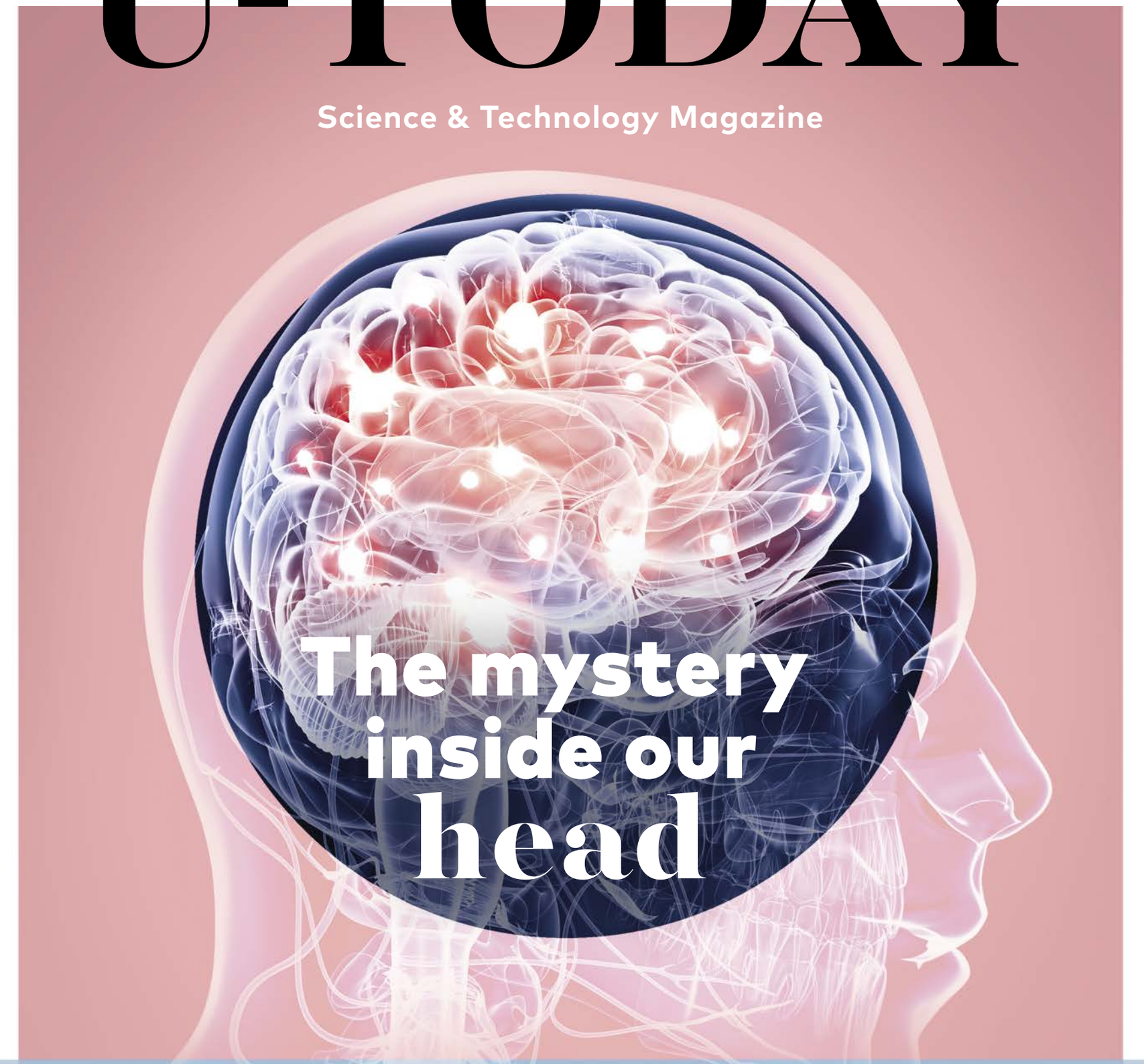
issue #6

UNIVERSITY OF TWENTE.

U-TODAY

Science & Technology Magazine



The mystery inside our head

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Logical fallacy

I recently attended a convention to keep my knowledge of my field up to date. One of the workshops I attended was hosted by Suzanne Weusten, psychologist, publicist and founder of De Denkacademie. She had us answer the following question:
Linda is thirty-one years old, single, outspoken and quite smart. She has a degree in philosophy. As a student, she was concerned about discrimination and social injustice and took part in various demonstrations to protest the use of atomic energy.
Which do you feel is more likely:

a. Linda works at a bank;
b. Linda works at a bank and is an active member of the feminist movement.

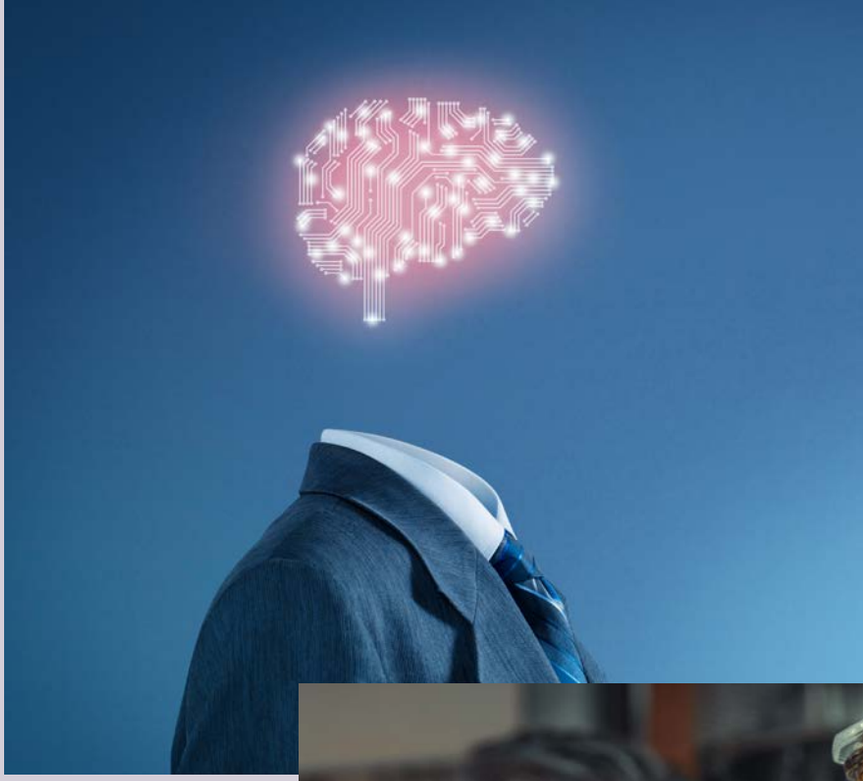
The correct answer is a, because the chance of Linda working at a bank is greater than the chance of her working at a bank and being an active member of the feminist movement. In this scenario, our intuitive evaluation of representativeness clashes with the logic of probability.
Weusten's workshop was about recognizing logical fallacies. 'Our biased brain leads us astray, deceives us and makes us believe that ours is the only correct opinion.' I was enraptured by her words, because our complex brain just so happens to be the topic of this edition's cover story.
All in all, it was a very successful convention about trends in the world of magazines. There were several international guest speakers, including Adam Moss, chief editor of New York Magazine. I loved hearing that a story comes across much better in print and that our faith in true journalism has increased by five percent. In other words, I left there brimming with renewed faith. What a fantastic field to work in. Print is the future! That feeling lasted until I got on the train back east and read a booklet titled 'How we deceive ourselves,' written by that same psychologist. One sentence in particular intrigued me: 'Focusing on your own truth can make you overlook essential information.'
Did I only hear what I wanted to hear? If so, what did I miss?

Anyway, in front of you is another wonderful, shiny edition of our magazine – in print.

Maaike Platvoet

Editor-in-chief at U-Today

u today



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Colophon

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Website
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U-Today editorial team
Maaike Platvoet (editor-in-chief), Michaela Nesvarova (magazine co ordinator), Sandra Pool, Rense Kuipers, Rik Visschedijk, Jelle Posthuma.

Other writers who contributed to this issue
Hans Wolkers, Wiendelt Steenbergen, Enith Vlooswijk, Frederike Krommendijk.

Photos by
Rikkert Harink, Eric Brinkhorst, Kalle Singer, Hans Wolkers.

Design and realization
Jeremiah Wetzel (SMG Groep, www.smg-groep.nl), Vanille (www.ikwilvanille.nl)

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U-TODAY

Science & Technology Magazine

Content

Text: **Michaela Nesvarova**
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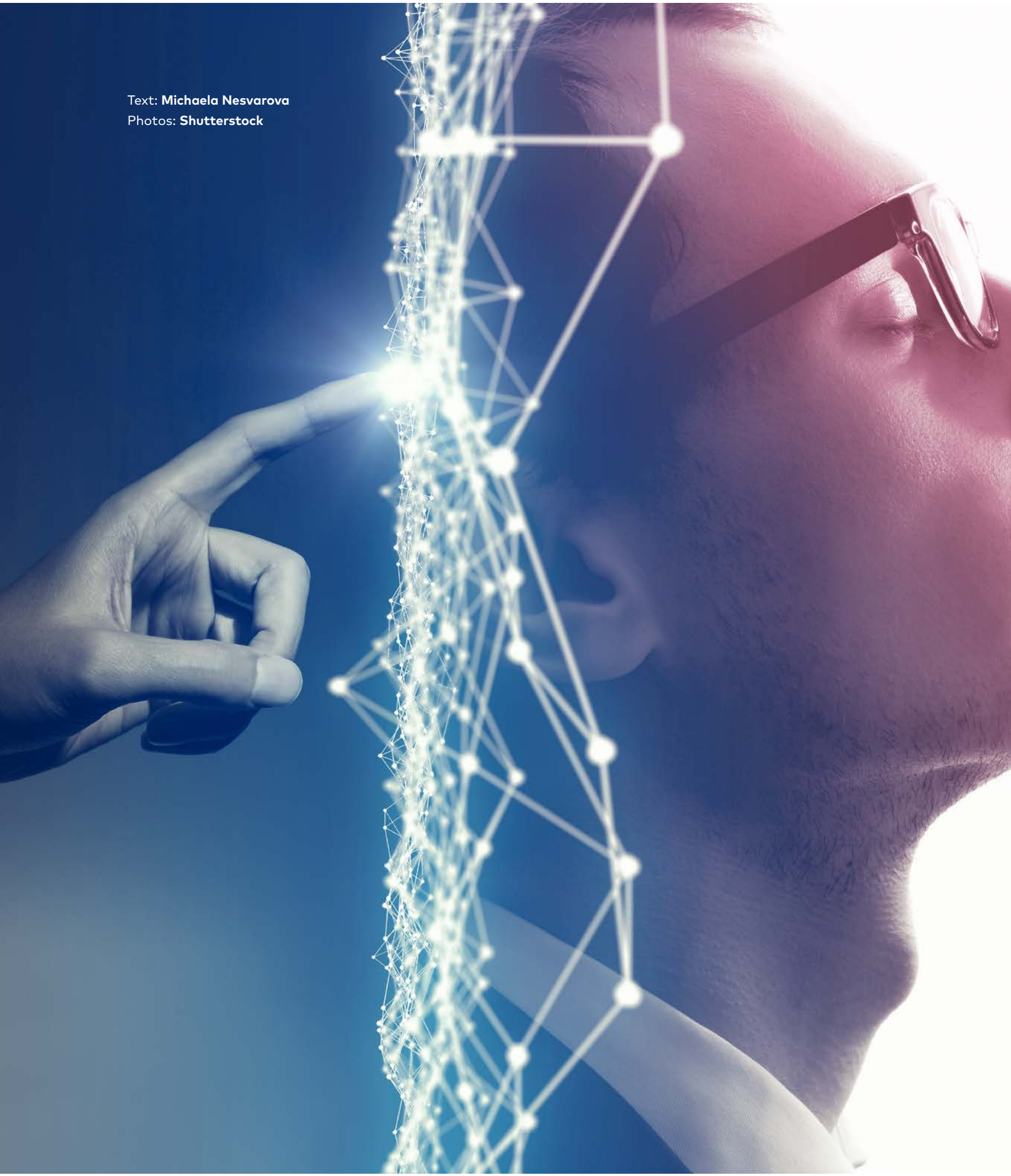


The mystery inside our head

I'm using it to write this story. To construct sentences, to move my fingers across the keyboard, to breathe. Yet, I have no clue how. 'It' does it all, but I - nor anybody else - know how it functions. The brain. Why is it that we still don't understand this black box inside our heads?

Many scientists at the University of Twente are working on uncovering the mysteries of the brain: from understanding and curing brain diseases to replicating its incredible computational power. What are the most puzzling questions in brain motivated research? And what could we achieve once we have the answers?

Describing the brain

One could say that the anatomical structure of the human brain is the organ's least mysterious aspect, but it still holds its secrets. 'We have a fairly good understanding of the architecture, but we only have a limited understanding of how brains can so efficiently process information,' says Michel van Putten, professor of Clinical Neurophysiology at the UT and a renowned neurologist working at the Medisch Spectrum Twente. 'There are essentially three basic types of brain cells: excitatory and inhibitory neurons and the glial cells. Neurons are excitable cells that continuously communicate mainly through chemical synapses using neurotransmitters or direct electrical communication. As neuroscientist Llinás once said: "Neurons are like people in a social network; they basically chat all the time." But what is their language? How important are the electrical rhythms they generate? We don't know.' Furthermore, the brain function seems to be constantly hanging in the balance, explains Van Putten: 'Brains operate based on a very delicate balance between excitation and inhibition, at the edge of total chaos and a totalitarian regime, essentially preserving "democracy". There needs to be a certain synchrony to allow efficient communication, but at the same time the different parts can't do the same. A healthy brain is like a team. Team members need to collaborate and communicate, but they can't all do the same tasks at the same time.' Although the team comparison is accurate, there is probably no single 'boss' in the brain. As far as we know, brain is self-organized. There are critical regions, sometimes called 'hubs'. These regions are extremely

important and can't be damaged without severely affecting function. On the other hand, there are areas in the brain that can be partly removed without significant consequences. Hence another puzzle without a clear solution. Brains are redundant. Why would nature create a brain with seemingly unnecessary parts?

Materials that can learn

Besides the brain's architecture, another fundamental question worth exploring is: How can the brain accomplish so much computational power using so little energy? This question is directly addressed at the UT. Professor of Physics Hans Hilgenkamp is aiming to see if we can at least partly mimic the brain's energy efficiency.

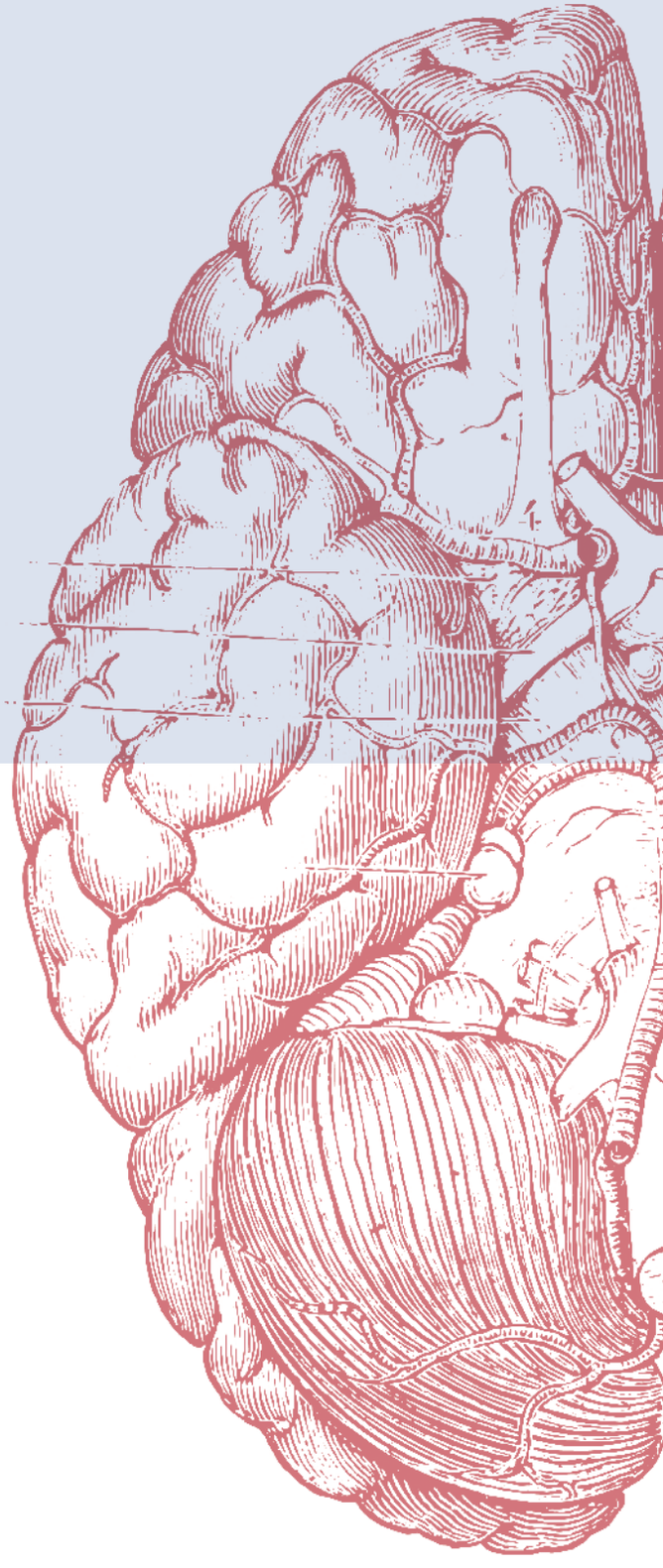
'In its abilities, the brain is comparable to a supercomputer,' says Hilgenkamp. 'However, the brain uses million times less energy. It uses about 10-20 watts while a supercomputer needs roughly 10 megawatts. Of course, there is a difference between the two. A supercomputer can perform different tasks, it is very good in calculating, for instance. The brain, on the other hand, is much better in pattern recognition. If you look outside, you can instantly tell that there is a tree. You don't have to calculate the amount of leaves to know. We have an amazing capacity in this regard.'

Within the setting of the newly established BRAINS (Brain Inspired Nano-Systems) Centre, various UT scientists would like to emulate this capacity in materials. 'There already are semiconductors that try to simulate the pattern recognition of the brain, but trying to simply mimic the function of the brain is very energy inefficient,' says Hilgenkamp. 'It would be much more favourable to focus on the hardware of the brain. Hardware is fixed in a computer, but in the brain it's always adapting. The brain's hardware uses connections that develop every time you learn something new. This is what they call the plasticity of the brain. We therefore want to create materials that can develop themselves as well, that can learn. We could call them learning materials, also known as neuromorphic computing.'

What is holding the researchers back from realizing such materials? 'There are many things in the brain that we understand but that are too complex to mimic in electronic materials,' answers Hilgenkamp. 'In a computer, a logic part and memory are separated in space. This is what we call the Von Neumann bottleneck. You constantly have to transfer the information from one to the other. In the brain, these two parts are intertwined, there is a colocation of memory and logic - which is something we can't recreate yet. Another complication is that the brain is very three-dimensional. Each neuron is connected with thousands of others through a huge 3D network. It's difficult to realize the same structure with the current technology. Semiconductors are based on thin layers. If we can make the step towards 3D structures, that would be a huge accomplishment.' It's precisely this 3D structure that Hans Hilgenkamp believes to be the reason why the brain is able to achieve its exceptional computational power - and the reason why current technology can't compete with it.

If we could recreate the power of our own brain, it could revolutionize the world of electronics. For example, we could apply learning materials in cameras for autonomous driving where pattern recognition is

'The brain is comparable to a supercomputer'



imperative. Regular computers and other electronics could become more energy efficient. 'A significant fraction of all energy worldwide is used for information technology. We could reduce that,' Hilgenkamp points out. Learning materials would naturally also be useful for AI (artificial intelligence) development. 'AI can be implemented in a normal hardware in a normal computer, but that costs an enormous amount of energy.' This would be solved - if we knew how the brain works.

Fixing the brain

Once the mysteries of the brain become unravelled, we can do more than improve the world's energy consumption. We can 'fix' ourselves. Because our brain seems as vulnerable as it is powerful. Brain diseases are something we all hope to avoid, yet they occur in high numbers. And more often than not, their cause and mechanisms remain an enigma. 'Besides acute disorders, such as stroke or traumatic brain injury, you could divide brain diseases into two groups,' Michel van Putten explains. 'Several neurological disorders are characterizes by cycles, such as epilepsy or migraine. In these cases, certain transitions can occur in otherwise normally functioning brains. For instance, in many patients with epilepsy brain function is nearly always normal. However, "glitches" can occur, resulting in a seizure – which suddenly begins and suddenly ends. Patients with epilepsy alternate between these two conditions and most of the time we have no clue what the cause is. The second category are slowly progressing diseases such as Parkinson's or dementia, which are caused by progressive failure of the neural networks. Such progressive neurodegenerative diseases are often irreversible, in part because neurons will eventually die if deprived from sufficient input, and unlike other bodily tissues, neurons cannot regenerate.'

Mysterious protein

What triggers these 'mishaps' in the brain is largely unknown and that means they are not preventable. Professor of Nanobiophysics Mireille Claessens is contributing to changing that. 'I focus on molecular understanding of brain processes. It's the mechanisms that destroy cells that are at the core of diseases,' says the expert. 'Protein aggregations are at the base of many neurodegenerative diseases, such as Parkinson's, Alzheimer, dementia, ALS. We know that in case of Parkinson's and Alzheimer's, protein plaques are the hallmarks of the disease. What we don't know is why they form.'

Claessens' current research concentrates on understanding the mechanism behind Parkinson's disease. 'The normal role of the protein associated with Parkinson's is not clearly defined,' she says. 'It has no clear 3D structure and probably many different functions. We don't know what exactly this protein does. Moreover, it's not an essential protein. You can completely knock it out of the organism and the organism will survive. The mystery is understanding how this protein works. Because there must be advantages to having it. Considering that it poses a risk, you would expect that evolution would have got rid of it. However, aggregation of

'Neurons are like people in a social network; they basically chat all the time'

the protein happens long after the reproductive age. It is a problem because the society is getting older. Age is the main risk factor when it comes to Parkinson's. We are basically fighting something that is not an evolutionary problem. We are trying to solve something that nature didn't deem necessary to solve. And we don't even know if it's solvable.'

Should we do everything we can?

Regardless of these doubts, Claessens notes that curing brain diseases would be wonderful for all affected individuals. Philosopher Saskia Nagel agrees, but suggests to be cautious when moving forward: 'It could be fantastic for individuals and their families. At the same time, we need to be sensitive on the way to get there. We need to have a shared understanding of what we think we should cure before we go on intervening. This is a critical task for responsible research. Should we do what we can do? With progress in the neurosciences, this is particularly relevant as it touches the core of what we think makes us human. While treating diseases is promising in most cases, there are also grey areas where we cannot say for sure that something should be treated as a disease. Note that our concept of what counts as diseases changes – homosexuality was once understood as a disorder, after having been understood as a sin before. It is wise to be careful with what we aim to cure.'

Mathematics to the rescue

While we are far away from curing or preventing Parkinson's, we are able to relieve its symptoms. Besides medication, doctors are using deep brain stimulation. This method involves opening the patient's skull and installing an electrode deep inside so that the brain is stimulated continuously. Professor Stephan van Gils from the UT department of Applied Mathematics believes that this method isn't as efficient as it could be. 'In many cases this works miracles, but in some cases the response is sub-optimal or even accompanied by more problems. We want to make a mathematical model to test other types of stimulation. We will test the deep brain stimulation devices on artificial basil ganglia developed in Nijmegen. It is quite spectacular,' he says enthusiastically.
Van Gils is a mathematician aiming to uncover some of the mysteries of the brain. Specifically, he'd like to further the understanding of pathologies of the brain - of why, how and where they originate. He is

convinced that mathematics is the one way to find these answers. 'I believe mathematics can contribute to crucial understanding of the brain. In fact, mathematics is the only science that can help us understand how this black box works. It can model the complexity. It can extract the abstract rules that rule the dynamics. I believe that one day mathematics can even help us understand the cognitive functions of the brain.'

Finding the epilepsy signature

For now, the mathematician mainly works on developing dynamic models of the brain to help make decisions in medical practice. One of his research projects focuses on epilepsy. 'More specifically focal epilepsy,' he clarifies. 'If patients with this epilepsy don't respond to medication, surgery is required. Our aim is to figure out what part of the brain can be taken out, so the patient becomes seizures free. Our partner University Medical Center Utrecht is trying to figure out how different parts of the brain are connected. Our task is to translate the outcome of their measurements to models for brain activity. Based on those models we can then predict which part of the brain can be removed in order to function optimally. We are making progress and it looks very promising.'

Michel van Putten is also working towards better diagnostics and treatment of epilepsy. 'We are trying to improve the interpretation of the electroencephalogram (EEG), that may show the specific ignition point of epilepsy. EEG is a monitoring method to record electrical activity of the brain. In essence, it allows you to listen to the neurons' talking, reflected in a rich repertoire of brain rhythms. In case of epilepsy, you are able to see that certain neurons don't chat correctly. For instance, you can see a little spike when the neurons basically talk too loud. Sometimes they only talk loud but don't disturb the neighbours; if they do, however, it may lead to a seizure. Interesting questions include: is it the neighbours that suddenly listen better, or is it the talking that is too loud, or both? Further, it takes a long time to assess the recordings visually, which is why we are using deep learning to detect anomalies in the EEG. We aim to find the epilepsy signature and hopefully contribute to a much faster diagnosis.'

You've caught me in a coma

Van Putten has more examples of how EEG could lead to 'saving our brains'. Using the EEG recordings of patients who suffered cardiac arrest, scientists can study energy deprived brains and possibly provide a better treatment for comatose patients.
'Brains need energy and are absolutely dependent on blood flow. After the heart stops, you can see that it only takes about twenty seconds for the brain to stop working as well. While this is still completely reversible for about two to three minutes, if it lasts longer synapses and neurons may become irreversibly damaged. However, the point of no return is not clear. This is what we study on a more fundamental level in our in-vitro lab at the UT, using a 'brain-on-a-chip' model to simulate this clinical condition. Important questions include: What defines the tipping point? Why do some neurons recover and others not? Can we limit damage by therapeutic interventions? There is so much to learn, and it is our hope that we may be able to shift the line of irreversible damage.'

Analyzing the brain

A fair amount of brain related mysteries has already been mentioned, but when asked about which mystery is the biggest of all, the scientists all answer similarly: our consciousness, our self-awareness, feelings, memory, language... In other words, the cognitive functions of the brain - possibly the part that makes us truly human. 'It's just fascinating that nobody has a clue of what happens in our brain when we say one plus one is two. Nobody has

a clue how we think,' says Stephan van Gils.
It is true - nobody knows how we think. But we can see when we think. Once again, thanks to EEG. 'In my work I mostly use EEG to see how it can help us understand the relation between cognitive functions and the brain,' says UT-based cognitive psychologist Rob van der Lubbe. Although measured brain activity is generally very difficult to interpret, there are certain things we are able to 'read' from EEG, says the Associate Professor. 'We can observe changes in brain activity when people are thinking and when they are performing motor functions. There is even something we call motor imagery: the motor areas in the brain show a change in specific frequency bands even if you are just thinking of the motion. The brain activity is actually almost the same when the person is only imagining the motion as when she/he is carrying out the task. In the long run, these findings could be beneficial for treatment of patients after stroke, for example, as people could train motion even without doing anything.'

Conscious decisions

Can we measure the moment when people decide to do something? 'Is there even such a moment?' asks Van der Lubbe in return. 'Scientists like Benjamin Libet performed experiments in the past, asking people to make a hand movement at any moment and then tried to determine when exactly was the decision made. The EEG findings suggested that the participants decided to make the movement about 500 milliseconds before they said they did. But is this really what the measurements show? What they measured could have been just the preparation of the brain to do something. Is there really a moment when we make a conscious decision? That is hard to answer because we don't even know what consciousness is.'
'The relation between consciousness and brain activity is not clear,' he continues. 'The brain is in a constant interaction with its environment, it's never a passive receiver. What is there around us and how we perceive it is not the same. Incoming information is already modulated by the brain based on existing information within the brain, based on our experiences, memory and knowledge. That means that probably everyone perceives the world rather differently. The relationship between brain activity and consciousness is definitely the big mystery I would like to solve. There are several theories but I don't think any of them are true. I think it's too simplistic to localize consciousness in a specific brain area. I think it's more likely that your level of consciousness depends on whether information can go to all areas of the brain. Maybe consciousness is as Daniel Dennett once said, like "fame in the brain".'

Are we too quick to dismiss the option that consciousness is not even fully brain dependant? Saskia Nagel suggests exploring further. 'If it is all just firing neurons, how can there be such differences between experiences? Why is one experience, for example seeing the trees outside, so different from another experience like feeling the sand at the beach with my feet?'

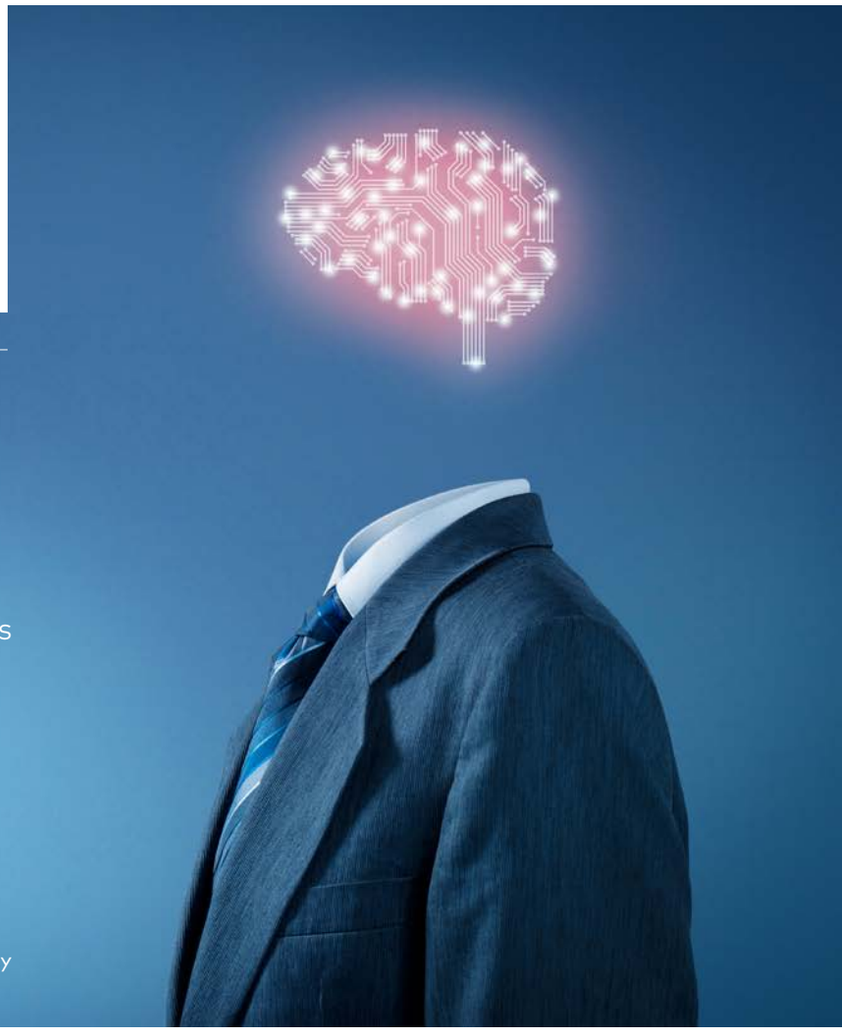
Using the brain

So many secrets remain concealed inside our skulls. Yet there are so many clever brains working on unveiling them(selves), it is not unrealistic to imagine a world in which brain diseases have been eradicated, brain inspired AI has access to all and brains are regularly modified to make us think or feel differently. What would that mean for us?

'In such a future, population would be able to grow much older, but we could argue whether that is necessarily a positive thing,' says Mireille Claessens. 'Just think of the innovative power that may be hampered. After a certain age your ideas are mainly based on experience, not on bright insights. If you look at Nobel Prize winners, most of them won thanks to work they did when they were relatively young – that is when they got their crazy idea.'

Hans Hilgenkamp doesn't have a straightforward answer. 'Imagine someone asked you this forty years ago. Imagine they said that we would have super powerful computers, brain scans, facial recognition... That would sound quite scary. And yes, of course there are threats coming hand in hand with new technologies. Cybercrime wouldn't exist without computers. But there are always some threats. Forty years ago there were no hackers but there was the Cold War. The question is: does the technology only create these threats or can it also help to mitigate them? For example, you can use AI to detect cybercrime in very early stages. Still, we should think of these possibilities as researchers. We shouldn't close our eyes to how the technology that we are developing could be used.'

Saskia Nagel offers a similar thought. She believes that before revealing the mysteries hidden inside our heads, we should use these heads to consider whether it will truly help us to know the answers. 'It would first and foremost require that we deeply think about what we want it to mean for us,' says the philosopher. 'We need a discussion about which values we want to protect. What do we value and why, and which boundaries do we want to keep? Which knowledge will help us reach our goals? This is a question we should ask in the process of scientific discovery. It will be central for our individual and social well-being to have a good idea of how we use the brain related knowledge that we gain. Just think of this line from time to time: "With great power comes great responsibility".' ●

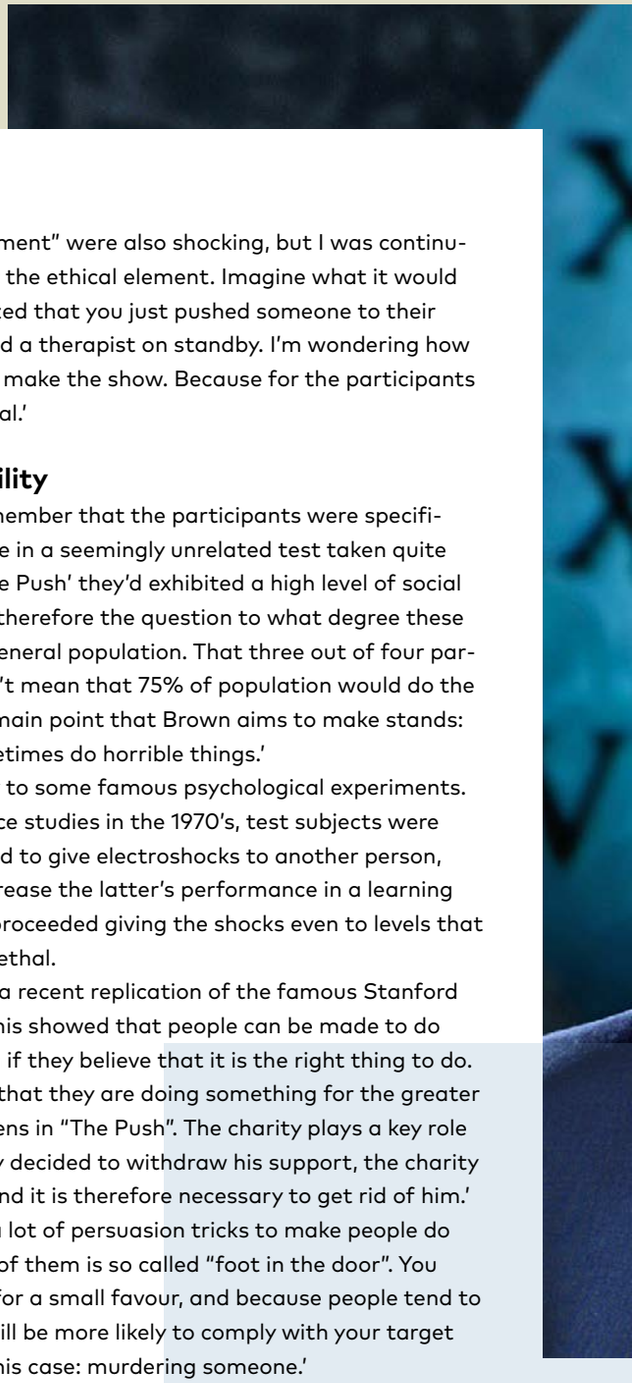


Experts who contributed to the article:

MICHEL VAN PUTTEN	Professor of Clinical Neurophysiology, TNW Faculty
MIREILLE CLAESSENS	Professor of Nanobiophysics, TNW Faculty
STEPHAN VAN GILS	Professor of Nonlinear Analysis, EEMCS Faculty
ROB VAN DER LUBBE	Associate Professor of Cognitive Psychology, BMS Faculty
HANS HILGENKAMP	Professor of Applied Physics, TNW Faculty
SASKIA NAGEL	Associate Professor of Philosophy and Ethics, BMS Faculty and Professor of Applied Ethics RWTH Aachen University

POP CULTURE

We binge-watch one Netflix series after another, we devour movies and games. Often it is no more than mindless entertainment, while at other times it even raises scientific questions. Pop culture, viewed through the eyes of a scientist.



In this episode, Peter de Vries, assistant professor at the department of Psychology of Conflict, Risk, & Safety, offers his view on the show 'The Push' (2016) by mentalist Derren Brown. If you haven't watched this show, beware of spoilers!

The plot

Would a regular reasonable person murder another human being? Your answer might be a stern 'no', but in the show 'The Push', the English mentalist Derren Brown proves otherwise. Brown uses the power of social compliance and careful manipulation, to try and persuade (preselected) members of the public to push a person off the roof.

The film allows you to watch as the illusionist stages a highly thought-through experiment using real people who are completely unaware of what is actually going on. He invites the 'participants' to a big charity event supported by a rich sponsor Bernie. All that the participants see and experience is meticulously prepared – there are hundreds of actors, even famous celebrities are involved to give the charity a stamp of validity –, and all of it is meant to eventually convince them to murder Bernie.

Shockingly enough, three out of the four participants do it. They are led to believe that they've just pushed Bernie off a building. (Don't worry, the actor playing Bernie is caught by the safety line he is attached to.) In this show, nothing was left to chance.

First impression

De Vries: 'I was rather shocked. When we conduct research we require an ethical approval, we can't ask people to do too much. In this show, Derren Brown puts people through a lot. He uses a lot of little manipulations to ensure that the participants are willing to follow orders and actually kill someone. This would never be allowed for research purposes and rightfully so. The results of the "experiment" were also shocking, but I was continually wondering about the ethical element. Imagine what it would do to you if you realized that you just pushed someone to their death. I hope they had a therapist on standby. I'm wondering how they were allowed to make the show. Because for the participants it's not a show, it's real.'

Realism / feasibility

'It's important to remember that the participants were specifically selected because in a seemingly unrelated test taken quite some time before 'the Push' they'd exhibited a high level of social compliance. There is therefore the question to what degree these results hold for the general population. That three out of four participants did it doesn't mean that 75% of population would do the same. However, the main point that Brown aims to make stands: ordinary people sometimes do horrible things.'

'The show links nicely to some famous psychological experiments. In Milgram's obedience studies in the 1970's, test subjects were led to believe they had to give electroshocks to another person, a confederate, to increase the latter's performance in a learning task. Many of them proceeded giving the shocks even to levels that could in principle be lethal.

'There has also been a recent replication of the famous Stanford prison experiment. This showed that people can be made to do horrible things, again if they believe that it is the right thing to do. They need to believe that they are doing something for the greater good. This also happens in "The Push". The charity plays a key role in it all. If the rich guy decided to withdraw his support, the charity would be in danger and it is therefore necessary to get rid of him.'

'Derren Brown uses a lot of persuasion tricks to make people do what he wants. One of them is so called "foot in the door". You first ask the subject for a small favour, and because people tend to be consistent, they will be more likely to comply with your target request later on. In this case: murdering someone.'

'Moreover, throughout the show the charity slogan "Whatever it takes" is constantly hammered in. In the end, the participants need to do "whatever it takes" to save the charity. Another important element Brown uses is peer pressure. Social pressure can be very influential and the participants are eventually being convinced by their peers to commit the murder. However, the results were so surprising for me that it's hard to say why exactly the people did it. It was most likely the combination of all these tricks.'

Text: **Michaela Nesvarova**

Photo of Derren Brown. Source: Channel 4.

E

Everyday Science

Winter tires

Do you ever take the time in your busy life to wonder about everyday phenomena? Things that are obvious to us, or perhaps just make for a handy trick? Nevertheless, there is always a scientific explanation for such phenomena. In Everyday Science a UT researcher sheds light on an everyday topic.

Text: **Michaela Nesvarova** Photo: **Shutterstock**

We've all heard the warning. 'Winter is here. You should not drive on summer tires.' Nevertheless, many people still believe that the difference between winter tires and summer tires is just a sales strategy made up by car tire manufacturers. Professor of Rubber Technology Jacques Noordermeer explains that this is certainly not the case. 'At first glance you see a clear visual difference between summer and winter tires,' points out the professor.

'The tread of summer tires includes broad segments and channels for water to escape, while the winter tires tread profile has many more and much smaller channels and ribs. The smaller ribs are able to slightly flip over and create somewhat of a comb structure, which gives the winter tire an improved grip on snow and ice. The ribs also wiggle when the tire-segment comes loose from the road, and so any snow is shaken out of the tire. With summer tires this does not happen and so they get filled with snow very quickly which damages the skid resistance.'

'There are three main requirements in tire technology,' highlights the rubber expert. 'Rolling resistance, which should be as low as possible, so it doesn't cost too much energy for the tire to start moving. Secondly, the skid resistance which should be as high as possible; and lastly durability. We call this the magic triangle of rubber technology. The issue is that the three properties are not independent on one another. If one is improved, usually the other two deteriorate. For example, summer tires in winter time are harder due to the cold temperature. This is great for the rolling resistance, but very bad for the skid resistance, which is extra needed in the winter.'
Which brings us to another important distinction between the two types of tires: their 'softness'. 'Tires need a certain hardness to work properly. Summer tires are tuned to summer weather, they get harder in colder temperatures which decreases their skid resistance. It therefore takes them longer to come to a full stop. In fact, there is a difference of 30 – 40% compared to winter tires,' explains Noordermeer 'Winter tires have a different, softer composition – they become harder in cold weather, providing a shorter braking distance and a better grip on the road.'

The accident

My newspaper reported 'the fall of conductor Bernard Haitink'. 'What!? #HeToo?' is what instantly flashed through my mind. It turned out that he had simply suffered a fall immediately after a performance. At his advanced age, that can be quite dangerous, of course.

This incident demonstrates how patterns can become ingrained in your brain. Ah, the brain, there it is again. It is brought into everything these days, no matter what the issue is, and here I am doing the same. I do not know much about our brain in general, but I believe having one myself qualifies me to write a few words about it. A bit of introspection quickly reveals three levels at which patterns are carved into my brain – sometimes through repetition, sometimes because of a one-time event.

The example above can be quite innocent. Apparently, my mind is made up when I see the concepts 'fall,' 'leader' and 'artist' together. Its relative innocence lies in the fact that some additional information can quickly make me realise my mistake and even let me rein in my prejudice (for that is what it is) somewhat.

A pattern in my brain with a physical effect is that I cannot step onto an escalator without walking a bit faster, as if pushed by an invisible hand. When the escalator is in motion, this automatic behaviour is quite useful. However, when it is turned off, I have to make a conscious effort to control my initial impulse, despite clearly seeing that the escalator is not in motion.

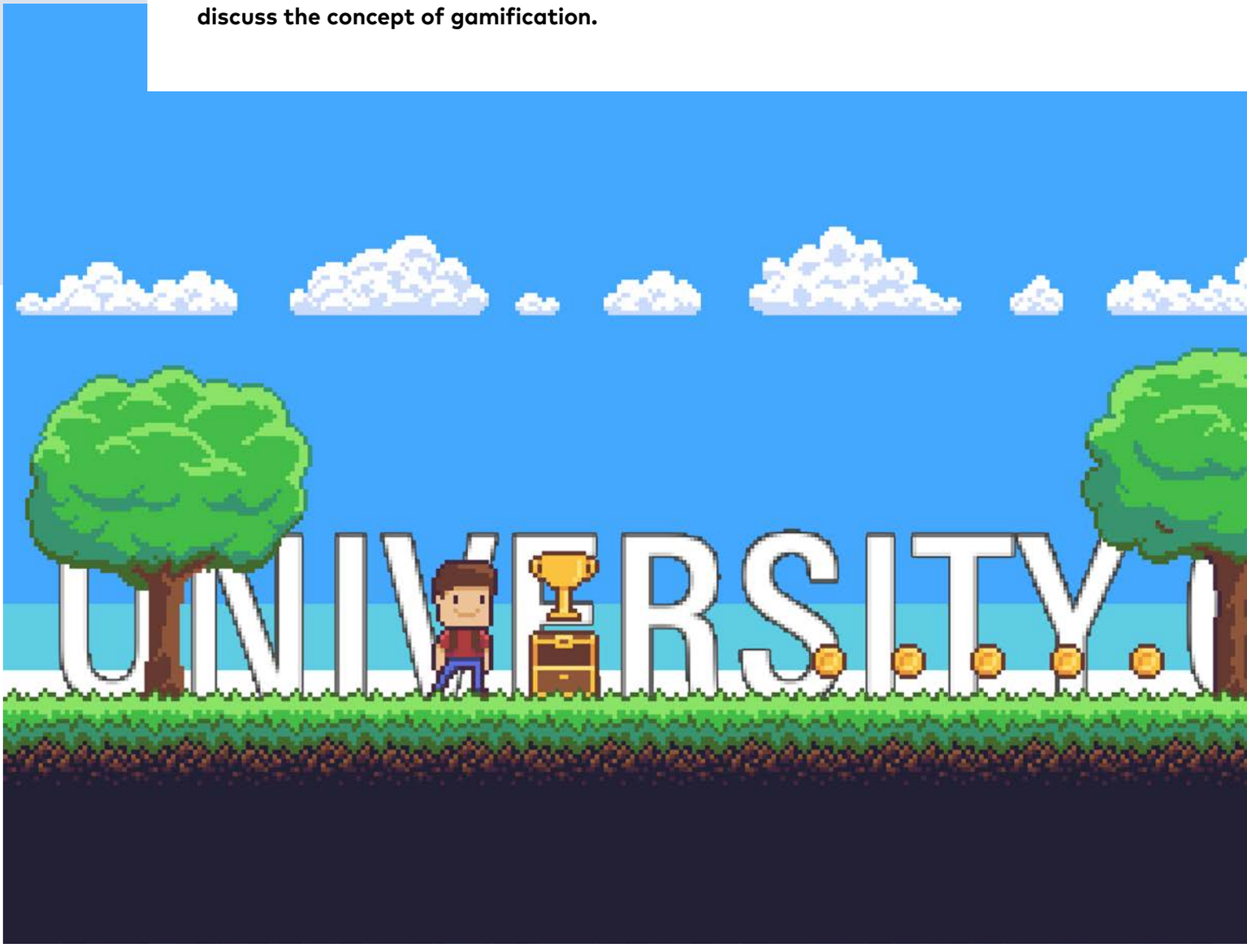
To me, the most disturbing is this. I often ride my bicycle across what used to be Twenthe airport. Two of the taxiways are lined with wooden posts to keep out cars and I loved racing through them at full speed. One day, however, I had to hit the brakes as hard as I could: barely visible barbed wire had been strung up between one row of posts. I tried to imagine what might have happened if I had not stopped and the wire had hit me somewhere between my thighs and my belly: it would have been a mess. There is no wire between the other posts, yet I am no longer able to ride through them without slowing down and feeling a bit queasy as I pass them. Apparently, my life has been marked by an accident that never happened. I can only imagine how deeply affected the people who did experience something like this must be. To end on a more positive note: might it be possible to make yourself feel better at will by thinking about a happy situation that never occurred to you?

Wiendelt Steenbergen
Professor of Biomedical Photonic Imaging

Text: **Rense Kuipers**
Photo: **Shutterstock**

Making the world our playground

Should we simply accept that playing is just for kids running around and teenagers with video game consoles? Or can gamification help bring out our 'inner child', when games blend over to our adult world? Researchers Robby van Delden and Robert Wendrich discuss the concept of gamification.



In 2009, the stairs of the Odenplan subway station in Stockholm got a makeover, turning into fully functional piano keys. It was supposed to encourage people to take the stairs, instead of the escalator next to them. And according to the makers, it increased the number of people taking the stairs by 66 percent, proving to them that a fun experience can change behaviour for the better.

Ground rules

'Playing can put a smile on our face and increase our feeling of well-being. I believe that's the major upside of gamification,' says Human Media Interaction researcher Robby van Delden. 'There is however a big difference between playful experiences and gamifying the world around us in a good way. At the moment, this research area is still making its first strides and we don't really know how gamification affects people's motivation in the long run, even in the case of a simple playful concept like the Stockholm piano stairs. I do think we overestimate how long something like that remains a truly fun and compelling experience.'

Van Delden thinks differences between playfulness, gamification and persuasion need to be taken into account. 'Games are fundamentally objective based and outcome oriented. So there are some ground rules you need to abide to as a designer, when you want to apply gaming elements in real life. Think of context, features, variety and personalization. Elements that work on a playground will most likely not apply to a nursing home. And you need to keep an eye on the expiry date of a game, since a lack of variety will ultimately bore people. I think mobile developers are happy when people play their games for more than a month. That's how fleeting it is.'

Embodiment

The researcher still sees people on the streets playing Pokémon Go. 'That's a good example of gamification done in a right way. Say what you want about Pokémon Go, but the app got people moving and connecting with each other. The sports app Strava also applies the concept well. By using gamification features like King of the Mountain, it encourages cyclists to improve their personal or other bests.' Still, Van Delden wants to have more insight into the behaviour of people when using gamified elements. 'The more we know as researchers, the better we can explore interventions, so designers can create better gamification experiences. In the end, they are tasked to create elements that embody us to make our lives more joyful.'

According to design engineering researcher Robert Wendrich, playing is about using our direct environment. 'Embodiment is key in providing something that alleviates the restrictions we face as human beings. The same way we use a hammer to build and a computer to help us think, we can play to help us activate, relax or learn. And why not? Too often, we seem to forget that the world is our playground and that we love to play in it.'

Receptive environments

Wendrich poses questions on how to unlock our 'inner child'. 'That's what I find interesting as a researcher: how can we create something in a playful way, from a non-structured environment? We live in a VUCA world; we're surrounded by volatility, uncertainty, complexity and ambiguity. As humans, we're afraid of chaos; we try to structure it and bend it to our will, because our basic attitude is that we're afraid to come up with bad ideas. That's why we think we need our world to be coherent. Which goes directly against the inner principles of playing and creating.'

To add to that point, Wendrich refers to Measuring the World, a book by German writer Daniel Kehlmann about world explorer Alexander von Humboldt and mathematician Carl Friedrich Gauss. 'Von Humboldt went out to explore and see the world with his own eyes; Gauss stayed at home and searched his mind to think about the world of space and time. These extremes are fundamental for everything we do. Not saying that one is better than the other, but when we want to play, we need environments that are receptive to the possibilities of playing and exploring.'

Finding a happy medium

The main challenge, according to Wendrich, comes down to intuitiveness and intention. 'I do believe in incentives in gamification. That's what gets people activated. But the question is: who are you incentivising? Nowadays, we have to deal with two basic groups of people: digital natives and digital immigrants. The natives are used to new technology and video games, while the immigrants have to learn something they're completely unaccustomed to. So when we're thinking of gamification, we're going to need our immediate space to be intuitive and hybrid. If we want everyone to start playing, we have to find a happy medium.' ●

Text: **Enith Vlooswijk** Photos: **Eric Brinkhorst & Shutterstock**

The breathing planet

TREES SHINE A LIGHT ON CLIMATE CHANGE

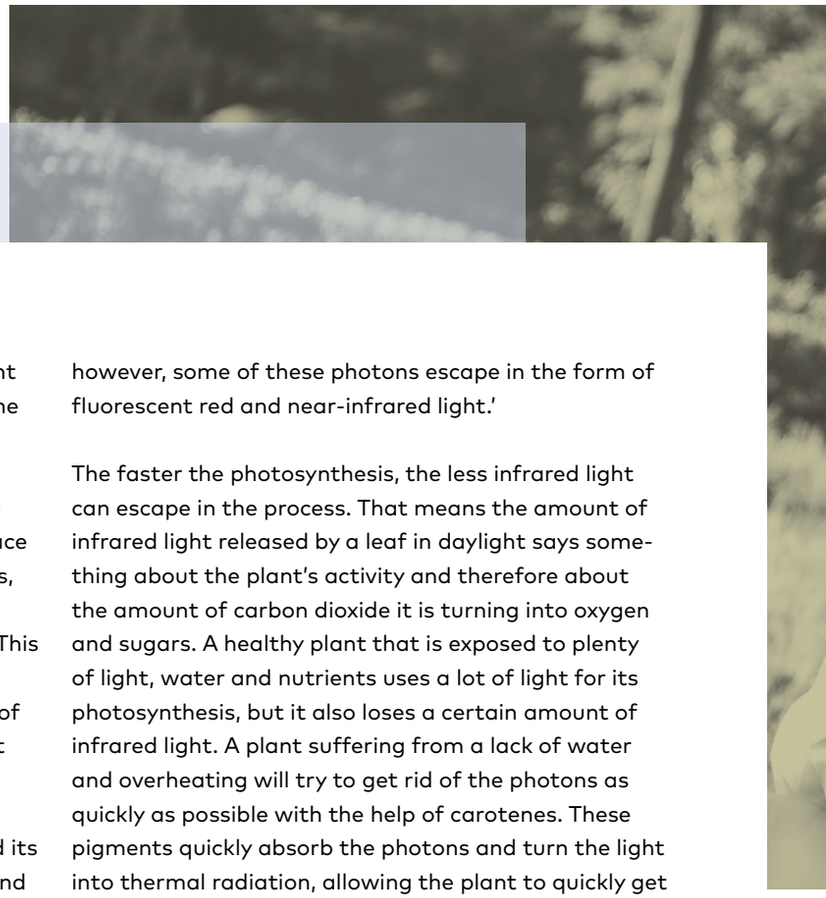
Plants and trees are not passive victims of climate change; instead, they play an active role in the composition of our atmosphere. With the help of FLEX, a new type of satellite, the European Space Agency will study the impact of Earth's plant life on climate change. ITC researcher Christiaan van der Tol is involved in the project.

When you think about climate change, you might see the clichéd images of dry riverbanks, desiccated animal carcasses, bare trees and sad-looking plants. These images are a bit misleading, says Christiaan van der Tol, researcher of Ecohydrology and Earth Observation. Plants and trees do not passively undergo the chances in our atmosphere. Instead, they not only respond to these changes; they actually affect them.

'The satellite moves at a speed of seven kilometres per second'

On the way to his office, the researcher pauses briefly at a poster that shows an image of tall coniferous trees. A man on a crane is dangling a sensor in one of the treetops. 'That was part of research conducted in the Speulderbos in the province of Gelderland,' Van der Tol explains. 'Our measurements showed that 550 litres of rain per square metre reach the ground every year via a tree's branches and its trunk. The rest, circa 200 litres per year, is caught at the top of the tree and evaporates. It then comes down as new rain at some point further inland.'

If it does not rain and a tree is at risk of over-heating in the sun, that does not necessarily spell disaster. The leaves shed excess heat through



evaporation and extract energy from the environment in the process. That, combined with the shadow of the canopy, is why a tree has such a cooling effect. That is not all, however. Plants can change the position of their leaves, allowing them to reflect more light than usual. The antennae that catch the light on the surface of the leaf also change direction. When that happens, photosynthesis, the process of turning water and carbon dioxide into oxygen and sugars, slows down. This produces less oxygen and traps more carbon dioxide in our atmosphere. On the other hand, the presence of more carbon dioxide in the air can lead to more plant growth, provided that there are sufficient quantities of sunlight, water and nutrients available. In other words: the balance between Earth's atmosphere and its vegetation is the result of continuous interaction – and that does not even factor the impact of mankind and the world's fauna into the equation.

Our climate under control

Increasing our control over climate change therefore requires more insight into the way in which plants and the atmosphere affect each other. To conduct that research on a large scale, the European Space Agency will launch a research satellite called FLEX in 2022. The satellite will be equipped with spectrometers that can detect light of different wavelengths. These past years, Van der Tol has contributed to the development of this technology.

'Trees and plants emit fluorescent red and infrared light,' the researcher explains. 'That has to do with the photosynthesis taking place in the leaves. Miniscule antennae on the surface of a leaf catch the Sun's photons (particles of light), which the leaves then turn into energy used for photosynthesis. Along the way, however, some of these photons escape in the form of fluorescent red and near-infrared light.'

The faster the photosynthesis, the less infrared light can escape in the process. That means the amount of infrared light released by a leaf in daylight says something about the plant's activity and therefore about the amount of carbon dioxide it is turning into oxygen and sugars. A healthy plant that is exposed to plenty of light, water and nutrients uses a lot of light for its photosynthesis, but it also loses a certain amount of infrared light. A plant suffering from a lack of water and overheating will try to get rid of the photons as quickly as possible with the help of carotenes. These pigments quickly absorb the photons and turn the light into thermal radiation, allowing the plant to quickly get rid of its excess energy. This process leaves less light available for fluorescence and photosynthesis. If a plant releases an unexpectedly large amount of fluorescent (infrared) light, it may have been sprayed with herbicides. These cause the photons caught by the leaves' antennae to become trapped. As a result, there is no photosynthesis and the light keeps bouncing around aimlessly inside the leaf until it ultimately bleeds out in the form of infrared light. All in all, the light spectrum emitted by plants during the day can reveal a whole lot about their conditions.

Floodlights

Of course, the infrared light released from plants and trees is not the only light that reaches the satellite. The spectrometers detect roughly a hundred times more reflected daylight than what the Earth's vegetation emits as infrared light. It is no easy feat to detect the light from plants and trees amongst all that other light. Van der Tol: 'It is like trying to detect the light from a nightlight in a room filled with massive floodlights.'

'The light spectrum emitted by plants can reveal a lot about their conditions'

The fluorescent light has a different colour than the reflected daylight. To accurately distinguish between the different wavelengths, spectrometers must utilise a specific shutter time to allow enough light to come in. The problem is that the Earth is not suspended motionlessly in space and neither is the satellite itself. 'The satellite moves at a speed of seven kilometres per second,' Van der Tol explains. 'The longer the shutter

'The same technology can be used for precision agriculture'

time, the more difficult it becomes to focus on a small part of the planet.' Here is an apt comparison: try taking a picture of a pedestrian while riding your bike in the dark; the longer the shutter time of your camera, the harder it is to capture a sharp image. More focus requires a shorter shutter time, but that will make the image too dark. Standing still for a few minutes is not an option for the satellite.

Until now, it was therefore only possible to detect reflected light of different wavelengths from an area of land several kilometres across. The new satellite's improved technology reduces that number to just 300 metres. Van der Tol developed a mathematical model that translates the measurement data into information about the plants and trees from which the light originates: are they getting enough water and sunlight or do they face drought and overheating? What do these conditions say about the amount of carbon dioxide absorbed by the plants and the production of new biomass? 'With this data, we can draw better conclusions about how the Earth's vegetation affects the composition of our atmosphere,' Van der Tol says.

Precision agriculture

A pilot version of the spectrometer was installed on an airplane and successfully tested earlier this year. If all goes well, FLEX will start producing usable measurement data in 2023. However, the model can also be used closer to ground level. 'The same technology can be used for precision agriculture,' the researcher explains. 'You could mount a spectrometer on a drone and modify your cultivation policy based on the reflected infrared light: which plants need more water or more nutrients? You can also see whether pesticides are spreading to adjacent fields.' A project about hyperspectral measurements of potato fields is currently underway. Who knows? Perhaps those spuds will soon shed some light on their individual wellbeing. ●

THE LAB

Text: **Rense Kuipers**
Photo: **Eric Brinkhorst**

Rapid Prototyping Lab

The Rapid Prototyping Lab, situated in the Westhorst, is not so much about research as it is about production. The lab focuses on 3D printing and has eight machines that help researchers and students to transform a computer file into a physical object.

'If you can dream it, you can print it', is a slogan on one of the machines in the lab. 'That is not completely true,' says Rapid Prototyping Lab manager Quint Meinders. 'For instance, some

UT researchers push boundaries by trying to 3D print a system of blood vessels. However, the machines we have are not able to print out the smallest vessels, the capillaries.'

As is displayed on a table in the lab, a lot is possible. Be it a flexible hand or a bite-sized, detailed figure of a man holding a cane, using different techniques like SLA (adding layers from fluids) or SLS (heating up powder), Meinders has quite an arsenal at his disposal.

As the name of the lab suggests, time does play a part. 'I usually print one or two times a week, depending on the assignments we're getting,' says Meinders. 'A flexible hand would take around nine hours – printing and cooling down. But the hood of one of the RoboTeam Twente robots takes one and a half days to make. So within our limits, we try to be rapid.'

UT ALUMNA LIEKE ASMA CONDUCTS RESEARCH IN MUNICH

‘There is no evidence that free will does not exist’

UT alumna Lieke Asma has been working in Munich for more than six months now. She is a philosopher and is conducting research into self-development at the Hochschule für Philosophie, an institution founded by the order of the Jesuits. ‘I know that the combination of philosophy and religion can quickly lead to negative views.’

Text: **Jelle Posthuma**
Photos: **Kalle Singer**

The Hochschule für Philosophie is located smack in the middle of Munich's student district. Philosopher Lieke Asma (34), who graduated at the UT in 2008, has been working at the institute since April of 2018. The fact that this school of philosophy was founded by Jesuits is still evident today, Asma says. 'My boss is a monk too. The Jesuits live on the grounds and live by the rules of their order. Still, my boss is also a big jazz lover and can often be found in underground bars.'

Religion and science

Asma's research project is sponsored by the Templeton Foundation, an organisation established by the wealthy American businessman John Templeton. His foundation focuses on the big questions in life, which are often situated on the cutting edge of religion and science. Over the course of the next three years, Asma will do research on self-development in Munich.
'I know from experience that the combination of philosophy and religion can quickly lead to negative views,' Asma says. 'It is true that I work for the church. Yet the Hochschule also offers a comprehensive philosophy programme. The institute does not care about my personal beliefs. Many of my colleagues at my previous employer, VU Amsterdam, were also religious.'

Media

Asma obtained her doctoral degree at the VU with research into the topic of 'free will'. Her doctoral thesis received attention from various media. The Volkskrant, Het Friesch Dagblad, Trouw and the Reformatorisch Dagblad all lined up for an interview. 'The topic of free will clearly speaks to many people. Of course, I liked being in the papers and it is important for scientists to descend from their ivory tower every now and again. Yet the papers often want a big story: some put it as if my research was in defence of free will – even though my doctoral thesis, which I spent four years working on, was extremely specific in nature. That was difficult for me. On top of that, I am down to earth and not really interested in all that attention.'

Twente

Asma is from the village of Rossum in Twente, near Oldenzaal. 'When I left for university, I heard of the UT's media psychology programme, which appealed to me a lot. I also liked the green, small-scaled campus. Our class was the first of the UT's psychology programme. We worked together closely with the lecturers and got to think along about the programme itself. We felt like pioneers. Eventually, I graduated in the field of neuroscientific research. At that time, roughly a decade ago, the common belief was that neuroscience would let us measure exactly what goes on in the brain. That knowledge was supposed to fully explain human behaviour by studying the brain.'
'In hindsight, the neuroscientific research was a disappointment for me. Sure, we measured all kinds of brain activity, but we did not know how to interpret our findings. We were left with a lot of unanswered questions. The terminology we worked with – such as attitude or motivation – was poorly defined as well. No one knew what these terms really meant and there was no discussion about it. That was what led me to study philosophy in Nijmegen. Philosophy is about the nature of the things we measure in our research.'

Consciousness

After finishing her studies in Nijmegen, Asma began her doctoral research into free will at the VU. In her PhD thesis, she was critical of the research conducted by neuroscientists, who have been claiming since the

'In hindsight, the neuroscientific research was a disappointment for me'

'I hope to bridge the gap between psychology and philosophy'

1980s that there is no such thing as free will. One of the most well-known among them is Benjamin Libet. In his tests, he has his subjects push a button. Libet then measures their brain activity. Prior to the intention to push the button, they already show some brain activity. Conclusion: our actions are determined by subconscious processes in our brain, not by our free will. According to these neuroscientists, this is proof of the fact that there is no such thing as conscious action and that the concept of free will is a myth as well.

According to Asma, the term 'free will' was defined incorrectly in Libet's research. 'Philosophers believe free will is based on reasons: it is about the deliberations a person makes. The neuroscientific tests were conducted in a setting in which people had no reasons, except to push a button. That setting kept the subjects from reflecting on their own actions.'

Impulses

'Philosophers believe that actions based on reasons are a requirement of free will. We perform many of our standard rituals on autopilot. I get dressed in the morning, brew some coffee and brush my teeth. Although there is some brain activity involved in all that, they are all conscious actions. I have the intention of going to the university and therefore do these things for a reason. My brain activity does not preclude me from doing something with a conscious intention.'

Whereas neuroscientists look at the brain, psychologists focus on external influences. People are constantly affected by unconscious influences. The smell of bread makes us walk into a bakery and the middle shelf in a supermarket looks more appealing to us than the ones below it. These are all unconscious influences that psychologists believe reduce or even eliminate free will. Asma acknowledges that our actions are affected by unconscious influences. 'Yet that does not mean I do not have an intention. Suppose I want to go for a run and I have a cup of coffee before I go. The caffeine makes me run faster and therefore affects my behaviour, but my action – the running – is still something I do consciously.'

Society

The concept of free will helps us understand our actions, Asma states. 'Free will is a fundamental aspect of how people treat each other. It is all well and good to claim that there is no such thing as free will and reduce everything to subconscious (brain) processes, but doing so goes against our very nature. There is simply a distinction between an accident and a deliberate action. If someone deliberately throws a drink in my face, that is something entirely different from the same thing happening by accident. These two things are fundamentally different, even if we cannot measure the difference in our brain.'

Asma's doctoral thesis was part of the Science beyond Scientism project that ran at the VU from 2013 until 2016. Scientism was the main focus of the research project. According to this belief, only (natural) science can lead to knowledge. 'All explanations occur at the physical level. Of course, that results in a fair amount of scepticism when it comes to the existence of free will. I am not trying to defend free will in my doctoral thesis. All I am saying is that neuroscientific research has not provided any evidence to disprove the existence of free will.'

Asma will spend the next three years conducting research into self-development. 'The project in Munich is based on a more positive principle. It is about the question of how to integrate psychological and philosophical models. These two fields of study each have their own terminology. That is unfortunate, because it inhibits their integration. In addition to philosophy, I also studied psychology. I hope to bridge the gap between both fields.' ●

Science is all about making choices. Some lines of research achieve great success, while others die unlamented deaths. Back to history delves deep into the archives looking for developments with historical relevance. This time, we look into the life of Hypatia, the fifth-century mathematician.

Hypatia stood for intellectual values

Text:
Rik Visschedijk

Under the name of Hypatia (350/370 – 415 AD), the UT is looking for ten more female professors to reach its target of having twenty percent female professors by 2020. Hypatia is an appropriate name for the campaign. This woman, who lived in Alexandria during the fifth century AD, is known as the 'first female mathematician.' She was also active in the fields of astronomy and philosophy. Following in the footsteps of her father, the mathematician Theon, she fought to preserve the mathematical and astronomical breakthroughs of the ancient Greeks.

Hypatia lived during turbulent times. The glory of the Roman Empire had passed. The Empire was split in two. Alexandria, located in what is now Egypt, became part of the Eastern Roman Empire. Unity was nowhere to be found. Christianity was on the rise and manifested itself as a militant movement. Heretical faiths were persecuted relentlessly. There is a (controversial) theory that these militant Christians destroyed the Great Library of Alexandria – the largest in the ancient world – because the works stored there did not fit into their religion. Hypatia lasted a long time in this torn Alexandria. Although the Christian Emperor Theodosius banned all 'heretical practices,' which included Hypatia's intellectual pursuits, she was spared. In fact, she was friends with bishop Synesius, who was a student of hers and had direct contact with the Emperor. In this manner, she even managed to exert some political influence.

All this came to an abrupt end when the high-ranking couple passed away and Cyril became bishop of Alexandria. The time of relative tolerance was over. Hypatia was abducted by fanatical and militant Christians, who took her with them to church and stripped her bare. According to the stories, she was beaten, skinned alive and dragged through the city streets.

Yet Hypatia lived on in later writings. The Enlightened thinker Voltaire used her name in his works to condemn the church and religion in general. Historian Michael Deakin describes her in his biography: 'Almost alone, virtually the last academic, she stood for intellectual values, for rigorous mathematics, ascetic Neoplatonism, the crucial role of the mind, and the voice of temperance and moderation in civic life.' Hypatia symbolizes the demise of the free thinking of Ancient times and the transition to the early Middle Ages, also known as the Dark Ages.

These days, the name Hypatia is connected to a scientific magazine about feminist philosophy. In a campaign bearing her name, the UT is looking for female professors. There is no better role model: she was a classic uomo universale, someone with many fields of expertise. That is what the UT strives for with its high tech, human touch. These new professors now face the challenge of honouring Hypatia's life and work. ●

Recovering energy and materials from *waste*

Flash pyrolysis, a mild heat treatment lasting just a few seconds, is becoming an important recycling tool. The University of Twente is leading in this promising technology that contributes to the circular economy, as it allows for a wide variety of waste streams to be well recycled. Organic waste streams, paper sludge, car tires, and in the near future maybe even composite materials can be effectively separated into energy and valuable reusable materials.

The laboratory of Department of Thermal and Fluid Engineering is stacked with impressive looking equipment. Shiny metal tubes, colorful wiring and countless meters and switches challenge the senses. In this science fiction-like world, Gerrit Brem, Professor of Energy Technology, and his team perform small and medium scale tests separating waste materials into valuable components. Brem holds a glass bottle with a sticky pitch-black fluid. 'This oil is one of the major and most valuable products resulting from flash pyrolysis of agricultural and woody waste streams, like straw, wood, and leaves,' he says. 'With our technologies we are able to produce these high-quality biomass-based oils for use in gas turbines and engines.'

Valuable products

Flash pyrolysis is a low-temperature separation technology used since the 1980's. In contrast to combustion, where temperatures reach between 800 and 1000 °C
and only ash and heat remain, pyrolysis occurs at only 500 °C and without oxygen being present. As a result, the material doesn't burn, but is separated into different fractions due to the exposure to heat. It is a relatively cost-effective and mild thermal separation

Text & photos:
Hans Wolkers

method, resulting in energy and valuable components that can be reused. For example, flash pyrolysis of wood, where small wood fragments are exposed to heat for just seconds, results in about 75 percent oil vapor, 15 percent gas and 15 percent carbon (char). Over the years, Brem's team has developed and optimized the pyrolysis of woody waste streams. First the biomass is chopped into small particles, just a few millimeters in size. These particles are blown along the walls of a hot cyclone reactor of 500 °C . 'We can't use air to blow the particles inside the reactor chamber, because the oxygen present would burn the biomass,' Brem explains. 'Instead, we reuse the gas formed during the pyrolysis process.' Sand is used as a heat carrier, resulting in a fast heat transfer. Within seconds, the materials are pyrolyzed. The resulting oil vapor is quickly cooled down to room temperature and collected at the bottom of the reactor. The gas formed is used to blow in new biomass fragments into the reactor, while the char contains energy and can be used to heat the pyrolysis reactor, resulting in an energy neutral operation.

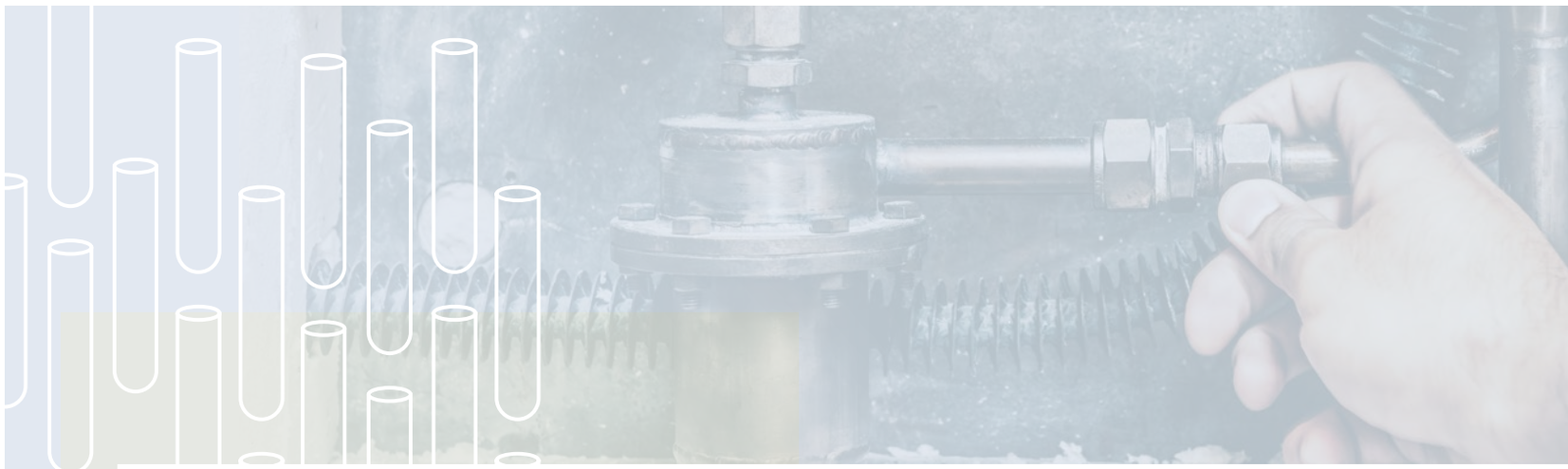
Better oil quality

Although the newly developed process is sustainable and cost-effective, there is room for improvement. The resulting oil is quite acidic and its consistency changes over time: it thickens due to polymerization. In addition, the caloric value is relatively low because of the presence of oxygen, originating from cellulose, an important wood component. 'It is possible to increase the oil quality during its formation, in the reactor,' Brem says. 'We can achieve that by adding catalysts, such as sodium- or potassium carbonate. This results in the removal of oxygen containing components and a much better oil quality.' Although this better-quality oil has similar properties as fossil oil, the yield is relatively low. Therefore, the team focuses on developing a milder deoxygenation and hydrogenation method that is a compromise between oil yield and oil quality.

Close cycles

After the success of wood waste recycling, Brem and his team further developed the pyrolysis method for application to other waste streams. The processing of paper sludge using pyrolysis proves to be another promising application. This large waste stream of the paper industry consists of equal amounts of short-fibred cellulose and minerals in water. Until recently, there was no sustainable method to treat this waste stream and dumping it on landfills was common practice. But applying flash pyrolysis on paper sludge results in an efficient and cost-effective thermal separation: the cellulose in the sludge is converted into reusable oil, while the minerals remain. The oil can be used to fuel the paper industry machinery, or to dry the paper sludge before pyrolysis. The minerals fall down and can be collected at the bottom of the reactor. 'These minerals still contain a small fraction of char, that can be removed by mild combustion, resulting in pure minerals that are perfectly suitable for reuse,' Brem says. 'With this patented method

'With this patented method we have managed to close the paper cycle'

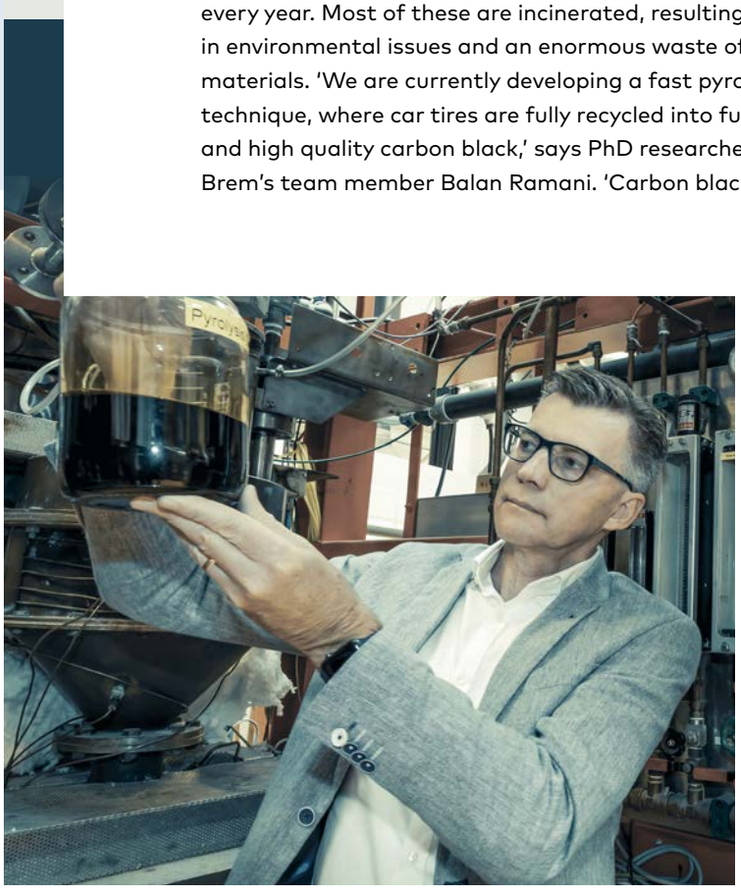


we have managed to close the paper cycle.' The waste recycling company Alucha in Arnhem has bought the patent and has successfully scaled-up the process in a working pilot plant in a mobile container with a capacity of 100 kg sludge per hour. The company is currently developing a large demonstration facility for the paper industry.

'We are developing fast pyrolysis technique where car tires are fully recycled'

Enormous waste

The application of Brem's pyrolysis techniques to other waste streams also proved effective. The team's research has shown that flash pyrolysis may solve the problem of the enormous amounts of old car tires. Worldwide, more than 800 million tires are wasted every year. Most of these are incinerated, resulting in environmental issues and an enormous waste of materials. 'We are currently developing a fast pyrolysis technique, where car tires are fully recycled into fuels and high quality carbon black,' says PhD researcher and Brem's team member Balan Ramani. 'Carbon black is the most valuable compound resulting from pyrolyzed car tires.' He shows a jar filled with pitch black grains: carbon black recovered from car tires. The black, grainy substance is used as pigment, but it also makes car tires more resistant towards wear and tear as well as UV radiation. Because of its high value, the new flash pyrolysis process is aimed at producing the highest quality carbon black possible that can be reused in new tires. The other resulting components are oil, that can be used as fuel, and chemicals like benzene, toluene, and xylene, important for the chemical industry.



Challenging

Brem and his team are also working on the thermal separation and recycling using pyrolysis of modern composite materials. Many consumer as well as industrial products contain carbon- and glass-based composite materials. For example, wind turbine blades, car parts and boats contain a lot of these materials. They often contain plastics as a base, reinforced with a matrix of carbon- or glass-fibers. Recycling proves to be very challenging, because mechanical recovery results in inferior materials, not suitable for reuse. 'With increasing applications of these composite materials, it will be essential to develop technologies for recycling, to save materials and reduce costs,'Brem states. 'We are currently exploring new pyrolysis techniques to recover these fibers from waste streams. The aim is to collect high-quality fibers and fuels that can be reused, hence closing energy and material cycles.' ●

Suzanne Janssen

Robots on the work floor

Text: **Jelle Posthuma**
Photo: **Rikkert Harink**

We hardly know how robots affect an organization. Over the course of the next few years, assistant professor Suzanne Janssen of the Communication Science department will therefore research what it is like to have a robot for a colleague. She received a Veni grant for her research proposal.

What drives and motivates people in their work? That question intrigues Janssen. 'For my doctoral research, I examined informal mentoring relationships between a mentor and a protégé on the work floor. To stay motivated, professional relationships have to satisfy three needs: autonomy, competence and connectedness. Is someone given enough room to do their work as they see fit? Is the work sufficiently challenging? Does it give rise to valuable relationships with colleagues? Whenever I spoke to employees as part of my research, their answers boiled down to these three basic needs.'

The introduction of robots on the work floor makes these three needs newly relevant. These robotic colleagues may affect employees' autonomy, competence and connectedness. 'In the context of my research, I am interested in robots that work together with people. The main question is how robotization affects our three basic needs. How do people feel about working with this new technology? I distinguish between social and non-social robots.'

To study the new relationships that arise on the work floor, Janssen will tag along with employees of various organizations. 'I combine observations and interviews. In general, people are creatures of habit. They tend to be critical of any organizational changes. This will be no different when robots are introduced in an organization. Perhaps a robot does reduce our autonomy. However, when given the chance, employees will undoubtedly structure their work differently to satisfy their need for autonomy in some other manner. On top of that, these technological assets can take care of all manner of tedious jobs, leaving more time for work that actually interests us. Robots will change an organization, but the culture on the work floor will partly determine how robots are implemented and utilized.'

For her research, Janssen does not look at robots that completely take over a person's job. 'I am interested in the collaboration between humans and technology. Take a robot in a production environment, for example, where it can take care of the heavy lifting or execute tasks that require a great deal of precision. Afterwards, a human employee can take over again. I do not believe that robots will ultimately take all our jobs. A lot will change on the employment market, but jobs for humans will never run out. Any technological innovation always creates new jobs.' ●

Our 'Rising Star' Suzanne Janssen :

2008	Master of Science (MSc), Organizational Communication
2008-2011	Lecturer, University of Twente
2015	PhD (Cum Laude) 'A Self-Determination Theory Perspective on Mentoring Relationships at Work'
2015 - now	Assistant Professor in Organizational Communication, University of Twente
2017	Visiting Researcher, AIT Austrian Institute of Technology GmbH
2018	NWO VENI Grant

Text: **Jelle Posthuma** Photo: **Eric Brinkhorst**

PROFESSOR OF INNOVATION AND REGIONAL GOVERNANCE MARCEL BOOGERS

‘Municipalities are a kind of microcosm’

A select group of UT students has been enrolled in the local and regional administration master’s track since 2017. It is designed to train the next generation of civil servants in a more specialist manner. The idea is derived from research conducted by Marcel Boogers, UT professor of innovation and regional governance.

Boogers knows that public administration in municipalities and regions is a special business. To better prepare his students for a career in local administration, he launched a separate master track last year together with his colleagues at the Public Administration department. Boogers’ research has shown that municipalities are the largest employers of public administrators, yet the training this group of people receives is still too generic. ‘Brussels, The Hague or city hall: it makes a world of difference. With this master track, we want to give students a more specialised education to prepare them for local administration.’
According to the Professor of Innovation and Regional Governance, the main difference between local and national administration is the smaller scale. ‘In municipalities and the region, the distance between policy and execution is much shorter. Plans that are developed today will be executed the day after tomorrow. At the national government, the situation is completely different. On top of that, administrators interact far more with residents at the local level. Our master track gives students a better feeling for this form of public administration.’

‘Brussels, The Hague or city hall: it makes a world of difference’

Executors

According to Boogers, the existence of this specialist master’s programme is justified by two developments. ‘First of all, a lot more is happening at the local and regional levels. Municipalities are no longer merely the executors of government policies. Because of the decentralisation in the healthcare sector, for example, large sums of money and major responsibilities are at stake at the local level these days. Additionally, there is more attention for local issues. In the past, city council elections were mostly a kind of popularity contest for reigning members of Parliament.’
Since the last elections, that all seems to be changing. Municipalities have become a nursery for political developments. Fragmentation, the rise of opposition parties and populism: it is business as usual in The Hague, yet studies show that all these developments occurred first at the local level.
The professor conducted research into the rise of independent local parties. ‘They are in the lead in municipalities nowadays, which makes them an interesting field of study. Take the rise of Pim Fortuyn, for example: that development was evident at the municipal level twelve years earlier. Parties such as Leefbaar Hilversum and Leefbaar Utrecht had similar agendas: they resisted the traditional, imperious parties. At the national level, this countermovement led to the rise of Fortuyn and the PVV.’
The fact that these developments occur first at the municipal level is due to the short distances that exist in

MARCEL BOOGERS

local politics. 'Municipalities respond much quicker to social changes,' Boogers explains. 'Far more than their colleagues at the national level, local public administrators are part of society. It is a kind of microcosm where strange things can happen and experiments are conducted that only become evident at the national level much later.'

Local parties were the clear winners during the past elections, yet policies will not change dramatically when these parties are in control, Boogers states. 'Politicians of local parties are commonly seen as populist troublemakers, but that is not justified. In fact, the policies of local parties are generally pragmatic. For example, they are more likely to bring an outside administrative talent into the municipality and figures indicate that an equal or smaller number of councillors is forced to leave. These politicians are also quite critical of each other – too critical at times, I think. I am not worried about their integrity.'

Efficiency or democracy

The decentralisation of the healthcare sector has given municipalities a major responsibility, Boogers says. He researched the transfer of healthcare duties, as well as the development of cooperative alliances between municipalities in a region.

'Some of the tasks that were transferred are quite risky. They involve the care for vulnerable members of society; if something were to go wrong, the media would be all over it in an instant. Several municipalities seriously considered the option of such a major operation ending in failure. They even conducted emergency exercises. Suppose a father shoots his entire family. How should a municipality respond to something like that? Ever since the decentralisation, healthcare is a regional affair and the responsibility of local administrators.'

'Municipalities respond much quicker to social changes'

'It turned out that many municipalities were poorly prepared to carry out their new responsibilities. That is why so much is handled at the regional level these days. Only through collaboration can municipalities successfully carry out their new tasks. There are now so many local cooperative alliances that city councils claim to have no idea what goes on in them. This development is undemocratic.'

The professor claims that this is a common dilemma in the world of public administration: the choice between efficiency and democracy. 'The regional alliances have reduced the influence of politics on the healthcare sector. It is all about money. The debate about the quality of healthcare is nowhere to be heard, even though it is so terribly important.' ●

E! EUREKA

The eureka moment, the moment when you have a brilliant idea or a sudden discovery. We asked UT researchers about their eureka experience.

It is important to make a distinction first. People operate in one of two ways: for most of the day, they are quite active, yet not particularly creative. Only when one is relaxed – which can be quite a rare occurrence – does one's creativity begin to flow. That is when you can have a eureka experience. There are three ways for me to reach that state of relaxation: in the shower, while swimming and while riding my bike.
I mostly commute by bike. As I ride from Borne to Enschede and back, I enjoy listening to some classical music – mostly piano pieces, sometimes a bit of Mahler. A while ago, as I was riding along, I had a eureka moment about telemanipulation.
With telemanipulation, a person can remotely control a robot via a display using a joystick. During the development of this technology, the problem of time delay came up. I often use the example of a shower to explain this concept to my students. Right before a lecture, a student decides to hop into the shower. They are in a rush and want the water to heat up as soon as possible, so they turn the hot water tap fully open. The water

Text: **Jelle Posthuma**
Photo: **Rikkert Harink**

Stefano Stramigioli

PROFESSOR OF ADVANCED ROBOTICS

stays cold for a few seconds longer, but then it suddenly becomes too hot. The student has to adjust the temperature again and turn the cold water tap fully open. This results in an oscillation of cold and warm without getting what is desired – that is time delay.

Telemanipulation is also plagued by the problem of time delay. There is a delay between the master (the joystick) and the slave (the robot), which results in instability. The connection between master and slave is realised via the internet. While riding my bike, I came up with a solution that roughly boils down to a division between information and energy: in the past, these were sent to the robot as a single component. The new method I came up with, which turns it into a single package, allows the robot to perform better. With this new technology, we achieved the longest possible telemanipulation: someone at the UT performed a stable flight with a drone all the way in Australia with force feedback.

Text: **Frederike Krommendijk** Photo: **Shutterstock**

RESEARCH BY AINARA GARDE

Ann app that helps to prevent child mortality

When your child is sick, you want to be able to visit a hospital as soon as possible. In third-world countries, however, the nearest hospital is often far away and hard to reach. Ainara Garde, scientist from the Biomedical Signals and Systems department of the TechMed research institute, is searching for a way to detect childhood diseases at an early stage. For this, she uses the oximeter, a device that measures a patient's blood oxygen level and other data and shows the results in an app on a smartphone.

In third-world countries, medical equipment and hospital beds are scarce. Smartphones are relatively easy to find, however. By placing a small clip on a child's finger, their blood oxygen level can be measured, as well as changes in their blood pressure, heartbeat and respiration. The clip can be connected to a smartphone with a cable. In under a minute, the app and the algorithm reveal whether a child is ill and should be taken to a hospital. This helps prevent unnecessary travel, stress and hospital admissions.
Ainara Garde published an article entitled ''Respiratory rate and pulse oximetry derived information as predictors of hospital admission in young children in Bangladesh' about the use of the oximeter and her app. Last year, this won her the Professor De Winter Prize, the international publication prize for female top talents. 'That was fantastic, of course. Yet what drives me most of all is the knowledge that technological innovations like this one can truly contribute to the reduction of child mortality in low-wage countries. The World Health Organization WHO wants to reduce child mortality in children under the age of five to 25 per 1,000; at the moment, that figure is much higher.'

Costly

Although the innovation has amply demonstrated its effectiveness during a trial with 3,000 children in Bangladesh, Garde does not expect every African family to have an oximeter soon. 'Even though the device is quite cheap, it is still extremely costly for the people there. Furthermore, the clip has to be put on the patient's finger carefully, otherwise the readings are unreliable. The results also have to be interpreted properly, preferably in combination with other forms of physical examination. I therefore see more possibilities for use in, for example, regional and local parent-child centres or healthcare centres.'
The major advantage of this method is how quickly it shows results. Its accuracy also appears to be excellent. 'By combining the various data from the reading, you can predict with a high degree of certainty whether a child will become ill or not. During our research in Bangladesh, we tested 3,000 children. It quickly became clear who needed to be admitted into hospital and who could be sent home.'
During the award ceremony last year, Garde also praised the efforts of her fellow researchers from Bangladesh, Canada (where she earned her post-graduate degree) and her colleagues at the UT. 'You

cannot pull something of this magnitude off on your own.' At the moment, she is part of several projects at various hospitals closer to home. 'My field of expertise is processing signals pertaining to cardiology and the respiratory system. Together with the Medisch Spectrum Twente in Enschede, I am working on a research project for people with sleep apnoea, with the UMCG university hospital in Groningen there is a project concerning chronic obstructive pulmonary disease (COPD) and in Rotterdam, I am part of a project studying apnoea in premature babies. On top of that, I am collaborating with a hospital in Vancouver (Canada) and one in my home country of Spain.'

Motivation and focus

What she loves most about the UT is the ability to work on the intersection between people and technology. 'The slogan 'High tech, human touch' ties in perfectly with what I value most. Technology can be used to help people. As a scientist, that means you have to talk to practical experts. In my case, those are medical specialists. What is missing? What do you need? That human component is what makes my work so interesting, much more so than if it were purely technical. This research has strengthened my motivation and focus. I now see the people behind the data.'

She is not sure if she will ever get to see the fruits of her labour with her own eyes in Bangladesh. 'That would be fantastic. When you think about it, it is amazing to contribute to the reduction of child mortality and I would love to see the oximeter being used in practice. At the moment, though, we are still working on improving its accuracy, for example by putting a clip on the patient's nose instead of their finger and seeing which works best. The work is not finished yet, but I am extremely hopeful about the contribution it can make.' ●

'That human component is what makes my work so interesting'

Text: **Rense Kuipers** Photo: **Eric Brinkhorst**

M

Master Research

Björn Nijhuis graduated with a 10

Making 3D metal printing more reliable

Halfway through his Master's research, Björn Nijhuis was asked by his supervisor, professor Ton van den Boogaard, to become a PhD student after. Apparently, it wasn't that hard for the professor to see Nijhuis' potential, since he graduated cum laude and with a 10 for his thesis.

Nijhuis graduated on the topic 'scope and limitations of gradient enhanced crystal plasticity in explaining macroscopic phenomena'. 'I know it's quite a mouthful, but it basically comes down to this: Usually when we model metal, we look at how something behaves in its entirety. But then you get the problem that the behaviour of some specific elements within the object is hard to predict,' Nijhuis explains. 'When you zoom in on metals, you can see they consist of crystals. My job was to predict behaviour of the crystal structure on this deeper level, so it can help in the simulation of the forming process of car parts for instance.'

Now, Nijhuis is continuing his academic journey with a PhD research focused on numerical simulations of 3D printing of metal. '3D printing is an up-and-coming technology that has a lot of potential. There is a lot less waste compared to the regular ways of shaping metals and you have more freedom to design. However, there is a lot of trial and error in the 3D metal printing process nowadays. Using numerical simulations, we can make this form of 3D printing more reliable.'

Since he ran into a lot of restrictions during his internship at a company, the young PhD student didn't have a hard time choosing to stay in academia. 'There are some things that I'll have to do. The first part of my PhD consists mostly of extensive literature research, but that's okay. I can now think of where I want to have my added value in this field of research. I believe that's the beauty of science: seeing what's been done and looking at ways I can make a difference.'

Nijhuis knows he has both intense and interesting four years ahead of him. 'I like that I'll be working in an up-and-coming research area, with new technologies around me. Possibly closely collaborating with companies. It really is pioneering.' And after that? 'My future is wide open, the same goes for my ambitions.'

Humour

A woman walks into a mortuary. The mortician lifts up the sheet and the woman says: 'Yes, that is my husband, but what detergent are you using to keep your sheets so white?' The joke comes from 'Das schwarze Buch' by the German comic artist Uli Stein. It was used in a Viennese experiment with 156 subjects. These people were asked whether they liked the jokes. Their intelligence, aggression, mood and educational background were also tested. The researchers' conclusion: the more someone liked Stein's jokes, the less aggressive and the more intelligent they were. Ergo, there is a link between intelligence and black humour. The experiment, which was published last year, received a disproportionate amount of attention in various media that do not shy away from clickbait. The question of whether appreciation of Stein's humour might have more to do with one's personal taste than one's intelligence was not covered.

I encountered this study while searching on Google for articles about humour and science. I was inspired to do so by my interest in Andre Konstantinovitsj Geim. This British-Dutch physician with a Russian background is, to the best of my knowledge, the only one with two Nobel Prizes to his name: the Ig Nobel Prize for making a frog levitate in a magnetic field and the Nobel Prize in Physics for his ground-breaking research into graphene. The Ig Nobel Prize is given out for research that first makes you laugh and then makes you think. On a Friday night in 1997, Geim had the idea of throwing water onto a high-powered magnet in Nijmegen. When it began to levitate, his wife suggested to try the same with a frog. The picture of the floating frog went around the world. The experiment also worked with his hamster, Tisha. Under the pen name of H.A.M.S. Ter Tisha, she was credited as the co-author of the article he published on his experiment. Geim has a great sense of humour, as interviews with him make abundantly clear. When asked about the importance of humour in science, he told journalist Bo Blanckenburg about the disgruntled response from the scientific community to his joke with the frog: 'I would not take my work too seriously. As if boring and serious always go together! If you have a chance to make fun of yourself, you should take it. It helps keep things in perspective.'

He eventually left Nijmegen for the University of Manchester, where the atmosphere on the research floor is supposedly less hierarchical. I envy his colleagues and can only hope they have a better sense of humour than the Viennese.

Enith Vlooswijk
Science journalist

Text: **Rik Visschedijk** Photos: **Rikkert Harink**

FREEK VAN DER MEER, PROFESSOR OF GEOTHERMAL ENERGY AND EARTH RESOURCES

More than just science

As professor of Geothermal Energy and Earth Resources at ITC, Freek van der Meer is involved in one of society's most important issues: the energy transition. He enjoys the role he can play in this as a scientist and as an intermediary between governments and businesses. 'Technology is one thing; getting parties to see eye to eye is quite another.'

Van der Meer's research group is trying to determine whether certain regions are potential application areas for geothermal heat as an energy source. This is done with a combination of satellite information and fieldwork. The resulting data is entered into geological models. 'That allows us to predict the potential of geothermal energy with an ever-increasing degree of accuracy,' Van der Meer says. 'It is a complex situation. You want to know how deep you have to drill into the ground, but also what layers of the Earth you will encounter on the way down.'

His department mainly focuses on volcanic regions in places where the continents are drifting apart. 'Those offer the most potential,' the researcher explains. That does not mean that this technology cannot be put to good use in the Netherlands. 'Extracting geothermal heat from the Earth is not that different from the geothermal heat pumps that are used in our country,' he says, 'although the scale is entirely different, of course.'

Cultural dynamic

At the moment, major projects are underway in Indonesia, Kenya and Tanzania. The dynamic in those countries is entirely different from that in the Netherlands. 'Take Kenya, for example,' Van der Meer says. 'It is an extraordinary country where geothermal heat has been a viable solution for decades. Fifty percent of its energy demand comes from geothermal heat, and in total, eighty percent of its energy supply is sustainable. We have been active in Indonesia for around ten years or so.'

The differences are vast. 'Mostly in terms of culture,' the researcher says. 'In Kenya, an entire infrastructure has been built around the extraction of geothermal heat. That is nothing like the situation in Indonesia, which is much more fragmented in an administrative and cultural sense. There are countless religions, some of which consider the land and mountains to be sacred. That means you have to talk endlessly to get anywhere.'

Added to that is the fact that things went disastrously wrong around ten years ago when a mud volcano was struck in Indonesia. 'Entire villages were wiped out,' Van der Meer says. 'It was clear that this was not a desirable situation.' He sees that same sentiment in the Netherlands. Shale gas, storing carbon dioxide; it all sounds great on a technical level. 'Yet these developments are about more than just technology. You inevitably touch on some major social concerns. Along the way, I learned that I enjoy taking part in these discussions – with politicians and policy makers, but also with the general population.'

'In my own way, I am contributing to a better tomorrow'

Social discussion

That social discussion is in full swing. Most people agree that the Netherlands must ultimately abandon the use of natural gas. That means other energy sources will be needed. 'Geothermal heat is an option,' the professor says. However, he is careful not to speak too highly about his field of study. 'There is still much we do not know. The same goes for geothermal heat. How sustainable is it, really? Extracting geothermal heat from the ground is less invasive than drilling for oil or gas, but what about the long-term consequences? Those are still unknown. Is geothermal energy a perpetuum mobile, a device that moves of its own volition and generates energy out of thin air? I do not think so.'

The search for alternatives to fossil fuels is a costly business. Similar to the development of a wind turbine park, the installations used to extract geothermal heat cost millions. 'On top of that, you only have a fifty percent chance of hitting the jackpot in most volcanic regions, even after thoroughly studying the region's potential,' Van der Meer continues. 'Who would want to take that financial risk? A government on its own will be hesitant to take the leap.'

As a result, these large-scale projects almost always take the form of public-private partnerships. Van der Meer plays the role of project leader in society, for example in Tanzania. It requires him to fly all over the world. 'In Indonesia, one of our goals is to get Dutch businesses involved in the project. That is quite a unique job for a scientist.'

As a researcher, he gets a lot out of this collaboration. 'By being involved in its execution, we can determine how the drilling process affects the soil. We can use the resulting data in our models.' It is a 'tense' collaboration. 'The researchers are mostly interested in the long term and want to feed quality data into their models. Businesses tend to adopt a more limited perspective: when will they start to see a return on their investment? I enjoy the interplay between these perspectives.'

Entrepreneurship

That is also why Van der Meer views the collaboration between the ITC institute and the University of Twente as an excellent development. 'ITC was originally a training and research institute. We can benefit enormously from the UT's more than fifty years of experience as an entrepreneurial university. I experience that in my work every day. For example, I have ten PhDs working on one project. Three of them have moved away from their original field of expertise to focus mostly on governance and environmental impact. We are still learning the entirely new language that comes with it.'

This ties into the new direction that the ITC is heading

Freek van der Meer in a nutshell

1989	Graduated from the VU, geology
1995	Obtained a doctoral degree at WUR in remote sensing
1999	Professor of Spectroscopy at TU Delft
2004	Professor at ITC
2004	Part-time professor at UU
2011	Editor-in-Chief of the International Journal of Applied Earth Observation and Geoinformation
2011	Member of the ITC's Faculty Management Team
2018	Education portfolio manager ITC-UT

towards with its Capacity Development. 'It is a major aspect of our faculty. In those underdeveloped regions, we want to acquire knowledge and experience alongside local partners, so we can help organisations together. That is what makes my job so much fun. It is more than just science; in my own way – no matter how small – I am contributing to a better tomorrow.'

In that sense, Van der Meer would like energy to be a more prominent theme at the UT. 'We are working on that together, though. Across the UT, we are doing a lot in this regard,' he says. 'At ITC, but also in fields of research such as making systems more energy efficient, storage and in industrial processes. The energy transition is a major talking point in political circles and in society in general. We can contribute to that discussion.'

Building the future

To Van der Meer, it is important that his work lets him build the society of the future. That does not mean that his career has been a straight path leading him to where he is today. 'As a high-school student, I was not sure what to do. I was good at the science subjects, but I wanted more than just theory. I eventually ended up at the Vrije Universiteit's Earth Sciences programme.'

'After my studies, I began my career in the world of business at a company that conducts geophysical research,' he continues. 'I soon grew tired of that. We had to churn out reports quickly. Above all, they had to support the client's perspective and be open to interpretation. When I received an offer to work as a lecturer, I accepted immediately. I realised that I had to obtain a doctoral degree if I wanted to advance my career. I did that in Wageningen. I finally started working at ITC back in 2004. Originally, I expected to work here for a few years at most. Things turned out differently and I still love my job very much.'

These days, he is less involved in the primary scientific process. Van der Meer supervises his research group, has served as education portfolio manager since September and is in charge of several projects. He is also the editor-in-chief of the International Journal of Applied Earth Observation and Geoinformation. 'I have plenty to do,' he says. 'I enjoy that very much. Of course, I am not going to solve all of the world's problems, but I do believe my work is meaningful. Do I have a goal for my future? No, I am satisfied with where I am and I love working with the enthusiastic people around me, whether that be in the context of the partnerships or with young researchers. It is wonderful to watch talent develop. That is what drives me.' ●

'I'm not going to solve all the world problems but I do believe my work is meaningful'

C

Captured on Camera

Test cell for next generation batteries

The clamp-like object in this picture is a test cell for the next generation of batteries. Professor Mark Huijben and other researchers of his Nanomaterials for Energy Conversion and Storage research group use this device to test new battery materials developed in the NanoLab. Huijben explains: 'We use a glovebox environment to place these materials in such test cells, closed off from any water or oxygen. Then we connect the cells to cables to charge and discharge – often up to a thousand cycles.' The goal is to create better batteries, hence a collaboration exists between the research group and the company Lithium Werks. 'Next generation batteries should have a good energy density, be able to charge quickly, pull off a lot of cycles and be safe,' says Huijben. 'That's what we're trying to accomplish.'

Text :
Rense Kuipers
Photo :
Eric Brinkhorst

Independent and *outspoken!*

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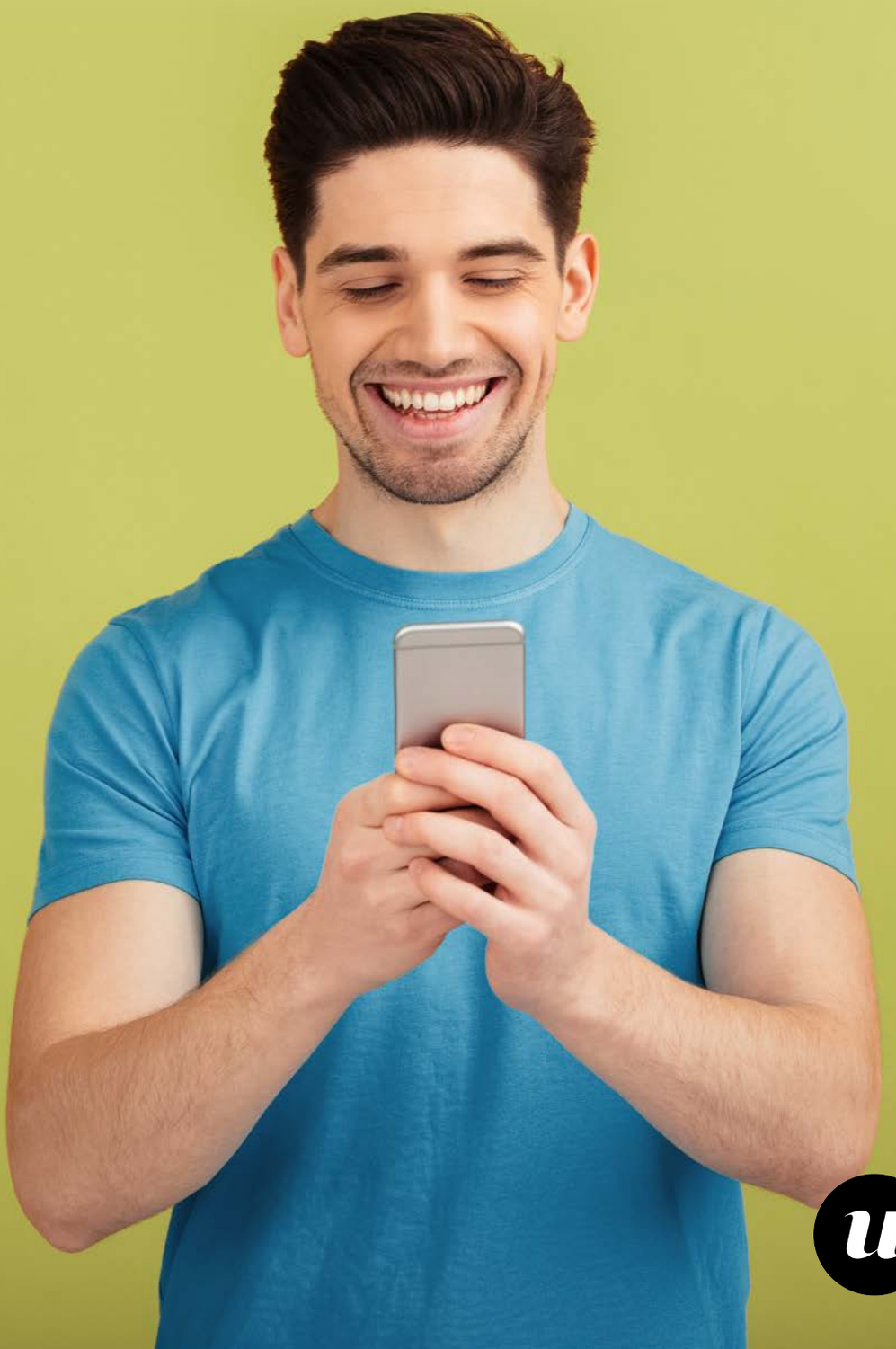

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