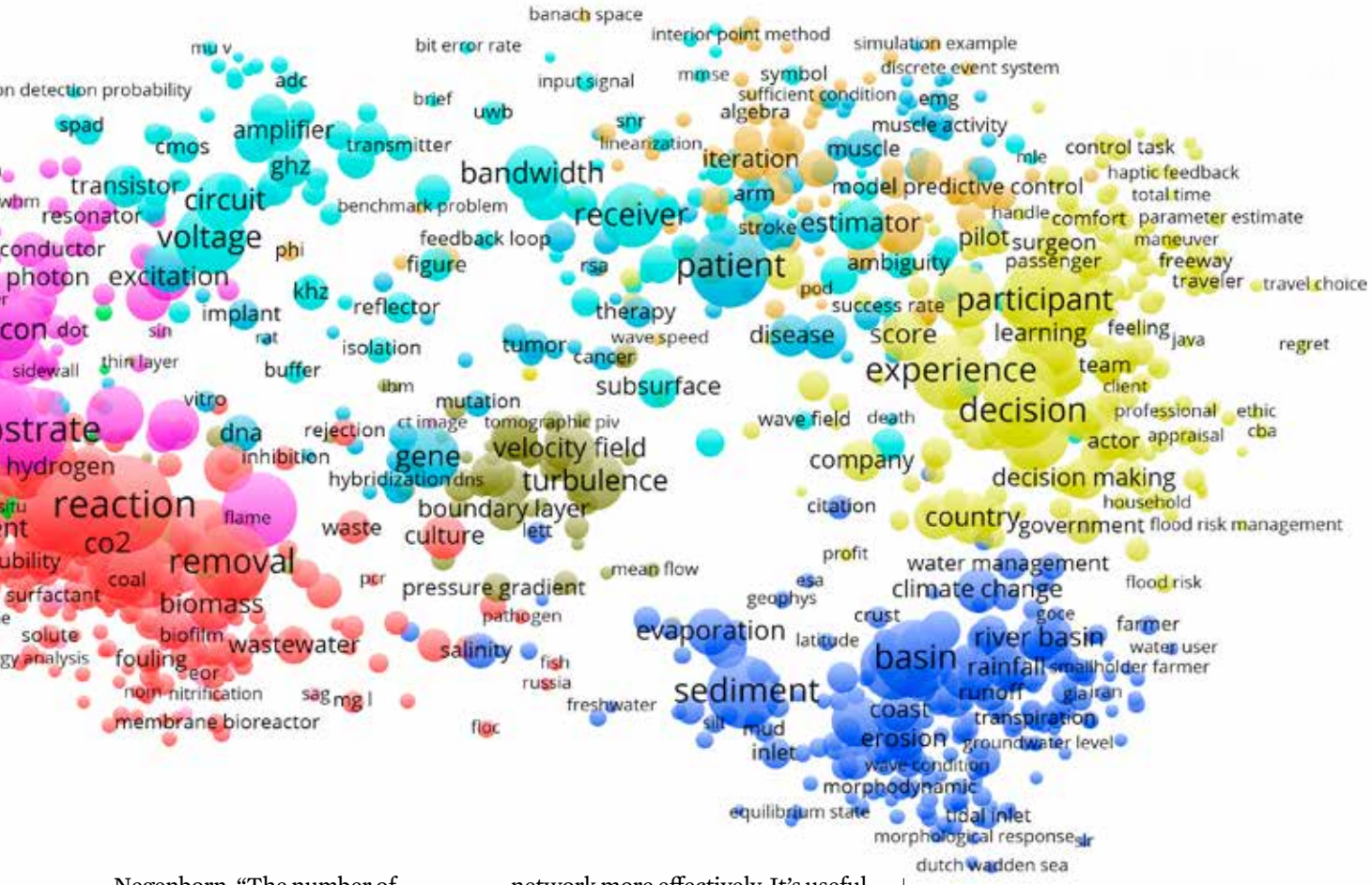
The Iranian post-doc from the 3mE Faculty mapped the relationship between the scientific terms using the visualisation programme VOSviewer, which was developed by researchers at the Centre for Science and Technology Studies (CWTS, Leiden University). With assistance from TU Delft Library, he also managed to link each publication to one or more faculties. This allows you to see which topics regularly appear in a faculty's publications and whether there is overlap with other faculties.

'It is becoming increasingly difficult for researchers to maintain an overview of their field'

IDENTIFYING TRENDS

The data visualisations provide an example of what you can do with VOSviewer and related programmes. These are calling cards for Aida (Automatic Identification of Research Trends). This project aims to familiarise researchers with scientific literature and, as the name indicates, identify trends. "It can be extremely helpful especially for fledgling PhD students and tenure trackers who want to position their research effectively," said Dr Rudy Negenborn, Aida initiator and associate professor in the Maritime & Transport Technology department (3mE).

"Thousands of new scientific articles are published every month," said



Negenborn. “The number of journals and channels through which publications are presented is only increasing. It is becoming increasingly difficult for researchers to maintain an overview of their field.”

Those who can no longer see the forest for the trees can turn to Aida. Researchers involved in the project, including Ranjbar-Sahraei, and colleagues from Leiden’s CWTS and TU Delft Library, help you explore your field of research.

“We help them use automatic big data analysis tools to map out which researchers and research groups in the Netherlands and abroad are active in their field and what the trends are,” said Ranjbar-Sahraei. “Who might you be able to work with? Also, are there groups you had wanted to cooperate with which have been associating themselves with other topics in recent years? The analyses can produce those types of insights, too. These are useful enquiries in preparation for attending conferences: you can network more effectively. It’s useful for writing grant applications, too.”

Back to the faculties. As yet, interpreting the images is tricky. “We are in the early stage of exploration. Consequently, it’s important that we interpret the visualisations with researchers from various disciplines who can identify the keywords.”

Ranjbar-Sahraei wants to zoom in closer on the faculties and go over the resulting images later this year with the TU Delft deans. “The study can indicate opportunities for better cooperation between research groups and departments that faculties are currently ignoring.”

3mE dean Theun Baller is already excited about the initiative that emerged in his faculty. “Data mining and the use of big data the way it is being done in this project is important. These tools can definitely further enhance our research.” <<

Aida will organise a workshop in the spring. More information: aida.tudelft.nl.
Read more at delta.tudelft.nl

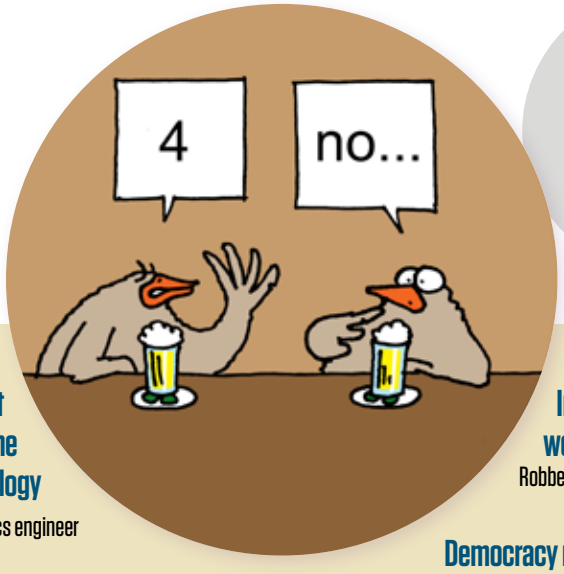
Data analyst Bijan Ranjbar-Sahraei (1966) has been working on the Aida project at TU Delft since last year. Before that he did his PhD research at University of Maastricht. In 2016 he defended his thesis ‘Mining and Modeling of Dynamic Social Graphs’. In 2011 he graduated as a master student in control engineering at Shiraz University in Iran. His graduation research concerned controlling robotic swarms.

HORA EST

Access to electricity should be a human right

Pradyumna Bhagwat, SEPAM engineer

"Electricity has become a basic requirement in society. The discovery of electricity has led to economic growth and hugely improved our lives, in terms of access to information, education, healthcare, mobility and entertainment. However, much of the world's populati on lives without electricity. Access to it would help these people to advance up the energy ladder and significantly improve their lives. This is why I believe everyone should have access to electricity. It should be a f undamental right."



All birds are four-legged
Nicolaas van Adrichem, computer science engineer

Astronomy is the best replacement of war when it comesto driving the development of new technology
Reinier Janssen, physics engineer

In a world ruled by war, there would be no reason
Robbert-Jan Dikken, materials engineer

Democracy relies on the education of the people
Rui Hou, electrotechnical engineer

The exponential growth of scientific publications on graphene does not imply an exponential growth of graphene large scale applications
Leonardo Vicarelli, physics engineer

The danger of direct democracy is that people are forced to have an opinion
Max Koole, electrotechnical engineer

Hydrological models benefit more from brain power than from computer power
Tanja de Boer-Euser, physics engineer

Tolerance works better than perfectionism since people are not perfect
Tiantian Yao, physics engineer

Having higher education or academic position is neither nesessary nor sufficient to attain social percipience
Zahra Kolahdouz Esfahani, electrotechnical engineer

3D stacking is the new Moore's law
Ali Rezaie Adli, electrotechnical engineer

THE FIRM

Opening a brand-new pub at the age of 22 isn't typical student behaviour. But Marijke Vuik knew what she wanted, and eleven years ago she founded Doerak – a fixture in Delft.

The large windows of the Doerak beer café look out onto the Vrouw Juttenland canal. Next to cosy vintage shops and a tobacconist's, everyone can find their perfect drink on a menu that features 200 special beers. Doerak is popular with students, families and singles; a real pub. In fact, it fits into the street so well, you'd think it had been there for hundreds of years. Nothing could be less true, however: eleven years ago, this was a vegetarian restaurant with a purple and gold façade. Business was going badly and the building was sold. Marijke Vuik seized her chance. "I could see just how I wanted to renovate it," she explains. Vuik was only 22 at the time. "Perhaps I was a bit naïve. I did all of the renovations myself with friends. It gave me such a kick! In those first weeks I worked 80 hours a week, fuelled by adrenaline alone."

In fact, Vuik was still studying at the time. "I studied Industrial Design: a great degree, but I soon realised that my heart was in catering. I'd always worked in cafés alongside my studies, such as Oude Jan and Kobus Kuch. When this opportunity came, I could not pass it up." She was in her fifth year and still had a few courses to pass before graduating. "I thought I'd be able to complete everything after the renovations, but starting my own business gave me such a kick that I opened straight away." So she never did finish her degree.

PHOTO: SAM RENTMEESTER

Name:	Marijke Vuik
Business:	Doerak
Founded in:	2006
Product:	Beer café
Mission:	To create a pleasant venue with a range of beers.
Turnover:	"I'd rather that wasn't published."
In five years time:	"Our selection will change, but that's it."

Things went well from day one and the success continued. Doerak was renovated once more to create additional space, but it is still often jam-packed. Vuik opened a shop selling special beer, Flink Gegist, 4.5 years ago. "Customers often asked me where they could buy beer to drink at home, and I had send them to Amsterdam. At a certain point, I opened my own shop, where we offer a selection of 800 beers."

Besides Flink Gegist and Doerak, each year Vuik organises the Winter Beer Festival in Lijm and Cultuur and, as of this year, also the Coffee Festival on Doelenplein. "I ended up doing that by accident. We were at the coffee festival last year selling coffee beer and there was such a great atmosphere! When I heard that the organiser was stopping, I thought it was such a shame that I took over. The festival is relatively small and doesn't really fit with Doerak, but I think that coffee is a fantastic product."

Nevertheless, Vuik is unlikely to be opening a hip coffee tent any time soon. "There's a big difference between day and night catering. You have different expectations, both from the waiting and bar staff and from the customers. The pub's fantastic, the people who come here, the atmosphere you can create..." Doerak won't be changing much in future. "We'll probably change the selection, because there are so many beers on the market. Aside from that, business is good."

TEXT: CONNIE VAN UFFELEN PHOTOS: SAM RENTMEESTER

Journey through the past

TU Delft is 175 years old. You can still see traces of its history throughout the city centre.

On 8 January 1842, King William II founded the 'Royal Academy for the education of civilian engineers, for serving both nation and industry, and of apprentices for trade' at Oude Delft 95. Within less than 22 years it became the Polytechnic School, which offered study programmes in road construction and hydraulic engineering, shipbuilding, mechanical engineering and mining engineering. It received academic status in 1905 when Queen Wilhelmina officially opened the Delft Institute of Technology on 10 July. As from the mid-1980s, the designation 'institute' is legal only for higher professional education, and Delft University of Technology was created on 1 September 1985.

SCHUTTERSVELD 2, LIBRARY

From 1915 to 1997, the TU Delft library was housed in the Neo-Renaissance building at Schuttersveld 2, a former parade ground.

OUDE DELFT 39

The Dutch East India Company (VOC) bought numerous buildings on Oude Delft between 1620 and 1631 and consolidated them into Oude Delft 39. The VOC's Delft Office for spices and porcelain trade was established. The Architecture department moved into the building around 1930. Today, it houses students and an engineering firm.

OUDE DELFT 81

When one of Martinus Willem Beijerinck's PhD students, Gerrit van Iterson, was named professor of microscopic anatomy in 1907, Nieuwelaan 1 became too small. In 1908, Van Iterson was given his own premises at Oude Delft 81: the old magistrates' court. He cultivated plants for teaching and re-

search in the garden. The course that he would later call 'technical botany' began here. The building has been a student house for 93 years now.

OUDE DELFT 95

Brewery De Cimbel was housed in Oude Delft 95 until former mayor Willem Hooft bought the property 300 years ago, demolished it and commissioned the construction of his dream house. From 1799 onward, the building served as 'provincial office' for the Batavian Republic and later as orphanage and military academy. In 1842, King William II founded the 'Royal Academy for the education of civilian engineers, for serving both nation and industry, and of apprentices for trade'. It served as the main building for 110 years.

OUDE DELFT 87-91

In 1842, the municipality began purchasing the series of adjacent buildings at Oude Delft 87-91 for the expansion of the Royal Academy. From 1864 onward, the long white building with 22 windows in a row housed the department of drawing and embellishment for the faculties of Architecture and Civil Engineering in the Polytechnic School. In 1945, the building became the student house De Engelenbak, now 87-89. Number 91 comprises apartments.

OUDE DELFT 71

The building with the five windows at Oude Delft 71 was built around 1800 and housed the Microchemistry laboratory from 1898 onward. Today, it is a listed building and features apartments.

WESTVEST 7 AND 9

The Neo-Classical building at Westvest 9 was built around 1865 as an extension of the former main building at Oude Delft 95. It housed chemistry and mechanical engineering. A duplicate was built at number 7 (now number 5) 10 years later, where Physics labs and a large lecture hall were set up.

NIEUWELAAN 1

Martinus Willem Beijerinck and Albert Jan Kluyver, the fathers of the Delft School of Microbiology, were amongst those who worked in the former Microbiology Laboratory (1897-1957) at Nieuwelaan 1.

The Neo-Renaissance building's facilities include a library, microscopy room, chemical lab, studies, drawing offices, a professor's residence and living quarters for the concierge and lab assistant.

NIEUWELAAN 76

Nieuwelaan 76 was built for the mechanical engineering and shipbuilding departments between 1905 and 1911. It had a laboratory with three halls for testing vehicles powered by steam, gas and petroleum. In addition to the boilerhouse (which generated the steam), there was a coal chamber that was connected to the chimney that can still be seen at Ezelsveldlaan 61. A temporary building for aero- and hydrodynamics was built in 1921.

OOSTPLANTSOEN 25

This property was built in the early 1920s for the road construction and hydraulic engineering department. Hundreds of students gathered on the steps of this building on 23 November 1940 to protest the dismissal of Jewish professors by the Nazis. They spontaneously decided to go on strike after a speech by student Frans van Hasselt. From 1975, it served as an extension of the Delft Institute of Technology library for some time. <<

ALUMNI NEWS

From the UFD

Under the apple tree

If you are a woman who graduated or completed your PhD at TU Delft in recent years, you can compete for the Marina van Damme grant. Worth € 9,000, it is intended to give you a boost in the next step in your career.

The Marina van Damme grant was made possible thanks to a donation by the Delft engineer (1953) Marina van Damme, also the first woman to obtain a doctorate at Twente University. Her aim is to help female engineers from the technical universities in Delft, Eindhoven, Twente, and soon also Wageningen, to develop their careers. It can be used to broaden your education, gain more in-depth knowledge of your specialist field or increase your international perspective.

"The grant meant a lot to me, personally and professionally", says Joyce Kuiken, the 2010 winner. Kuiken graduated in architecture at TU Delft in 2006. She decided to apply for the grant several years later. "I prefer light and mobile construction and am particularly interested in building using textiles. There is a programme on that in Germany at the

The grant meant a lot to me, personally and professionally

Institute for Membrane and Shell technology [IMS] at Anhalt University of Applied Sciences in Dessau. The Marina van Damme grant enabled me to fund the course. It proved to be hugely enriching", she continues. "You work at a different level than as a student and I was able to develop a worldwide network."

Kuiken is now part of the panel judging applications and also chairs the Marina van Damme network. Every year, Van Damme invites this network of winners – 35 in total – to her garden, where they exchange experiences and forge contacts under the apple tree.

If you would like a chance to win this grant worth € 9,000, apply by 17 April – for details of the criteria and procedure, see ***universiteitsfonds.tudelft.nl***

Alumni Activities

4 April
Alumni event Oslo

16 April
TPM Alumni event NIBC

19-20 April
IDE Masterclass Brand Driven Design

Week starting 9 May
Canada alumni event - Vancouver, Toronto and Montreal

10 May
Applied Physics Alumni Day (VVTP)

17-18 May
IDE Masterclass Design Leadership and Innovation

8 June
Research Exhibition open for alumni - Delft

9 June
Anniversary Alumni Event – Delft

You too can support TU Delft talent by donating to the Delft University Fund:
ufondst@tudelft.nl
universiteitsfonds.tudelft.nl
NL48 ABNA 0441 4822 95,
'Universiteitsfonds Delft'.

CONTACT
Any questions, comments or changes of address? Alumni TU Delft:
alumni@tudelft.nl
alumni.tudelft.nl

175th anniversary of TU Delft

TU Delft celebrates its 175th anniversary in 2017. We plan to celebrate in style and hope you will be able to attend. For 175 days, Delft will focus on the theme Technology for Life. From 13 January to 6 July, activities will be organised on and around campus for and by students, staff, alumni, companies and residents of Delft.

International Festival of Technology

The annual International Festival of Technology will be held on campus from 7-9 June. This three-day festival combines technology, music and art. This year's IFoT will be particularly special, in view of TU Delft's 175th anniversary.
ifot-delft.com

TU Delft Research Exhibition

The TU Delft Research Exhibition will take place from 6-8 June: the Netherlands' largest exhibition of its kind. It will feature 175 TU Delft research presentations. In alliance with public and private parties, these state-of-the-art innovations have the potential for application in wider society. You can also listen to inspirational speed lectures and enjoy excursions to various research facilities.

PHOTO: ROY BORGHOUTS

The scientists behind the 175 cutting-edge technological and innovative research projects will be on hand to explain the research themselves. Come and meet them in person! Everyone is warmly invited to attend the TU Delft Research Exhibition. Admission is free, but registration in advance is compulsory. Professionals working in the business community, government or knowledge institutions and anyone engaged in technology and innovation will be particularly welcome on 6 and 7 June.
tudelft.nl/exhibition

IDE Alumni Programme

On 8 June, IDE alumni are invited to enjoy drinks/refreshments in the Study Association i.d.'s updated i.d-Kafee. There will be an exhibition of student projects and a programme by Master disputes for alumni, DfI, IPD and SPD students.
io.alumni.nl

CEG alumni programme

Alumni from the Faculty of Civil Engineering and Geosciences are welcome in the afternoon of 8 June for guided tours of various labs, soapbox sessions with new professors and a lecture by the "Practische Studie" study association. It ends with a drinks reception in the faculty café PSOR.
citg.tudelft.nl

9 June: Anniversary Alumni Event 'Technology for Life'

Especially for all alumni, we offer an afternoon and evening programme full of variety starting at 16.00. Featuring the announcement of the 2017 Alumnus of the Year and numerous prominent speakers from the 'Technology for Life' field, including Prof. Jack Pronk (biotechnology, industrial microbiology) and presentations on promising and inspiring student projects. Of course, you can also catch up and reminisce with your contemporaries at the campus music festival. In other words, an inspiring and celebratory programme for all TU Delft alumni.
175.tudelft.nl/programme

Stay up to date

Make sure you don't miss anything: visit 175.tudelft.nl for the latest news updates

TU Delft SINCE 1842 FOR LIFE

Book your calender!

From April on you can register for the alumni events on 8 and 9 June. You will receive a personal invitation by email.

The lab of...

Otte, Quantum nanoscience

Mari Carmen Martínez Velarte works with a low temperature scanning tunneling microscope, one of the most powerful techniques to study the surface of materials with atomic resolution. In the Otte lab researchers explore the very beginnings of what makes a material. To this they engineer and craft assemblies of sometimes thousands of atoms and investigate their collective characteristics as they emerge.

PHOTO: SAM RENTMEESTER