issue #7

UNIVERSITY OF TWENTE.

U-TODAY

Science & Technology Magazine

REAL FAKE

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u today

7,5

So many people, so many wishes, so many opinions. Also known as: the UT community. It's a delightfully critical environment that sometimes offers major challenges for journalists to work in. That was also confirmed by the results of our 'reach and appreciation survey', recently conducted by Newcom Research & Consultancy.

A sampling of the responses: 'Get rid of the magazine and be proper journalists', 'you can tone down the cynicism', 'change the name back to UT Nieuws', 'contribute to the community feeling of the UT', 'up the frequency of the magazine', 'offer a good mix of feel good articles and objective news for students and employees', 'get rid of the printed editions'.

Thanks for all the responses. Although some of them were a lot to take in. It was evident that you are all very engaged readers. We're very happy with the rating we received for this magazine: a neat 7,5. We also see room for improvement. Maybe by telling why we do the things we do. And why we decided to create the Science & Technology Magazine in the first place. That doesn't stem from our role as critical watchdogs (although we take that role very seriously, in fact: it's the most important pillar of our raison d'être at this university), but from a connecting role that we also hold dear. We think it's important that students and employees dare to peek over the walls of their own disciplines. Ask yourself what happens in research in another building or at another faculty. What stories do these scientists have to tell? That's a different approach from all the news, background and opinion articles on www.utoday.nl.

The fact that we choose paper for our connecting role serves a function. Especially because we want the readers to look beyond their own disciplines, it's important to be 'confronted' with a physical copy. In the displays at the entrances of buildings. Or on the reading table in the coffee corner. This magazine ensures that physical visibility. Which is nice for us, of course. But it's also up to you as a reader to dare to look beyond. Peek over that wall. Need a stepladder? Use U-Today.

Maaike Platvoet

Editor-in-chief at U-Today

u today

Colophon

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U-TODAY

Science & Technology Magazine

Content

Text: **Rense Kuipers & Jelle Posthuma**
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WE'RE LIVING IN THE POST-TRUTH ERA

Really, it's true

Until a few years ago, no one had ever heard of the term 'fake news'. These days, however, twisted facts are a threat to our free and democratic society. Now that the truth is often reduced to an opinion, fake news is thriving online. How did it get this far, how should we behave in the post-truth era and what can science do to help?

First, let's take a look at the term 'fake news'. These days, it is thrown around haphazardly, says Alexander Pleijter, a lecturer at Leiden University and an expert in the field of online journalism and factchecking. 'It is about information that is delivered in the form of news, but which has actually been made up to serve a predetermined commercial or political purpose. These are also stories that people can talk about around the coffee machine. News has always had this social function – even if the news itself is actually false.'

The hype

Pleijter says the term 'fake news' rose to prominence during the American presidential elections in 2016. 'Before that time, the term was hardly ever used. Trump started using it to dismiss and belittle the established media. He called news organisations like CNN, The New York Times and The Washington Post 'fake news media.' That is how the general public first came into contact with the term.'

Although the current American president made the term tremendously popular, the researcher from Leiden says that fake news is nothing new. 'Historians who study this concept actually date it back to Roman times,' Pleijter explains. 'Technological developments like the internet have made it much easier to spread fake news. In the past, an organisation had to have the financial means to afford a printing press. The internet has completely eliminated this obstacle. Digitisation

has resulted in an exponential increase in the amount of information that is available to us, and some of that information consists of fake news.'

The underlying factors

Iris van Ooijen, UT researcher in the BMS faculty, agrees. She conducts research into the role that information plays in our data-driven society. 'The internet has made the distribution of news a democratic process. In the past, it was clear as day where news came from: the government, newspapers and the church – all traditional institutes. These days, anyone can easily create a news site that looks reliable, while social media give everyone the option to share its content. Fake news is clearly a downside of this development.'

Studies have shown that people have difficulty recognising fake news, Pleijter adds. 'That is because it is almost indistinguishable from real news. People also have a natural tendency to believe what they hear, especially when it comes from familiar channels. News consumers know that a lot of nonsense is being spread around on the internet, but when it comes to messages shared by friends and family, they are less quick to doubt the information. It is not surprising that people are less likely to distrust messages from people they know: after all, our society is built on trust.'

Trust is not the only decisive factor online, Van Ooijen states. Myriad algorithms running in the background determine what you can and cannot see. 'Major players like Facebook and Google allow countless parties

> *'People have a natural tendency to believe what they hear'*

‘Those who shout the loudest will receive most attention’

– often with commercial motives – to target us. An algorithm detects whether you are interested in “right-wing” news, for example. Before long, that is almost all you see. You end up in a so-called filter bubble. I am reasonably confident that if filter bubbles did not exist, people would receive a more balanced stream of information.’

According to the BMS researcher, the next step is for such a filter bubble to cleverly play into our confirmation bias. ‘People are more likely to accept information that is in line with their own beliefs. The effect is so strong that ambiguous information – which does not clearly lean in one direction or another – is still interpreted in a way that suits people’s ideologies.’

According to Van Ooijen, step three is the echo chamber that people end up in. ‘Because people with similar opinions keep finding each other, they resonate and produce an echo of opinions and beliefs that reinforce each other.’

Sensationalism

The media landscape, which has changed drastically since the dawn of the internet, has taken on an entirely new shape. To Van Ooijen and Pleijter, their daily practice offers ample proof that parties make clever use of the trinity of filter bubbles, confirmation bias

and echo chambers. Wherever a system exists with its own mores, people will find ways to exploit that system. 'Fake news reports generally make use of sensational headlines and content. That is a common phenomenon on the internet, even when you are dealing with "real" news.' It is inherent to the internet, Pleijter knows. For example, he states that most large media organisations produce so-called 'pulp news'; sensational messages that generate a ton of clicks via online channels. 'In general, this news is true, as opposed to fake news. Pulp news is also about sensational messages that generate a lot of revenue. The sensational packaging is designed to draw people to the website. One example of such a sensational packaging is the double clickbait headline, which online news organisation Upworthy first started using: 'She believed to have a flat tyre and got out of her car. You won't believe what happened next!' – this is a typical example of a clickbait headline.'

According to Van Ooijen, not only new online players present their news in a sensational manner; even traditional news organisations are out to maximise their clicks. 'You have to do something to stand out amongst the enormous quantity of information that is available online. Reports from quality media outlets are becoming extremer in nature and bear more sensational headlines. Even the NOS uses this tactic and puts controversial quotes in its headlines. We are experiencing an information overload: those who shout the loudest will receive most attention.' This leads the researcher to the following conclusion: 'These days, the underlying social mechanisms that facilitate fake news and clickbait are polarising opinions, division and a lack of unity. The cues that play into this are sensation: the more clicks or pictures that speak to people's emotions, the more effective they are. This leads to a vicious cycle, with polarisation leading to more fake news, which means in turn more polarisation.'

Motives

According to Pleijter and Van Ooijen, there is certainly no one single reason why fake news is distributed. There are as many motives as there are parties, as the American presidential elections in 2016 made perfectly clear. For example, Macedonian youth made clever use of the hype that surrounded the elections. 'They wrote thousands of fake news messages about the race between Clinton and Trump. Not without success, it turned out: they reached millions of Americans and earned a lot of money,' says Pleijter. 'Furthermore, Trump supporters made up news with a political bend to discredit Clinton. The reverse was also true: some Democrats spread fake news about Trump.'

The result of the campaign brought even more attention to fake news. Trump won the elections and brought about a dramatic shift in the American political landscape. According to Pleijter, that was the moment that fake news became an even more prominent issue: 'How could this have happened,' the press wondered. They believed that fake news, which was spread so frequently during the campaign, might be one possible explanation. Added to this were the stories about Russian interference in the election. Note that it was never proven that Trump won the elections because of fake news.'

Murder

Although fake news has caused quite a stir in America, it has not yet demonstrably led to any catastrophes. According to Pleijter, fake news only become truly dangerous when news consumers start to rely solely on channels like Facebook or WhatsApp for their information. 'In countries like Mexico and India, the disastrous consequences of that development have become clear. When people get all their information from a single WhatsApp group and when that news is fake to boot, it can lead to lynch mobs. In India, a rumour was spread via WhatsApp that paedophiles were active in the area. This inspired concerned parents to take matters into their own hands, resulting in the killing of multiple innocent people.'

Djoerd Hiemstra, data scientist at the UT's EEMCS faculty, places the blame in the hands of the internet giants. 'Organisations such as Facebook, Apple, Amazon and Google do not do enough to prevent fake news. The economic motives still come first for these companies. In the end, it is all about data, because the internet user is the product. Those who collect data have all the power.' As a gruesome example, he mentions the violence in Myanmar, where people ended up on the internet after years of living under a military regime, with censorship and restricted freedom of the press. 'People were riled up against each other via the internet and the fake news was spread via Facebook. In that sense, the social network has blood on its hands. I believe the term 'fake news' is euphemistic in this case; it is propaganda used to manipulate people.'

The fake news about the Muslim Rohingya minority in Myanmar ran rampant on Facebook since the opening up of the internet and therefore facilitated the ethnic violence against this group. Facebook openly acknowledged that it did not do enough to prevent what happened in Myanmar. Following the violence there, the company had its own role in the events examined. In 2018, Facebook concluded in a blog about the research: 'Prior to this year, we weren't doing enough to help prevent our platform from being used to foment division and incite offline violence. We agree that we can and should do more.'

'If filter bubbles did not exist, people would receive a more balanced stream of information'

The Dutch landscape

Such an escalation is less likely to occur in the Netherlands, says Pleijter. 'Our media landscape is quite diverse. There are few people who rely only on Facebook or WhatsApp for their news reports. On top of that, we have excellent journalists who correct each other. That is essential for balanced news reporting. Our faith in the journalism sector is also fairly large. In a country like the US, the situation is quite different. The media there are completely polarised between left- and right-wing news organisations. In the Netherlands, there are some who renounce the established media. They call the NOS a state news network and believe all journalists are colluding, but they are relatively few in number. To them, the established journalism sector is the mainstream media, while they get their news from alternative websites.'

Together with his fellow researcher Peter Burger, Pleijter launched the Newscheckers project in 2009. 'We were not out to spot fake news – like I said, that term did not exist yet. We wanted to check facts. Above all, we believed this project would be educational for our journalism students. They were asked to critically follow the media, ask themselves whether stories were correct and then uncover the real truth. A journalist has to check their facts beforehand, of course, but as an educational method, the retrospective assessment of news reports is quite valuable.'

CHECK THE AUTHOR

Do a quick search on the author. Are they credible? Are they real?

SUPPORTING SOURCES?

Click on those links. Determine if the info given actually supports the story.

CHECK THE DATE

Reposting old news stories doesn't mean they're relevant to current events.

'It quickly turned out that Dutch articles do indeed contain falsehoods. Our students called the journalist who wrote the article to ask how the piece had been written. Their findings revealed that certainly not everything is checked in the journalism sector. They were told things like: 'We needed a small item,' or 'This is just a fun little piece, it is not a serious journalistic topic.' For our students, it is very educational to experience these processes for themselves. On top of that, we noticed that editors began to change their guidelines after being scrutinised by us.'

After the American presidential elections in 2016, when the commotion surrounding the term fake news reached new heights and the elections for the Dutch House of Representatives were coming up, Pleijter decided to factcheck the elections with his students in 2017. They did not check the media, but rather the politicians themselves. What did the different parties say during their campaigns and what falsehoods did their statements contain?

Not long after the start of this initiative, Pleijter was approached by Facebook. The newscheckers from Leiden collaborated with Facebook for roughly a year. The fact hunters provided false articles with links to a website. 'This website contained a second opinion, an explanation of why the article on Facebook was false. False messages were also made less visible on Facebook, although we did not delete anything. Everyone should be free to publish whatever they want. When we start to control what someone can and cannot publish, that is when things get really dangerous. After a while, Facebook came up with a different contract. We presented it to the university's lawyers, who were unable to come to an agreement with Facebook after lengthy negotiations. In the end, the issue of liability was the biggest pitfall.'

What is real?

Facebook is gradually taking steps to combat fake news. However, what happens when technology makes it increasingly difficult for us to tell what is real and what is fake? A technique that was initially used to paste celebrities' faces onto the bodies of porn actresses is now increasingly known as 'deep fake videos': fake videos that are virtually indistinguishable from the real thing. Bloomberg journalist Jeremy Kahn calls the technology potentially 'fake news on steroids.' UT researcher and facial recognition expert Luuk Spreeuwers recognises the trend of deep fake videos becoming easier to make and

IS IT A JOKE?

If it is too outlandish, it might be satire. Research the site and author to be sure.

CHECK YOUR BIASES

Consider if your own beliefs could affect your judgement.

ASK THE EXPERTS

Ask a librarian, or consult a fact-checking site.

harder to detect. 'However, when you pay close attention to certain parts of a person's face, you can still spot the fakes. Certain areas often do not move along with the rest of the face, details are missing or you see a kind of static in the video.'

Advances in artificial intelligence continue to make the videos more and more convincing, Spreeuwers says. 'The underlying technology of pasting one face over another has been around for thirty years or so, using simple local geometric distortion. Today, it is possible to explicitly train a so-called 'convolutional neural network' to generate faces with realistic expressions. Simply put, it involves inputting a large array of facial expresses into a network and training it. When the neural network recognises and processes the right facial expressions in a video, it is merely about rewarding the network's good behaviour and trying to minimise the number of errors it makes. This training works by reinforcing the behaviour of the network, if it has generated a natural face with the desired expression in a video. In addition, it is important to minimize the errors. With a powerful network and enough training materials, you can create a truly convincing and complex model.'

Fighting back

Characteristic of the rising phenomenon of fake news is that the four researchers interviewed here are each trying to combat the problem in their own way – or have been doing so for some time. Pleijter has been working as a factchecker since 2009, Van Ooijen has serious plans to introduce a master-level course about fake news, while Spreeuwers wants to dedicate his research to the development of new techniques with which to detect fake images. 'To me, this is a real problem with tremendous social relevance. Since the invention of television, we have relied on the fact that the footage we saw with our own two eyes was trustworthy. I believe we should treat video material in the same critical manner as written text. That is why I want to develop a piece of technology that can detect whether videos are real or fake based on technical characteristics.'

Data scientist Hiemstra is conducting research into federative search engines and networks. He also sees opportunities to fight back against fake news. He says these networks can break through the (commercial) power of major tech companies. 'At the UT, I created our own federative network in the form of Mastodon. The functions of the platform are similar to those of Twitter, but instead of the large commercial networks, Mastodon is set up in a decentralised manner: nobody is the owner of the entire network. Every separate part of the network has its own rules and users who misbehave, for example by spreading fake news, are removed. It can be seen as a small town where everyone knows each other. Like in the real world, there is an element of social control.'

Mark Zuckerberg of Mastodon

Mastodon currently has circa two million users. 'The major advantage is that the network is not out to earn a profit. I am the moderator of the UT network, but I do not have to sell any data. There is no Mark Zuckerberg of Mastodon. I believe the technology behind this network represents the future of social networks. In that sense, the UT is leading the way as the first Dutch university with such a network. Still, it is hard to live your life entirely free from the major tech companies. I have a doctoral degree in computer science, but I cannot imagine life without Google.'

Van Ooijen is also aware of the role played by the tech giants. 'I am researching the data collection efforts of businesses and how they relate with regulations such as the GDPR. One thing I keep seeing is that legislation lags behind technological developments. No, Facebook will not abolish its algorithm. The company

'I believe we should treat video material in the same critical manner as written text'

has gotten so big and it is the core of their business model. Alternatives like Diaspora never attracted enough public attention. Apparently, the social aspect is such a major part of our lives that we value it more than the loss of our privacy.'

Nevertheless, Pleijter wants to put the role of technology in the right perspective. He believes it is problematised. 'During the dawn of the internet, the pioneers said it would renew democracy, because everyone could now take part in the public debate. Today, the focus has shifted to the disastrous effects of digitisation.' Van Ooijen also sees plenty of good in the internet and social media as they exist today. 'We have been granted unrestricted access to a veritable treasure trove of information. There are certainly downsides, however: parties seek to benefit from the current situation and undermine people's autonomous thinking. Most people fail to realise how far this can go; in data collection, it is even about people's individual personality traits. Although our basic knowledge and awareness are growing, much of our online behaviour is irrational and subconscious. We are not confronted with our own online behaviour often enough.'

New professional group

Perhaps the keyword of this whole discussion about fake news is 'responsibility.' Pleijter mostly places it in the hands of journalists and suspects that we might see a new professional group arise: the fact-checkers. Spreeuwers believes that responsibility can be built into technology, for instance in the form of video encryption and verification methods with which to protect people. Hiemstra mainly thinks that the tech giants have to accept their responsibility to protect people. For Van Ooijen, it is a combination of various issues. Should the major companies change their algorithms? Should legislators do something? Should we take responsibility ourselves to become more aware of the dangers we face when we enter the immense online world? She aptly summarises: 'We have to ask ourselves what world we live in, in this post-truth era.' ●

Experts who contributed to the article:

ALEXANDER PLEIJTER	University Lecturer in Journalism & New Media, Leiden University
IRIS VAN OOIJEN	Assistant Professor of Digital Communication, Design & User Behavior, BMS Faculty
DJOERD HIEMSTRA	Associate Professor in Database & Search Engine Technology, EEMCS Faculty
LUUK SPREEUWERS	Assistant Professor at the Datamanagement & Biometrics Group, EEMCS Faculty

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.

This time, Ruud Jacobs, Assistant Professor in Communication and Technology who teaches and researches how games communicate, shares his views on the game Red Dead Redemption 2. Beware, if you haven't played the game: spoiler alert!

The plot

In Red Dead Redemption 2, you play as Arthur Morgan, who is a loyal member of the notorious Van der Linde gang. The story starts in 1899, in a fictional recreation of the American Old West. After a botched heist, the gang is on the run. Realizing that the progress of civilization is ending the time of outlaws, the gang decides to scrape enough money together to escape the law and retire.

First impression

'It's an open world game, like many others. But the beginning is always like an alleyway: you don't feel an immediate sense of danger – although the circumstances story-wise beg to differ. The game just wants to teach you the set of controls. But when you're heading towards the small town of Valentine, the snow melts away and you see the open world in all its splendor and glory. You immediately get a sense of the convincing depth of this game.'

Realism/feasibility

'I found that the developer, Rockstar Games, has its own ideas of what a cowboy should behave like. That doesn't really comply with my way of playing games: I always try to be the most kind and helpful person imaginable. The game really doesn't help me with that. You usually get one positive option to interact with non-playable characters – Arthur saying 'howdy' – opposed to a ton of unpleasant or violent options. On top of that, the sometimes clunky controls didn't help me to move around peacefully: while trying to hitch my horse to a post, I bumped into someone on the boardwalk. I tried my best to de-escalate the situation, but I ended up being shot in the street.'

'The game also has an honour system, allowing you to be good or bad. But I experienced that the freedom of choice is a false sense of freedom. It's much easier to be a bad guy. Especially in the story missions, you're often forced to threaten, rob and kill. I don't believe Rockstar wanted this game to carry out a message, but there is always a message in how a game plays. In my own research, I made some adjustments to a cotton picking game that visualised the scandal of kids forced to pick cotton in Uzbekistan. It turned out that making it easier to pick cotton cut the persuasion power in half. Translate that to moral choices you make in Red Dead Redemption: Arthur is by no means invincible, but he's good at shooting. So the game is telling you that in moments there's no way out, you can always turn to violence to resolve the issue.'

'But I did like the depth of the game, its characters and the way it allows you to be a cowboy. That's why everyone who played the game has their own unique experiences. For instance, I loved hunting and crafting, so I thoroughly enjoyed making a hat out of a skunk. Someone else probably enjoys being a gunslinging bank robber. I found that approaching the game like you're literally cosplaying is the most fun and satisfying. I don't like the violent robbing missions in the story, but this way I could stick to my own nice guy way of playing and still identify with the story for about 80 percent.'

Stray observations

- 'I own two horses: Nylon and Cotton. I love the fact that you're able to bond with your horse and for me it works. I truly feel sorry for them if I let them crash into something on accident. I always try to remember to brush and feed them. If I don't, my girlfriend makes sure to remind me.'
- 'It's a 'Made in America' game through and through. And the current political climate also shows. For an outlaw, Arthur has some morals and values that some people could learn from nowadays: he respects women's rights and is against slavery.'
- 'Another sign of the developer's take on modern society: If you kill Ku Klux Klan members, you gain honour. If you walk into an Indian reservation, the game forces you to put your guns away. I think Rockstar wanted to avoid as much controversy as possible.'

Text: **Rense Kuipers**
Photo: **Rikkert Harink**

Cover of Red Dead Redemption 2

- 'If I would compare this game to other forms of pop culture, I'd say it's like a Netflix series of multiple seasons: you can either choose to binge it or choose to even enjoy the slower 'filler' episodes. Although I do think video games can play more into the emotions of people.'
- 'The detail I loved most – besides the great dialogue with random characters you encounter – is your hat. It's humiliating to see it getting knocked off your head when you're in a brawl and even more humiliating to pick it out of the mud later. To me, those are the true Wild West moments.'

Delft, 1983

There is a commotion in the hall of the Department of Aerospace Engineering, in what was still known as the Technical College Delft at the time. A group of students has gathered around a notice board with exam results and shouts of dismay are heard. Between the pinned lists of grades, there is a note saying that 'due to an unfortunate series of events, the results of the Thermodynamics exam cannot be announced.' The disturbance draws the attention of a staff member of the college. She smells trouble and pulls the note off the board. The damage is done, however: several students are already on their way to the teacher's office to call him out on his actions. The results are published shortly afterwards, some six weeks after the exam.

I made that letter together with a fellow student of mine with an electric typewriter, a pair of scissors, some tape, some white-out and a copier. We believed it was high time to take action: the teachers in Delft seemed to care little about their students. Our suspicion that this letter would light a fire under the normally quite reserved future aerospace engineers proved to be correct. Still, the dynamic of the events surprised me. There were quite a few steps between our amateurish – even for 1983 – notice board stunt and actually confronting the teacher. Upon closer inspection, everyone could have easily seen the letter was fake.

Today, our practical joke would probably be classified as fake news. For the teacher, it resulted in little more than a bothersome disturbance of his university life. These days, however, false rumours can have deadly consequences. A single text message is all it takes; a poisonous cocktail of simmering herd mentality, fanaticism and a lack of proper information does the rest. This is an extreme example of the broad category of fake news. The term is used haphazardly: for deliberately false articles designed to attract clicks, for satire, propaganda, incitement, and for normal news that you simply don't want to hear. The ease with which people label something as 'fake news' is inspired by laziness and a desire to spoil the public debate. Of course, we have to worry about technological developments that redefine the term 'fake,' but the real problem lies with people's inability or deliberate unwillingness to examine our reality from multiple sides. It is quite possible that the future possibility to create 'authentic' videos in which someone does and says whatever you want, the so-called deep fake, will actually be beneficial for our awareness of the distinction between the truth and a lie.

Wiendelt Steenbergen
Professor of Biomedical Photonic Imaging

E

Everyday Science

Fear of heights

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: **Jelle Posthuma** Photo: **Shutterstock**

Everyone seems to suffer from it to some extent: a fear of heights. For some people, however, this fear becomes unbearable. Even a kitchen ladder will leave them with shaking legs, a pounding heart and sweaty palms. Where does our fear of heights come from? What can we do about it? Jean-Louis van Gelder, Professor of Innovative Methods in Public Safety Research, developed an app that allows people to overcome their fear of heights in virtual reality.

'Fear is very important to people,' Van Gelder explains. 'It warns us of danger and serves an evolutionary purpose: it prepares the body for dangerous situations. When such a fear reaches clinical levels and requires treatment, it is called a phobia. The phobia starts to affect the patient in their daily life. On top of that, this fear is irrational and no longer has an objective foundation. Some people have a fear of flying and prefer to drive instead, even though driving is statistically more dangerous than flying.'

'A fear of heights is a specific phobia, an extremely intense form of fear of a situation or an object. Specific phobias are often born out of negative experiences or by adopting the fears of those around you: it is contagious in a sense. It does not usually start as an extreme fear; instead, the intensity gradually increases over time. Someone is on a skiing holiday and starts to feel dizzy in the ski lift. That can be the beginning of a phobia. This person will start to avoid ski lifts from then on. This avoidance leads to an intensification of the fear and results in the development of an incorrect association: avoidance creates a feeling of safety, while in reality it actually feeds the fear.'

'Luckily, a fear of heights is excellently treatable. The core of the treatment is exposure. Think of it as reverse engineering the fear. The fear is fed through avoidance, so it is crucial to confront your fear instead. The trick is to gradually expose people to heights. They must stay in a situation long enough for the fear to begin to subside. The body cannot maintain the tension of the flight response indefinitely. The brain learns that exposure to heights has no negative consequences.'

'The ZeroPhobia app utilises VR (virtual reality) to practise these situations. It is often difficult and time-consuming to visit tall buildings in real life for the treatment. VR is more practical because you do not even have to leave your house. People know full well that they are in a VR environment, yet they still experience a fear of heights. We recently tested our app on a group of 193 people. The results after the digital treatment: a 60% reduction of the fear symptoms.'

WANT TO SAVE 9.000 LITRES OF WATER A WEEK? BECOME A VEGAN

Every litre counts

We already knew that switching to a vegetarian diet would reduce a person's water footprint by roughly 38%, but - until now - nobody looked at the more 'drastic' option. We decided to explore what it truly means to eat vegan - through scientific data and through a personal experience, by becoming vegan for a week.

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

It takes 3000 litres of water to produce a 200-gram beef steak. While getting a soy burger of the same size onto your plate will only cost the world 200 litres. Scientists everywhere warn that, in order to sustain our planet, we need to dramatically change our diet, to replace meat and dairy with plant-based food. The large water footprint of animal products is one part of the issue. We asked the world's leading expert on water footprint, UT Professor Arjen Hoekstra, exactly how much water we could save if we took the most radical step in changing one's diet: turning vegan. The answer? If you are an average Dutch consumer, by becoming a vegan you could save about 1300 litres a day.

'The average Dutch consumer has a food-related water footprint of about 2800 litres a day. If the Dutch consumer would become vegan, he or she would have an average food-related water footprint of approximately 1500 litres a day. That is a reduction of 46%,' says Professor Hoekstra, after he and his colleague Joep Schyns took the time to do some calculations. Calculations that have never been done before in the Dutch context.

What is a water footprint?

- The water footprint is a concept developed by Professor Arjen Hoekstra. It measures the amount of water used to produce a product or a service, anything from a hamburger to a pair of jeans. It looks at both direct and indirect water use and includes water consumption and pollution over the full production and supply chain.
- The water footprint has three components: green, blue and grey.
  - The **green water footprint** refers to rainwater that is directly used where it falls; it is the water that evaporates and that can thus not be used for another purpose.
  - The **blue water footprint** is water from groundwater or surface water (rivers, lakes etc.) that is abstracted and not returned, thus not available for use for another purpose either.
  - The **grey water footprint** is the amount of fresh water required to assimilate pollutants to meet specific water quality standards.
- While the water footprint differs in every country and region, the global water footprint of humanity in the period 1996-2005 was **9087 billion cubic meters per year** (74% green, 11% blue, 15% grey). Agricultural production contributes **92%** to this total footprint.

Source of data: waterfootprint.org

Diary of a five-day vegan

I'm a meat eater. And a dairy eater. A fish eater, a vegetarian, a vegan. I love food. I do not plan to give any of it up, but I also think that reducing our consumption of animal products is one of the most important things we can do to protect this planet. So I turned vegan for a week, to experience it, to see how easy or difficult it would be to live this lifestyle. This is how it went.

Day 1:

I've prepared for this week. It has been planned to every detail: I bought supplies of soy milk and soy yoghurt, gathered all the vegan recipes I could find at home and planned all my lunches. I'm all set to be vegan!
Breakfast is easy. My cereals are already vegan, so all I need to do is to replace my regular yoghurt with soy yoghurt. For lunch I meet with a small group of UT researchers and employees that have joint me on this week's mission. We've ordered the meal upfront from the campus caterer. We enjoy our sandwiches with hummus and salads, discovering that I'm the only regular meat eater at the table. That doesn't matter. I've prepared for this challenge. Tonight I'm making Italian caponata: eggplant, celery, onion, tomato sauce and some homemade garlic bread. One of the favourites in our house.

Inefficient and harmful for the planet

The numbers are clear. Meat and other animal products have a much larger water footprint, and therefore a much bigger impact on the environment, than its plant-based counterparts. What does this stem from? 'Essentially, either we can use land and water to produce plants that we eat ourselves or we can grow feed for animals and eat the animal products,' explains Professor Hoekstra from the UT Water Management group. 'The latter is very inefficient. About 3000 litres of water is used to produce a 200-gram

Illustration: **Timm Kekeritz**

steak. This number includes all water used to sustain the cow during its lifetime and to bring its meat to customers: the cow's feed needs to be grown and watered, the animal drinks, and there is water used during the meat processing. The water footprint includes water used in every step of the supply chain. In this case, 99% of a steak's water footprint is in the first stage, though. In the feed production.'

Day 2:

Another successful day. Our 'vegan' group has a decent lunch in the Faculty Club, where they serve us soup and a salad with fried mushrooms. For dinner I make some nice 'chilli sin carne': beans, peppers, spicy sauce, rice. I don't understand why people keep asking me if I feel okay. I'm totally fine.

Day 3:

I no longer feel totally fine. I have stuck to my vegan diet. I even refused coffee in a restaurant, because they didn't have any non-dairy milk that I could use. I ate my vegan breakfast, salad for lunch and made tostadas with avocado for dinner. In quantities, I've eaten and slept enough. But I feel tired and irritated. My body seems to be going through some sort of a withdrawal, craving meat and chocolate with an alarming intensity. But I will prevail!

Day 4:

I have prevailed, but I feel just as tired and irritated. To cheer myself up, I decide to go out for dinner and to the movies. After a rather extensive research I find an Indian restaurant in the area with a couple of vegan options. The cinema kiosk is also a pleasant surprise: all their snacks have clear labels, marking any animal products contained. I feel relieved. Going to see a movie without snacks just wouldn't be right. Now I just need to spend ten minutes reading all the labels and we are good to go.

In simple words, raising animals for food is inefficient and, given the large scale at which we keep livestock, it is also harmful for the planet, says Hoekstra. 'Inefficiency doesn't count only for the use of water. To raise animals for meat requires land; 77% of all agricultural land in the world is used for livestock. In many areas, this leads to deforestation and loss of biodiversity. Animals, cows in particular, also have a high carbon footprint. Cows produce a lot of methane. There is also a moral element to eating meat. How ethical is it to raise animals in order to kill them, particularly because there is no need to for a healthy diet? It appears that for every animal product there is an alternative plant-based product with the same nutritional value but much smaller claim on our limited land and water resources.'
All in all, the environment could be helped by consumers choosing to eat less meat. 'The biggest step you can make to lower your water footprint is becoming a vegetarian,' says Hoekstra. 'Becoming vegan will naturally have an even bigger impact, but the step is smaller. By eating vegetarian you reduce your water footprint by 38%, by eating vegan it is about 46%. That is why I would say that eating no meat is the number one step to take. If you never shower again, you will save about 50 litres a day. If you replace all meat by proper plant-based alternatives, the average Dutch consumer will save about 1060 litres a day.'

Water conflicts on the horizon

Arjen Hoekstra predicts that, if we don't change our current patterns, more and more water problems are awaiting us. 'If we don't reduce our water footprint, we can expect a series of disastrous events. They are already creeping in. Just look at the situation in Cape Town, a major city that basically ran out of water last year. The amount of water conflicts will increase. If there is no water supply, there won't be a harvest. People will starve. It will be the poor in dry regions that are hit first, because the rich can buy water from 'the outside'. In the Netherlands we are vulnerable as well though, because 95% of our

water footprint relates to imported commodities and lies outside the country, partly in water-scarce regions. But if we use all land that is now used for producing animal feed, we can produce a much bigger part of our own food than we currently do.'

Although regular consumers, meaning anyone of us, can do their part and change their consumption, there are certainly other ways of reducing the global water footprint than just giving up animal products. 'There are other solutions,' says Hoekstra. 'For one, governments should set water footprint caps per river basin, establishing how much water can be used per river basin every part of the year. Furthermore, we could develop a water footprint benchmark for each product based on what is reasonable given good practices available. We could urge companies to become transparent and to set water footprint reduction targets for their products. Finally, we could work towards international agreements on fair and sustainable trade. At some point, politicians need to agree on reducing our water footprint globally. To solve the problem, we need to involve governments, industry, investors - and consumers.'

Day 5:

Day five would be best described by words that are not really suitable for print. My stomach hurts, I feel tired despite sleeping a lot more than the usual eight hours. I'm extremely irritable. I keep evaluating. Is this worth it? How bad could it be to have a cheeseburger? I try to persevere, but in the evening I give up. I eat fish. Immediately I feel better. Miracle! It might have all been in my head, but that doesn't matter now. I feel better.

I expect to also feel ashamed. I have failed on my noble quest. I ate meat. The issue is, I feel fine. I must be a horrible person because I don't feel any guilt over eating the fish (and a steak two days later).

In conclusion: Eating more vegan? By all means. Only vegan? Absolutely not. It might be more sustainable for the planet, but it does not seem to sustain my body. Luckily, being a vegetarian a few days a week also helps – and I can manage that. At least, I have managed that for the last couple of years.

Indeed, the consumer perspective is only one part of the puzzle, but a part nonetheless, points out professor Hoekstra. 'Our water footprint is distributed all over the world. If you reduce it, it's hard to determine where exactly it will make an impact, but you need to remember that everything counts.' ●

The final numbers

I've embarked on the vegan journey not only to see how it would feel. I mainly wanted to know how much it would help the environment. The initial numbers were encouraging. An average Dutch consumer would reduce their weekly water footprint by 46%, saving thousands of litres of water. I kept a detailed diary of everything I ate during 'a regular meat eating week' and during my 'vegan week' (or to be precise, of what I would have eaten if I didn't give up on day five. I did plan all my meals, after all). But the result was rather disappointing.

Apparently, I'm not an average Dutch consumer. By turning vegan, I only reduced my water footprint by 20%. According to Arjen Hoekstra's calculations, in the meat week I had an average food-related water footprint of 3092 litre/day. In the vegan week I had an average food-related water footprint of 2481 litre/day. I really hoped for more, but I try to remember: every litre counts.

Read more about this vegan experience on www.utoday.nl

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 science wars of the 1990s.

Science wars

Text:
Rik Visschedijk

In the heat of battle during the 'science wars' that raged during the 90s of the last century, physicist Alan Sokal invited his opponents to come to his house and jump out the window. 'I live on the twenty-first floor,' he added. His opponents were scientists just like him, but they specialised in a new field: science and technology studies. The two sides – the 'scientific realists' and the 'postmodern critics' – were engaged in a heated debate.

The debate was about scientific theory and objective facts. The postmodern critics believed in the idea first brought forth by physicist and philosopher Thomas Kuhn: science always occurs in a paradigm, the way in which we look at the world. Sooner or later, that paradigm will shift, for example when we accept that the Earth revolves around the Sun, instead of the other way around. When that happens, some old facts will be dismissed forever and new facts will be created. Scientific theories, he says, are social constructs.

It was extremely dangerous to therefore call all facts into question, said the 'realists.' That would open the door to relativism. 'If you do not believe in facts like gravity, why don't you jump out my window?' The realists saw where this was headed: if this academic discussion was to blow over into society at large, would it destroy people's faith in science?

The French sociologist Bruno Latour was part of the postmodern camp during the science wars. He wrote the influential book Science in Action, in which he showed how scientists develop new facts. They are not there for the taking out in nature, he demonstrated, but are created in networks. Politics, money, interests – these all affect the outcome of scientific endeavours.

The science wars slowly died out. However, the discussion appears to be rekindled today. Anti-vaccination, denying climate change and a lack of faith in science are all common phenomena in this day and age. Latour, who was a 'postmodernist' two decades ago, watches these developments warily. Back in 2004, he already warned against caricatures of his ideas. They are used as weapons by shadily financed studies to question the scientific consensus.

In his recent book Down to Earth, Latour develops this idea further. Critics of science forget that robust facts exist only by the grace of a shared culture, of institutes we trust and of reliable media. In this time of 'alternative facts,' it is not so much about the certainty of a fact, but its construction. Who makes the fact, what institutions are involved and how was it developed? The scientific community should shed more light on those aspects.

He now says that this is exactly what he fought for during the science wars. Instead of an all-out attack on the realists, he wanted to make clear how reliable facts are developed – and especially how we can recognise unreliable facts. ●

Reducing stress of nurses in hospitals

Stéphanie Gauttier

Text: **Michaela Nesvarova**
Photo: **Rikkert Harink**

A degree in Communication and Political Science, background in Computer Science, a job in marketing, PhD in Information Systems... Not a random list, but a brief description of Stéphanie Gauttier's journey to the UT's Philosophy department. 'It sounds complicated, but I have always been asking the same question: what makes us accept human enhancement?'

Was it Gauttier's interdisciplinary background or her unique research focus that won her the prestigious Marie Curie fellowship in 2018? Possibly both. 'I'm looking into how we could use human enhancement technology at workplace. There are almost no other social scientists working on human enhancement. Plus, the EU has no real clue of what the impact of smart wearables is, and they need to know in order to design policies.' Which is what makes Gauttier's project GLASNOST (reGuLAting Staff eNhancement in OrganiSaTions) very relevant.

Within this project, the scientist explores how people could use enhancement technologies to be more productive and feel better at work. 'My focus is on stress reduction of nurses in hospitals,' explains Gauttier. She is applying wearable technology that measures nurses' physiological data indicating stress. 'This can show us under which conditions they are most stressed and under which they work best. The findings could then be used to improve their work conditions. After analyzing the data we plan to suggest policies that are needed to protect the nurses, as well as ensure effective management.'

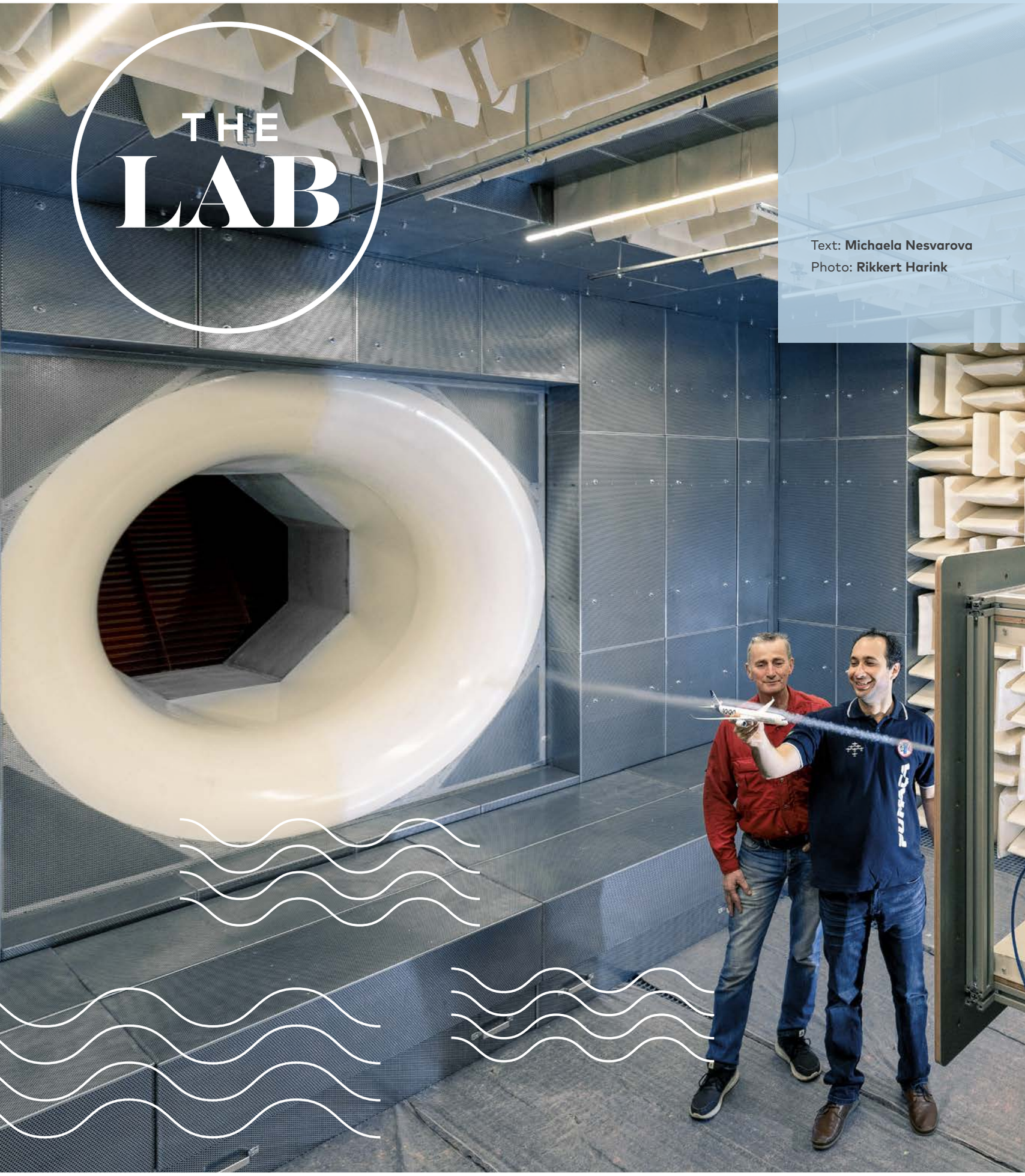
Stéphanie Gauttier is conducting the study in two hospitals, one in Twente and one in Italy. 'The hospitals and staff are willing to participate, but I expect that some nurses will refuse to wear the bracelet that measures their activity at all times. They might see it as too controlling. And that is what I'm interested in. Under which conditions do enhancement technologies make us feel too controlled and when do they make us feel like we have more autonomy? What are the factors that make us accept it?' ●

Our 'Rising Star' Stéphanie Gauttier:

2018	Marie Curie fellowship for her individual project GLASNOST
2018	nominated for VIVA400 award
2017	Postdoctoral researcher at the UT's Philosophy department
2017	PhD in Information Systems from the University of Nantes (France)
2011	Double Master degree (cum laude) in Communication Science and Political Science

THE LAB

Text: **Michaela Nesvarova**
Photo: **Rikkert Harink**



Aeroacoustic wind tunnel

The aeroacoustic wind tunnel, located in the Horst, is a testing facility of the UT´s Engineering Fluid Dynamics group. It is also known as the 'silent' wind tunnel, as it is able to absorb practically all the noise produced by the air flow, which can reach up to 240 km/h. This is achieved by the acoustic foam insulation of the walls in the anechoic chamber, as shown in the photograph. Thanks to that, the tunnel is well suited for research and different experiments that study the physical phenomena that lead to noise. More specifically, the anechoic chamber is used for measuring the aerodynamics and noise of applications related to aviation, drones or home appliances. This includes, for example, optimal wings, airplanes' engines and landing gears, wind-turbines and ventilation fans.


AMON MURWIRA

Text: **Michaela Nesvarova**
Photos: **Zimbabwean Ministry of Higher Education, Science and Technology Development**

'If you focus on results, mountains will move'

'My motivation? The privilege of working in this office. The knowledge that anybody can contribute to a better world. If you focus on results, mountains will move. I used to walk sixteen kilometers to school every day and now I'm a minister.' Those are the words of Professor Amon Murwira, an ITC alumnus and the Zimbabwean Minister of Higher Education, Science and Technology Development.

Until 2017, Professor Murwira was a 'regular' scientist. Doing research in his lab, giving lectures and helping PhD candidates at the Department of Geography and Environmental Science of the University of Zimbabwe. Then a phone rang. 'On the 13th of November, 2017,' he remembers. 'I was sitting at home and suddenly I got a phone call. They told me they had the list of new ministers and that my name was on it. It had never crossed my mind that I would be a minister. Never ever! So if you ask me how I became a minister, I have to answer: I don't know! It was a great surprise. I didn't do anything to deserve it.'

As the professor puts it, somebody must have been looking at him while he wasn't looking at himself. A few weeks later after the unexpected phone call, the scientist took a national oath and became the Honorable Minister – a title that people in his office use frequently and a title that he is living up to. In the past one and half years, Amon Murwira has already transformed the world of science and education in his home country. 'I can be a catalyst. Make sure other people's lives can be better and exciting because of my contributions.'

'ITC taught me to be truly cosmopolitan'

Improving people's lives is a motto Professor Murwira repeats many times. Perhaps because his own life has been changed by leaps and bounds. 'I grew up in a very rural area. And when we say "rural" in Zimbabwe, we really mean it,' he says. Surrounded by cows, chickens and donkeys on his long walks to school, he was worlds apart from the high-tech equipment of geo-information science. 'I was not thinking of becoming a scientist. I dreamt of doing my best at school, so I would have good opportunities in life.' This attitude has led him to a degree in geography at the University of Zimbabwe, and consequently to his studies at ITC in Enschede.

'I was exposed to geo-information science (GIS) very naturally, through my work as a staff development fellow in the Department of Geography and Environmental Science. A joint project with ITC allowed me to do my Master's in the Netherlands. I did very well and was able to start a PhD program immediately after.'

The professor looks back at his time at ITC with joy. 'It was a great international environment. It taught me to be truly cosmopolitan, to be a person that accepts everybody and is able to interact with anybody. Moreover, there was surely no deficit of resources. There was a lot of great equipment and very good teachers. It was a scientifically powerful environment. Really amazing.'

Murwira's research results were similarly so. In 2003,

'I'm excited that I can contribute to humanity'

'We shouldn't do science for science's sake'

he defended his doctoral thesis titled 'Scale matters', in which he explored a new method of using remote sensing to understand ecological landscapes. 'It was quite exciting,' he says. 'I'm still excited by it. It was in the top 10% of all PhD theses of that time.'

Back in Zimbabwe

Armed with GIS knowledge, the scientist returned to his home country. 'I was teaching GIS and remote sensing at the University of Zimbabwe, but it wasn't an easy time. The country was going through an economic crisis. Almost all my colleagues left because of the economic situation. But I stayed. I wanted to contribute the best I could.'

In 2011, seven years after he started working at the university, Murwira became the Head of the Department of Geography and Environmental Science, a department that he decided to change to its core. 'I changed the entire curriculum. I worked together with ITC to provide trainings. I wanted us to become the center of excellence for GIS and remote sensing.' These efforts yielded results. 'The department grew enormously. When I arrived, we had only six computers. When I left there were labs that could accommodate 300 people. The interest in GIS is much bigger now in Zimbabwe. There were twenty students when I became the head of the department. Now the university has over 500 students!'

It is apparent that geo-information science and Earth observation is a field close to the minister's heart. 'GIS is very important because we need to understand our planet in order to keep it sustainable. This is the technology that can help us understand it intimately, it can help us to map resources and measure sustainable use of these resources, to manage our environment. This is the natural scientific field to ensure that we live on a good, green and sustainable Earth.' Environmental monitoring has been the focus of Murwira's scientific career. He's written over eighty publications and trained more than fifty PhD students. 'ITC gave me this ability,' he says. 'The ability to publish good papers in renowned journals. To become an international scientist.'

Remaking the system

Writing scientific papers is, however, something that Amon Murwira needs to put on hold for now. 'Being a minister is a lot of hard work,' he says. 'I never realized that.' The minister doesn't seem afraid of the challenge. Just like in his previous position, he has once again introduced significant changes - and this time on an even larger scale, influencing not one university but Zimbabwe's entire higher education, science and technology. He began with a skills audit at his ministry. 'The last one was done in 1981,' he points out. 'So the first thing I did was gathering my team to assess their skills. You need to know what you are capable of and what you need to work on.' On that note, the professor ordered a national audit. 'This showed that there is a deficit of technical skills. Zimbabwe is a very literate country, but we need to grow in science and technical abilities.'

To ensure improvement, the minister turned his attention to the country's universities. 'I realized that many researchers in Zimbabwe did science for science's sake. While at ITC I learnt to always focus on practical issues, on real problems. I realized our researchers needed to do more and talk less. So I essentially had to remake our

Amon Murwira

1970	Born in Nzuwa village in Gutu district (Zimbabwe)
1993	Bachelor degree in geography, University of Zimbabwe
1993 -1998	Staff development fellow in the Department of Geography and Environmental Science
2000	Master's degree in Environmental Systems Analysis and Monitoring, ITC (Faculty of Geo-information Science and Earth Observation)
2003	PhD degree in Geo-Information Science, ITC and the Wageningen University
2004	Lecturer at the University of Zimbabwe
2011	Head of the Department of Geography and Environmental Science, University of Zimbabwe
2016	Full professor
2017	Minister of Higher Education, Science and Technology Development

whole educational system. I increased our focus on skills development and practical education.' Another issue the professor saw, was the infrastructure related to universities. And he decided to try something his predecessors never did. 'I involved the private sector. They can build the infrastructure, while the universities concentrate on their curriculum.' A lot of changes in a rather short period of time. 'Yes, indeed. But I have enjoyed a lot of support from the universities. I've been involving them since the beginning, made it a democratic process. This has been possible because I'd had the relationships already.'
As the minister, Amon Murwira also founded the Zimbabwe National Geo-Spatial and Space Agency. 'Zimbabwe needs to solve its own problems,' he replies when asked why he decided to do start this institute. 'And I see that many of our problems are related to a lack of practice and knowledge in GIS. For instance, we have rich mineral resources and we need a way to monitor them.'

'Our research should solve problems'

In essence, the professor wants to make sure that science and technology in Zimbabwe truly contribute to people's lives. 'We need education that produces social responsibility and ensures good life for our citizens. Basically, we want nice and intelligent people that do something for humanity,' he says with a smile. Because of that, he strongly believes that all research should serve the needs of the people. 'And our people need good life, good food, proper medicine to be healthy. The Dutch are good in water engineering. Why? Because water is a problem in the Netherlands. Research in the Netherlands is problem driven. We should do the same. We shouldn't do science for science's sake. We shouldn't do things just because they are interesting. We should be interested in things that are useful. Our research should solve problems. And the number one problem in Zimbabwe in poverty. We need to eradicate poverty.'
Big challenges lie ahead, but Amon Murwira looks everything but discouraged. 'Mountains move for focus,' he repeats. 'It's possible to make life better. It's not easy, but it's possible. I'm happy to be alive during this exciting time. I'm excited that I can contribute to humanity. I didn't expect to be a minister. I didn't bring myself into politics, I was brought into it. I will see where life takes me next. I enjoy science and I would love to go back to research, but I am happy to do anything in life, as long as it helps people.' ●

Text: **Rik Visschedijk** Photo: **Shutterstock**

‘Our goal: a healthy healthcare sector’

The healthcare sector faces enormous challenges, such as the ageing population, more demanding patients, personalised care and the affordability of the latter. Erwin Hans, professor of Operations Management in Healthcare, travels all over the world to explain that the logistics in the healthcare sector can be improved and made more efficient.

Hans still has an engineer’s perspective on healthcare. Roughly fifteen years ago, he made the switch to the healthcare sector, although he has a background in mathematics and technical business administration. ‘I had intended to stay at the university for a few years after acquiring my doctoral degree – until a decisive moment changed everything. A friend introduced me to an operation room manager, who invited me to apply my knowledge of logistics to the healthcare sector. I was shocked at how inefficient the planning was.’

‘I was shocked at how inefficient the planning was’

The operation schedule often ran long, because surgeries took an average of forty minutes longer than planned. Hans learned that the estimate of the duration of an operation was based on the time that the surgeon was present. ‘They did not account for the preparation before and the clean-up after the operation. I was baffled to learn that they did not use the historical duration of an operation, which is after all the first step of logistical improvement. Planning with historical averages resulted in spectacular improvements: less overtime, fewer cancelled operations, shorter waiting times. That was fifteen years ago, but many hospitals still have not implemented these methods.’

Stone Age

It is not Hans’ intention to criticise the quality of the Dutch healthcare sector. ‘It is one of the best in the world.’ However, when it comes to planning and logistics, the sector is still stuck in ‘the Stone Age’ and running far behind the industrial sector. Together with the Operations Management in Healthcare department, the professor is working to improve the situation as part of the Centre for Healthcare Operations Improvement & Research (CHOIR) research group. ‘There are two sides to this improvement. We want to make healthcare more efficient and therefore cheaper, but also more effective: patients receive better care and staff gets to work in a more pleasant working environment. Instead of “hurry up and wait”, they will have more insight into what is coming next.’

That is quite a challenge. ‘The healthcare sector is inherently risk-averse,’ Hans explains. ‘This makes the sector wary of organisational changes. As engineers, we have an entirely different mindset. We learn through experimentation: we build prototypes or models and keep at it until we get it right. That is why I always present computer simulations to people in the healthcare sector: you have to show them what the improvements will actually look like.’

Far-reaching specialisation

Changes have to be made to healthcare logistics, says Hans. ‘The number of options available to patients is growing, the quality of healthcare is improving and care is becoming increasingly personalised. However, that involves far-reaching specialisation. We see an increase in the number of service windows where patients have to

go. Capacity, such as manpower and equipment, is being dedicated to specific care.'

More service windows, each with its own queue, mean longer waiting times. As more and more people need care, these waiting times grow exponentially. So, a balance must be found. 'With our knowledge of mathematics and operations management, we can objectify choices. This lets you make responsible decisions, both for patients and for society as a whole.'

Islands

Another sore point is the islands policy that plagues the healthcare sector. Hospitals turned their departments into so-called result-responsible units. That problem will only grow in the years to come as healthcare becomes increasingly personalised – a field in which the UT is also active.

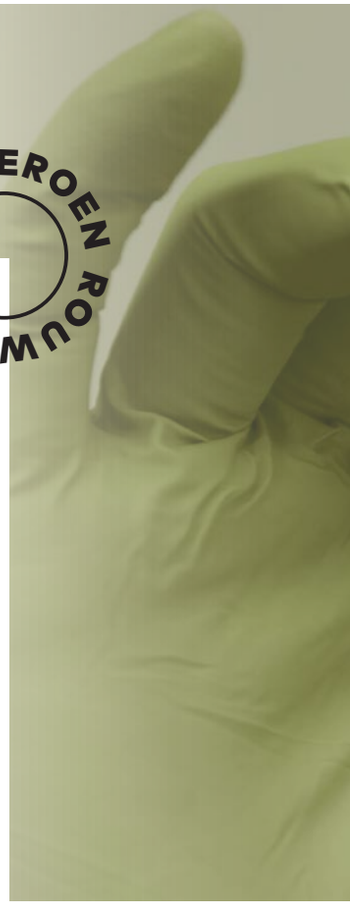
'You will end up with more specialists and therefore more service windows,' Hans continues. 'There is an entire operation behind each service window. Let's say a restaurant allows you to order a fully custom-made meal. Curly, thin, straight or long fries, peanut oil or sunflower oil, etcetera. Each ingredient needs its own specialist. That would make the food unaffordable.'

Taking steps

There is no one-size-fits-all solution for this problem, Hans says. 'However, you can certainly take steps to bring yourself out of the Stone Age. Use data to make predictions: Take an integral look at your capacity, instead of dividing your hospital into myriad islands, each with its own rigid schedule. Start mapping out ways to fund the care you provide. At the moment, it is a confusing mess. The stated costs of treatments are unreasonable. Healthcare insurance providers make their choices based on these costs. It is an irrational process.'

These logistical changes designed to keep healthcare affordable cannot come from a single source, Hans states. 'It will require input from mathematicians, technical business administrators and financial experts. The social sciences must also be involved: it is partly about behavioural changes and accepting new technologies and working methods. It is clear that something must be done. The problem is that it is really difficult to make my area of expertise seem sexy. The first things to come to people's minds are reorganisations and costly consultants who will come in to upset the status quo. That is exactly what we do not want. Our goal is to make the healthcare sector healthy – for patients and employees.' ●

Text: **Michaela Nesvarova** Photo: **Rikkert Harink**



JEROEN ROUWKEMA ENGINEERS VASCULAR NETWORKS

3D printing blood vessels

Developing blood vessels within engineered tissues. That is a simple description of Jeroen Rouwkema's highly complex research in the field of tissue engineering. 'We are able to 3D print the larger vessels and we are using the natural organizational capacity of cells to create the smaller vascular structures.'

Rouwkema has focused on tissue engineering his entire scientific career. His interest in vascular networks was sparked during an internship at MIT in 2002. 'We were the first to demonstrate that it is possible to add vascular networks to other engineered tissues. Making that happen is one of the main challenges of getting engineered tissue to clinical practice,' says the Associate Professor in the UT Department of Biomechanical Engineering, whose work on vascularization has earned him a research visit at Harvard Medical School, as well as the VENI fellowship and the ERC Consolidator Grant worth two million euros.

Macro and micro

Artificial blood vessels are of key importance if we ever hope to implant engineered organs in patients. 'It might be the only way to get oxygen and nutrients to the tissue, which would otherwise die,' explains Rouwkema. 'To create a perfect vascular network, however, is extremely complex. It is a multiscale structure: there are bigger vessels branching into very fine veins and capillaries. The main challenge now is to bridge the gap between the macro and the micro structure.'

'Tissue implantation is already a reality'

The larger structures can already be produced using 3D printing and similar biofabrication methods. What do these 3D printed tissues look like? 'Jell-O pudding,' answers the scientist. 'We can essentially make small-scale Jell-O pudding in any shape with cells included inside. At first the structure is transparent but the cells start forming their own matrix, turning it opaque. We are able to print the shape of the tissue, such as cardiac tissue, and print a vascular network within it.' Even 'blood' can run through these printed 'veins'. 'We use 3D printed structures composed of special sugar in the hydrogel. They dissolve in the watery environment, creating an empty cavity through which we can pump fluids.'

Steering nature

As Jeroen Rouwkema points out, the biofabrication of larger vessels is relatively well developed, but there is currently no fabrication method to produce the small capillaries. It might not be necessary to 'fabricate' these fine blood vessels, though. The UT researcher is testing a different approach.

'We are using the natural organizational capacity of the vascular cells. Our biological system knows how to grow the vascular network. After all, it's able to grow a whole human being from a single fertilized egg cell. We therefore try to use this natural capacity and steer the development

Jeroen Rouwkema

2017-now	Associate Professor in the Department of Biomechanical Engineering at the UT
2017	TERMIS EU Robert Brown Early Career Principal Investigator Award
2016	ERC Consolidator Grant
2014-2015	Visiting Researcher at Harvard Medical School
2014	Marie Curie International Outgoing Fellowship
2010	VENI Fellowship
2008	PhD in Vascularized tissue engineering, UT
2002	Internship at Massachusetts Institute of Technology (MIT)

using chemical and mechanical signals, moving it in the right direction.' Understanding how to use signals to optimize the organization of vessels is the main goal of Rouwkema's project VascArbor, for which he received the ERC Consolidator Grant in 2016.

To test exactly how vascular networks develop when various signals are applied, Rouwkema's research group has started using chicken eggs. 'We put the contents of a fertilized chicken egg into a transparent container, so we can follow how the vascular networks form around the yolk. The container also allows us to locally offer signals to the vasculature, to study how different signals regulate organization,' explains the scientist.

Test animals and donor organs

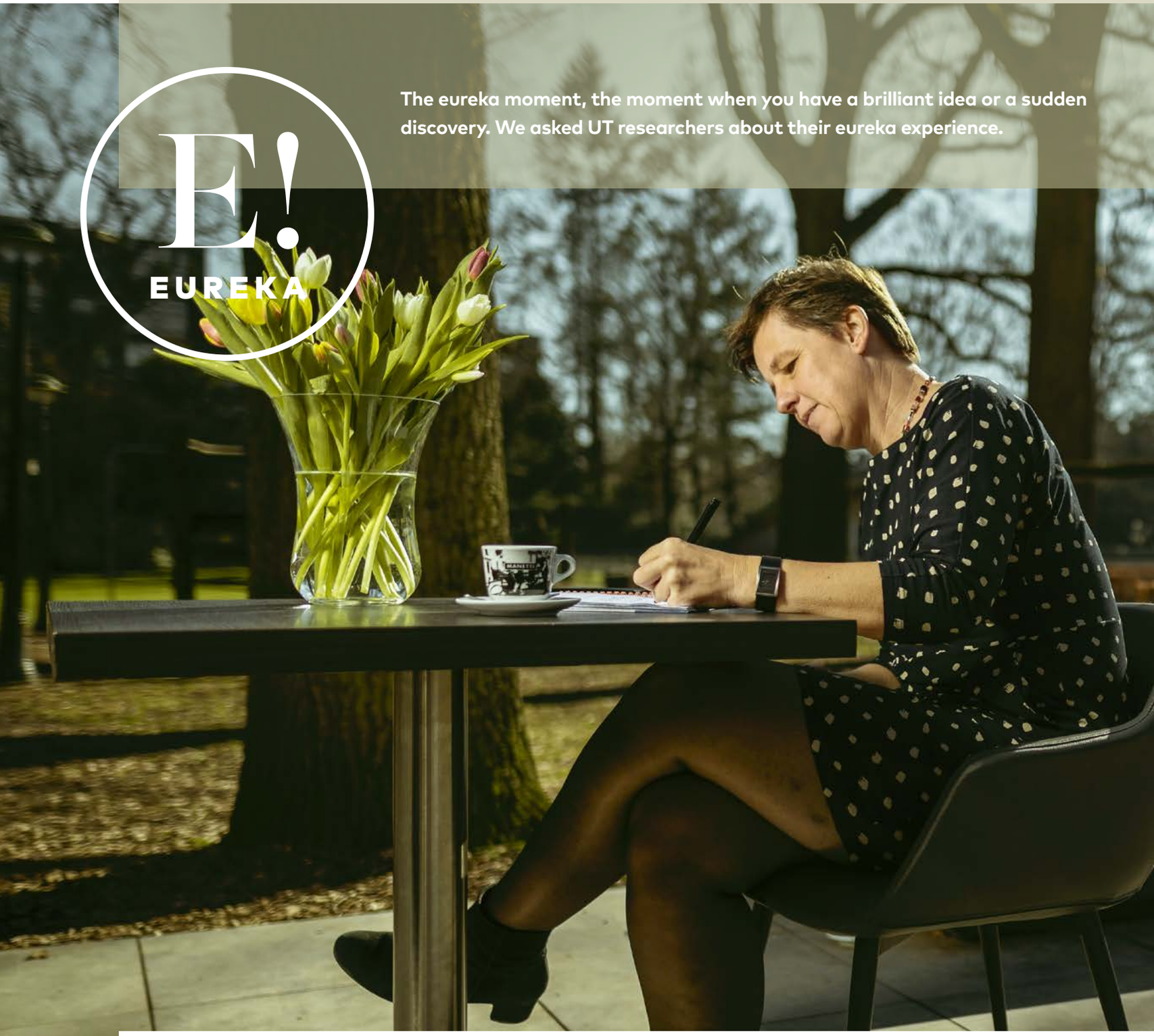
'Our current research is more fundamental. We first need to understand how we can control vascular organization before we can focus on applications,' says Rouwkema. Yet, the real-life implications are on top of his mind. 'There are two main applications of vascularized tissue engineering: drug testing and "replacement organs". In the first case, the engineered tissue would be used in a lab for drug testing as an alternative to animal testing. Secondly, - in the long run – we could make the tissue from the patient's cells, implant it into the body and ultimately replace donor organs.'

How far are we from making this a reality? 'If it comes to drug screening platforms, for research applications we are already there. But to use it for the pharmaceutical industry would require standardisation and changes in legislation,' answers Rouwkema. 'Tissue implantation is already a reality, but only for simple and thin tissue, such as skin or cartilage. To be able to do the same with more complex tissue, we first need to solve several major problems, one of which is the implementation of vascular networks.'

Does the UT scientist believe this will be accomplished in his lifetime? Will we be able to create perfect vascular networks? 'One of the big unknowns right now is determining how mature the tissue should be before we implant it. Until recently we assumed that it should be fully developed before we put it into the body. However, that might not be necessary. It might actually work better if we implant a tissue precursor that still needs to develop, so it can mature inside the body. If that is true, then engineered vascular networks might be less important because they would simply organize themselves in the body. It is hard to predict where the field will be by the end of my career, but I do believe my work is relevant. I hope that, at the very least, there will be no need for test animals twenty years from now.' ●

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.



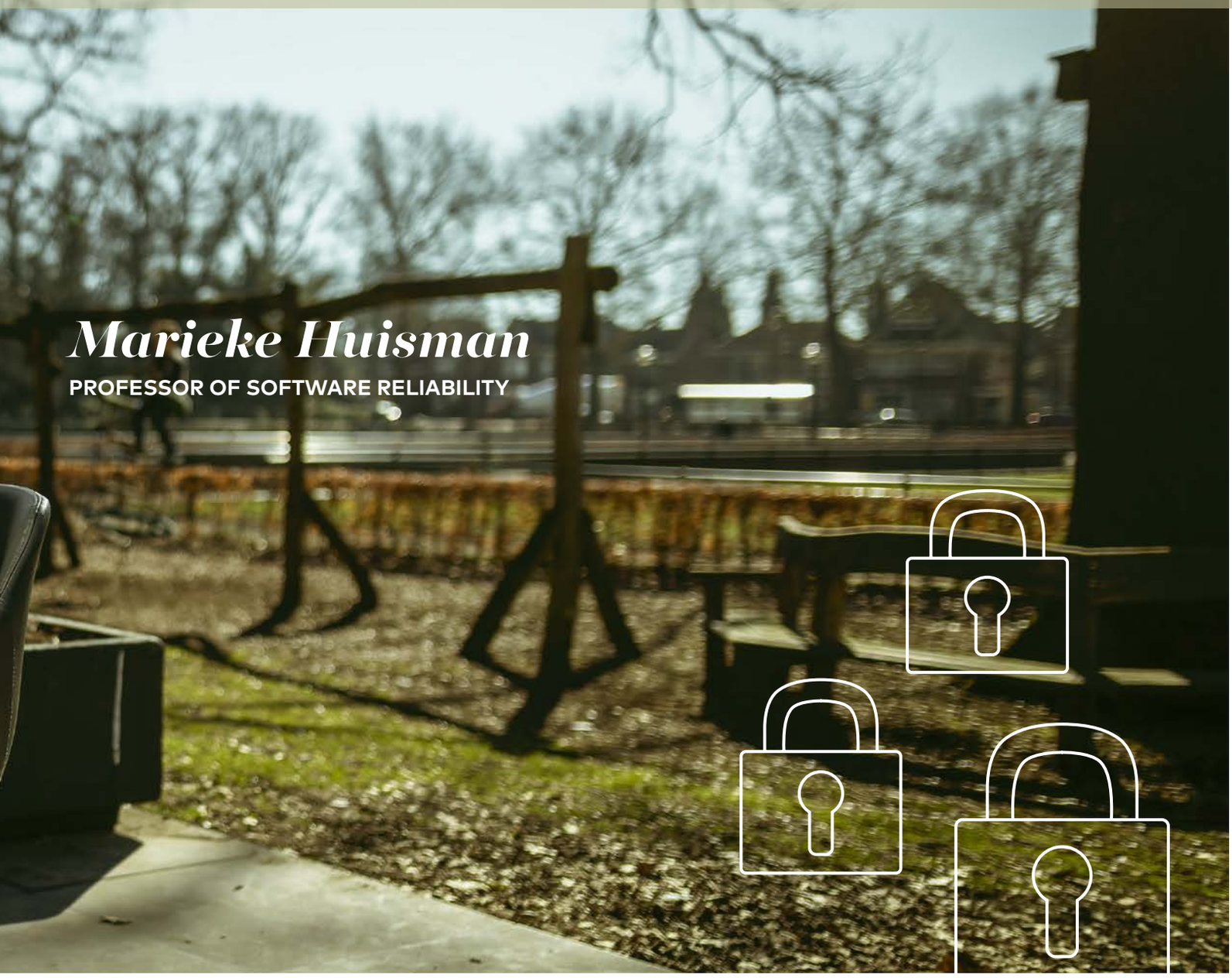
At work, my days are often filled with appointments and meetings: the major research questions are lodged in the back of my mind. That is why the moments I have to myself are so important. One of the places I go to get those is Wattez near the Van Heekpark in Enschede. When my children were smaller, I worked from home a lot. We would often go to Wattez for a slice of apple pie.

When the apple pie was gone, my children would go outside to play. My daughter would knock on the window from time to time while I worked on my research in peace. Family and research are the two most important things in my life: they are both close at hand at Wattez. During those moments, I can escape the chaos of the day and often develop new insights. My research is about the verification of software. We want software to always perform well, to never crash. That is a major problem, because software typically contains a ton of errors. With our research, we strive to develop techniques for people who write software. With these techniques, developers can avoid errors in their software. I focus in particular on concurrent software, which executes multiple processes at the same time. That makes the software even more prone to errors.

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

Marieke Huisman

PROFESSOR OF SOFTWARE RELIABILITY



I started out developing verification techniques for the Java programming language. After a while, we began to ask ourselves whether we could also use the technique we developed for Java for other programming languages, which run on other hardware such as a graphical processor. My eureka moment came when we managed to use the Java technique – with some minor adjustments – for other programming languages. The principles turned out to be universal. In all cases, the process is as follows: in what order should it be done, can it take place concurrently and how do I keep the various processes from interfering with each other?

What we do contributes to the security of software. Take self-driving cars, for example. It is essential that the software in these cars does not crash suddenly. This so-called safety-critical software utilises our verification techniques. The same goes for medical procedures, where it is also of paramount importance that the software does not crash. My goal is to allow all software developers to use our tool, even when they are developing something simple like a smartphone game. I want to make even that software less prone to crashing, although I'll need a few more eureka moments to get there.

THE ROLE OF TECHNOLOGY, LOCALS, TRUST AND EVEN MARK RUTTE

ITC helping Colombians to get land rights

In the Netherlands, it's common sense that when you own a property, you also have the land rights to prove that you do. In Colombia, people live in a different reality – especially in rural areas. That's why ITC researchers and the Dutch Kadaster are helping the Colombian people to receive the rights they are entitled to.

Text: **Rense Kuipers** Photo: **Rikkert Harink**

In 2016, the Colombian government came to a peace agreement with the FARC rebels, ending more than five decades of civil war. 'I'm all but in favour of the FARC, but one of the positive terms they wanted to stick to in the agreement was the country-wide registration of land rights,' says Javier Morales, one of the ITC researchers involved in the project. 'This part of the treaty was so well-put together that the government couldn't refuse. Since then, the government has to map and register all of the countries' parcels within seven years.'

Too slow, too expensive, too complex

First, the Colombian government made an estimation of how many properties there are still left to register. The urban areas were mostly covered in that regard. But it's a whole different matter for the rural areas. According to Morales, the Colombian government has about forty percent of the rural areas registered – of which forty percent contains outdated information. 'The government estimated that they still had about five million parcels left to register – which is a fairly reasonable amount left to cover. However, there is a multitude of problems with the current way the government handles this: the pace is too slow, the costs are too high and the procedures are too complex.' When Morales compares the Colombian procedure to the Dutch, the situation becomes even more poignant. 'In the Netherlands, you go to the notary – who makes sure the Kadaster takes care of mapping and measuring parcels and their legal status. In Colombia, you have to go to three separate institutions yourself.' Another issue is the standard procedure of measuring, says Morales. 'The combined costs of equipment, methodology and human resources: about 500 dollars. Most people don't have that kind of money. Even worse, some people's property aren't even worth that much.'

To add insult to injury: by Morales' calculations, if the Colombian government institutions would measure and register five million parcels with their current methods, it would literally take centuries to do so. 'But when they started measuring, early 2018, they realised that it's not five million parcels that have to be measured, but twelve million. The problem turned out to be much bigger.' Moreover, Morales stresses the importance of proper land rights. 'Especially farmers want to develop their land. For that, they need money. And a bank only lends money if you have a title.'

Fit for purpose

Enter the Dutch Kadaster and ITC. 'We wanted to tackle the three expensive and time-consuming factors all at once,' says Morales. 'So we tried to reduce the costs of equipment, methodology and human resources, while still abiding to the LADM, the international standard of land administration. That was our baseline.'

> *'A bank only lends money if you have a title'*

The researchers came up with a fit-for-purpose (FFP) application. 'We settled for a land measuring device that was able to deliver accuracy between 10 centimetres and a meter, depending on varying circumstances like hillsides and foliage,' explains the ITC researcher. 'The idea was to combine that with a simple application in which we registered the personal information of the owner or tenant, so we had both the land mapped and the person who it belonged to. After several tests, where – admittedly – a lot of things went wrong, we decided which app we wanted to use.'

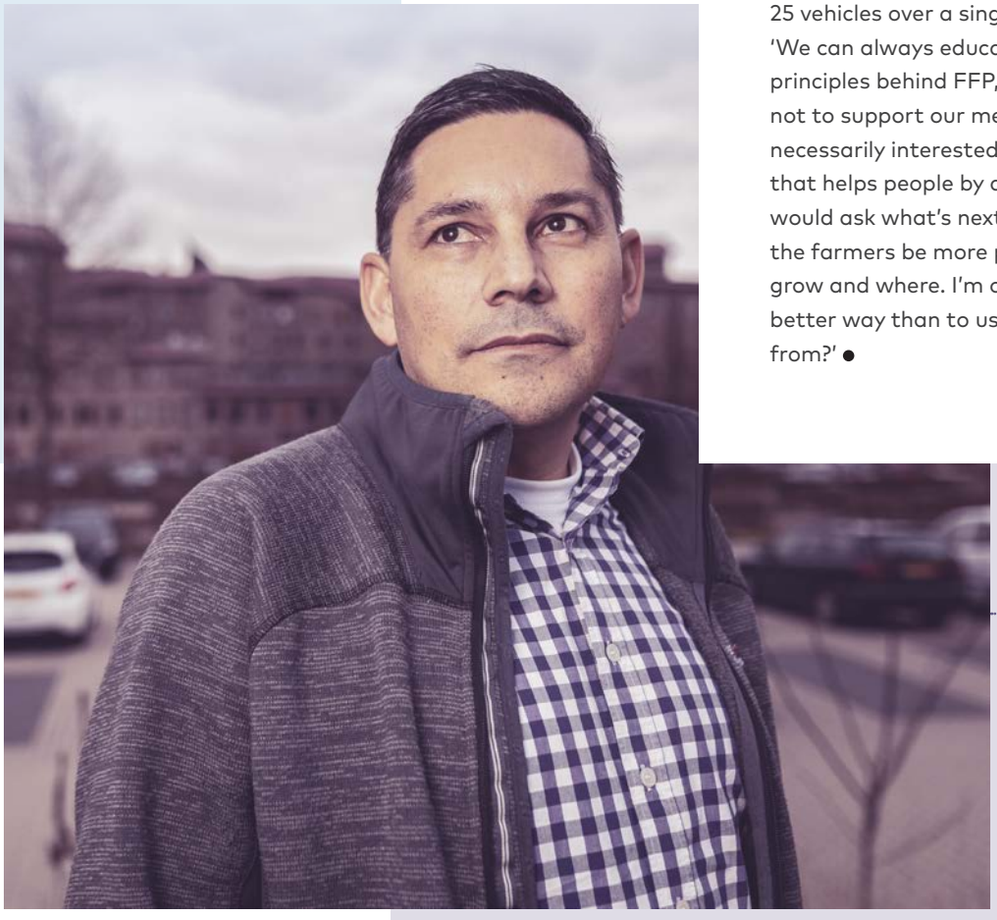
The human aspect

Understanding the technology is one thing. But then there's the human aspect. The pilot took place in two small rural villages: Los Mandarinos and Termales. 'We started by informing the local communities. It came down to expectation management: maybe the people could get land titles and maybe not. We had to be very clear about our tests and the way it would work.' Another part of the human aspect was the use of local youngsters. 'They're way more proficient with technology than the local farmers,' says Morales. 'Besides, people can get sensitive about their possessions. Wherever there is a border, there is bound to be conflict. So we wanted to have a neutral party involved.

The measurements are taken by the owner, who carries the GPS unit, and the youngster - we call them grassroot surveyors - who uses the app. The idea is that the farmer, who knows the property well, points out his or her own boundary to avoid misunderstandings and not have the people involved measuring their land themselves, to avoid discrepancies. We assigned one FFP expert per community and trained local youngsters in the procedure and how to use the app. They accompanied the farmers to measure their own parcels. And of course, the people had to provide evidence that there is a relationship between them and the land. In the end, it comes down to trust. It really helps if they're there to see it with their own eyes.'

After the measuring, the locals gather again to check the collected data on a map. It's still possible that there are discrepanciess amongst neighbours, says Morales. 'Since our measuring unit isn't accurate to a centimetre, it can happen that some areas overlap. In that case, the local FFP expert and the farmers discuss the facts together to solve the problem.'

The ITC researcher says trust again plays a big role in the following step. 'If someone agrees with the measurements, they write down their signature. In a way, the proof by means of accuracy becomes secondary you could argue that the signatures of two neighbours adds more reliability and value than the decision of an external party as to who get the rights to a piece of land. Of course, if you sign, you agree that the government uses the data to give you a title.'



Mark Rutte

The results of the FFP project by ITC and the Kadaster speak for themselves: in four days in Termales, 75 parcels were measured. In Los Mandarinos, it took three days to measure 55 parcels. Only one conflict did not get resolved. 'I believe we have demonstrated that measuring land can be done fast, cheaper and can result in land titles,' says Morales. 'Instead of 500 dollars, our method costs about 25 dollars.'

Still, the government institutions aren't full convinced about the FFP method. 'Apparently it's difficult for some civil servants to understand that they are there to help the citizens. But they also know that fast and effective land administration is essential for the implementation of the peace agreements, and to maintain public confidence in the peace process. They're finally starting to turn around and we hope the government will pass a law soon that allows the local municipalities in charge of registering land.'

Aiding the ITC researchers and the Kadaster are efforts by the Dutch ambassador in Colombia and a visit from Dutch prime minister Mark Rutte. 'The Dutch embassy keeps informing the Colombian government that our method is working,' says Morales, who's even more enthusiastic about the efforts by Mark Rutte. 'He went to Colombia last year. He could have posed in front of a government building, but he actually went to Los Mandarinos himself to hand out the first land deeds to the local community, based on our method. That helped us a lot in being taken seriously.' He jokingly adds: 'The only people not happy with him were the security personnel, who had to escort 25 vehicles over a single lane dirt road.'

'We can always educate people at local universities on the principles behind FFP, even if the Colombian government were not to support our method,' says Morales. 'At ITC, we're not necessarily interested in property, but in developing knowledge that helps people by directly addressing their needs. So if you would ask what's next for us in Colombia, I would say helping the farmers be more productive on choosing which crops to grow and where. I'm originally from Colombia myself. What better way than to use my own skills that others can benefit from?' ●

'It really helps if they're there to see it with their own eyes'

8068

In Korea, 1004 is apparently a popular PIN number. Koreans pronounce the number as 'cheonsa,' where 'cheon' means one thousand and 'sa' means four. At the same time, 'cheonsa' is also the Korean word for 'angel.' 'What a great pun,' countless Koreans must think, 'I'll use that as my PIN number.'

This factoid comes from Nick Berry, a British Big Data scientist who gained access to tens of millions of cracked passwords. While our alphabet allows for a staggering number of unique passwords, he discovered that 9.1% of all accounts can be accessed with just one hundred words, including: fuck, monkey, dragon, gandalf, iloveyou, hello and abc123. Similarly, while there are tens of thousands of possibilities for a four-digit PIN number, it turns out that only twenty of these combinations can be used to access a quarter of all bank accounts. The most popular number is 1234 (10.7% of all accounts), followed by 1111 (6%) and 0000 (1.88%). The Korean pun is in sixth place.

PIN numbers with a date of birth are popular, as are codes like 2580: the middle column of numbers on a PIN machine's keypad. In short, Berry says, our lack of originality and imagination makes things very easy for hackers.

Although I see his point and should probably change my PIN number again, I believe the problem has little to do with our imagination. For our brain, it is simply hard to store information that is not connected to something else. Four random numbers with no context whatsoever are terribly easy to forget. Linking them to an event (your lover's birthday) or creating a clear pattern (10203040) makes a code far easier to remember.

Melodies and rhythms can also help. Children learn the alphabet with the help of a catchy tune. When I tried to teach my children my phone number, I used the same trick. To me, my phone number is a fixed tune with a certain rhythm: after 06, I first list three digits, then two, then the last three. If someone reads the number back to me in a different rhythm, like 06 followed by four sets of two digits, I get confused. If you ask me for my number in English, I have to think for quite a while before I can answer.

The least common four-digit code that Nick Berry found in his data collection was '8068.' That is remarkable to me, because I think a number with so many round shapes is quite easy to remember. Too bad I cannot use it for my bank account now.

Enith Vlooswijk

Science journalist

Text & photos: **Hans Wolkers**

New coating to protect buildings against fire

Fire-retardant coatings protect steel constructions due to a chain of chemical reactions when exposed to heat. These change the coating into a thick, insulating layer. Current coatings are all based on chemistry and offer little room for improvement. Therefore, the Physics of Fluids group at the UT and the company PPG are developing a completely new fire-retardant coating based on microscopic water droplets. Assistant Professor Guillaume Lajoinie received a 250.000 euro NWO Veni grant to develop this idea.

'The new coating should offer far greater fire protection'

Modern buildings are often built around a steel skeleton. However, this steel backbone is vulnerable to fire: when temperatures reach 400 C, steel starts to soften and easily collapses. A fire-retardant coating of several millimeters is therefore applied on many steel constructions. 'The principle of these coatings is that a chain of chemical reactions occurs inside when heated,' Guillaume Lajoinie explains. 'At about 250 C, tiny, insulating bubbles are formed inside the coating, expanding it. Also, its consistency changes into a thick, rigid structure, insulating the construction and slowing down the effects of fire.' Nevertheless, the destruction of countless buildings and the death of thousands of people by fire illustrate the limitations of current coatings. In the USA, fire caused over 2500 deaths and a material loss of 80 billion euro's in 2015 alone. The 2017 fire in the Grenfell Tower in London is a recent example on the massive toll that fires take on human lives as well as on material when unsuited fire protection is used in buildings.

Suboptimal

The main shortcomings of current fire-retarding coatings are the uncontrollable bubble formation inside the coating. Lajoinie: 'When a coating is exposed to heat, bubbles of various sizes are formed. This results in a less effective coating expansion, insulation and shielding of the underlying steel as compared to a situation when more even bubbles are formed.' One way to make insulating properties of protective coatings better, is to stimulate the heat-induced formation of densely-packed, similarly-sized bubbles. However, possibilities to improve current, chemical-based coatings are limited. Therefore, Lajoinie came up with a completely new idea to make buildings more fire-safe: coatings based on physics. The key point of this concept is to design a coating containing microscopic, fluid-filled microcapsules. The fluid absorbs heat and is consequently vaporized. This results in the formation of huge amounts of similarly-sized bubbles and a massive volume increase.

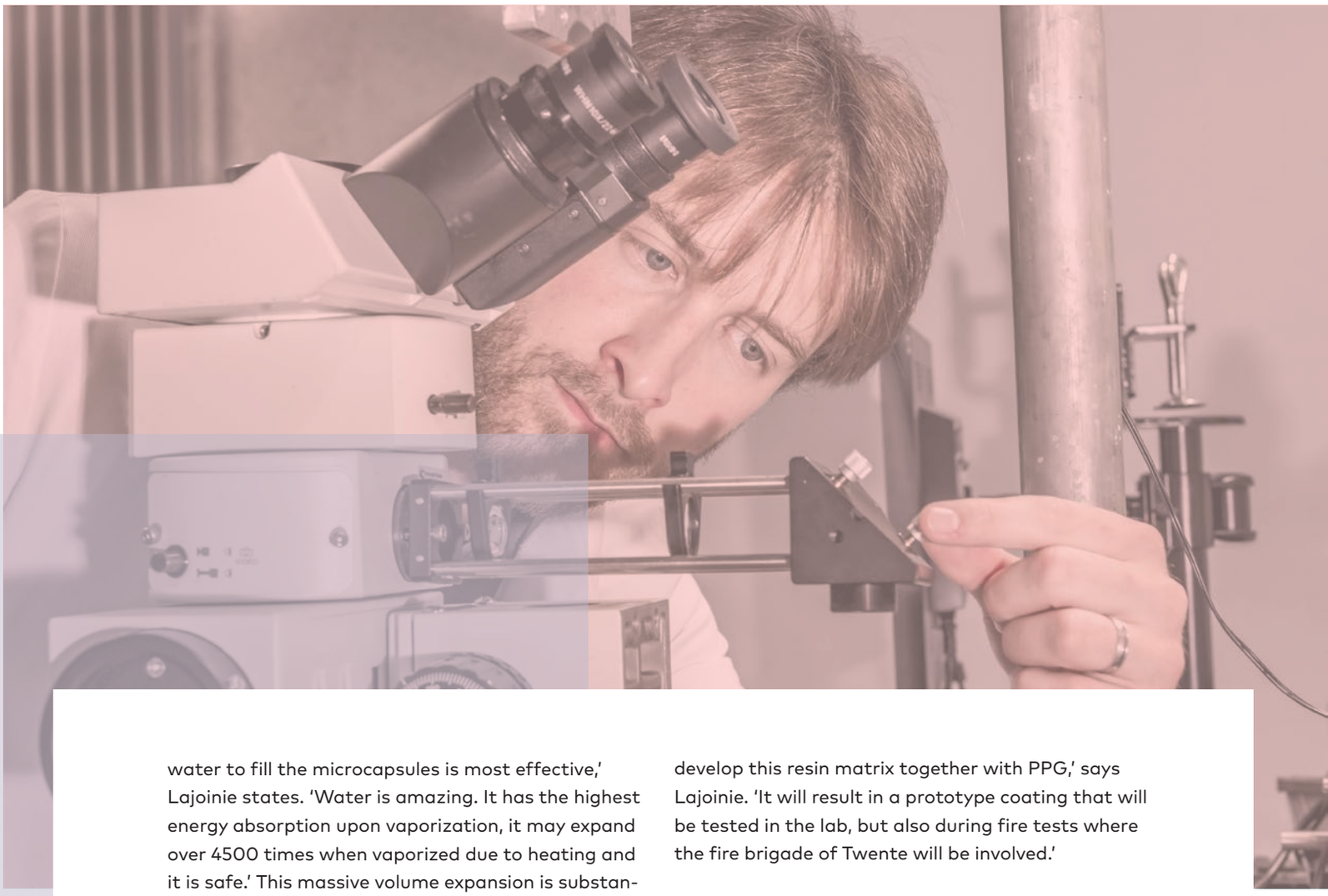
Improve fire-retardant coatings

Lajoinie can rightly be called a 'bubble expert'. His background in medical imaging such as ultrasound and photo-acoustics required extensive studies of bubble formation. 'Microcapsules are also experimental contrast agents, and consist of an outer shell of a polymer and a dye, filled with oil,' Lajoinie explains. 'In photo-acoustics, laser light heats up the fluid inside the microcapsule really fast and within a fraction of a microsecond, it forms an explosively expanding bubble, thereby generating strong acoustic waves.' By measuring these waves, an image can be constructed, similar to an ultrasound image. Because new expanding technologies were needed to improve current fire-retardant coatings, Lajoinie's joined forces with PPG, a company that makes fire retardant coatings for buildings, to develop a completely new coating. In 2018, Lajoinie received a 250.000 euro Veni grant and a 50.000 euro funding from PPG to develop his idea and make a more effective fire-retardant coating. The new coating should offer far greater fire protection resulting in a reduction of fire damage.

Controlled explosion

The first step in developing an effective fire-retardant coating, is the design of a suitable microcapsule. The main criterion for these microcapsules is the controlled formation of bubbles when exposed to heat. It all starts with choosing the right materials: what would be the best polymer to form the microcapsule's outer shell? Which inside fluid would be most suited? And in what coating resin can these microcapsules best be mixed, to be effective? 'Using

'When a coating is exposed to heat, bubbles of various sizes are formed'



water to fill the microcapsules is most effective,' Lajoinie states. 'Water is amazing. It has the highest energy absorption upon vaporization, it may expand over 4500 times when vaporized due to heating and it is safe.' This massive volume expansion is substantially more than the 100-times expansion of current coatings. By using electron microscopy and high-speed camera's the behavior of these capsules will be studied in detail. For the outer shell of the capsules, the researchers have to redesign a completely new formulation. The capsules will break down around 300oC, resulting in a controlled explosion and the formation of many evenly-sized bubbles. The new capsule design will be the basis for a coating with better insulating properties and much better protection of the steel parts.

Scientific quest

But there are more challenges. The development of expanding microcapsules is just a first step. Another important aspect of the new coating is the right medium in which to suspend the microcapsules. A resin has the best properties, however, understanding and controlling its interaction with the capsules is still a scientific quest. This resin, solid at room temperature should melt when heated, just before the microcapsules vaporize. It must then solidify again by charring, to stabilize the holes formed by the vaporized bubbles. Charring occurs when this resin is partly carbonized due to heat, resulting in a residue that consists almost entirely out of black carbon. 'We will develop this resin matrix together with PPG,' says Lajoinie. 'It will result in a prototype coating that will be tested in the lab, but also during fire tests where the fire brigade of Twente will be involved.'

Numerous applications

Lajoinie's coating project will not only result in a new, state of the art, fire-proof coating, but also in a lot of knowledge of the different aspects of the technology. Some members of the users committee want to directly apply the new coating: the fire brigade of Twente has obvious interests in more efficient fireproofing materials for increased safety of people, while partner PPG looks for new coating technologies to create different products for the market. Also, the company 'Bouwen met Staal', involved in advice and consulting on fire safety issues, sees some important values of the future coating and wants to boost the steel market with better fireproofing technologies for steel buildings. Other members of the users committee are more interested in applying basic aspects of the science behind the coating, for example, the process of bubble formation in the resin matrix. The company BubClean wants to apply these principles to develop a thermal cleaning system, while the Mesoscale Chemical Systems group of the University of Twente aims to use the bubble formation technology for needle-free injections. Lajoinie: I'm very excited about this users committee and look forward to work together with them in this project and translate our research to the different application fields.' ●

Text: **Rense Kuipers** Photo: **Rikkert Harink**

Master Research

'Sometimes my tendency towards perfection got the best of me'

The complicated Brexit

The Brexit is as intriguing as it is complex. So, how to tackle this already historic event, while it is still going on? Maikel Waelen, a Master's student of European Studies accepted the challenge and recently defended his thesis on the subject. His main question: 'To what extent is the United Kingdom able to take back control from the European Union via the Brexit arrangements?'

Is Brexit really Brexit? To Waelen, there is more to that question than just a semantic argument. 'Everyone knows the Brexit process is immensely complex and has a lot of impact on everyone involved. My research question involved the loaded slogan 'Take Back Control'. I aimed to find out to what extent the UK was able to take back control, by digging through the withdrawal agreement that the UK and the EU presented in November.'

Going through almost six hundred pages of legal text is no easy task, Waelen knows from experience. 'I did end up cherrypicking in a way, since there is an overload of information in the withdrawal agreement. So I took three criteria in account: the level of control for the UK, the difference with the status quo, and the impact for citizens and organisations.'

One of the main conclusions of Waelen is that the UK especially loses control in the short run. 'During the transition period the UK still has to follow EU law, but cannot decide on legislation anymore. Since the Court of Justice of the European Union (CJEU, ed.) is considered to be the authority on the interpretation of Union law, the CJEU remains to have jurisdiction in the United Kingdom. For this reason, the UK is not able to take back control, but still has to follow the rulings of the CJEU and implement all the new legislation of the EU.'

And when the Brexit will finally be 'completed', Waelen says that the UK will still be dependent on the EU. 'During a conference that I attended in December, one of the speakers mentioned that the withdrawal agreement referred around 62 times to the CJEU. So yes, I think it's inevitable that the CJEU and EU law will still play a role in the UK well after the Brexit.'

While writing his thesis, the recently graduated Master's student tried to be as concise as possible. 'I really paid attention to the way I constructed my sentences. Yes, sometimes my tendency towards perfection got the best of me and I ended up with finishing one paragraph a day. But I wanted to stay clear of writing down more than necessary. With a complicated subject like the Brexit, you have to make choices and explain well why you do and do not include something. In the end, quality takes time. Maybe a good tip for other students working on their thesis or about to start theirs: never lose sight of your main question and focus on your ultimate goal.'

HMI RESEARCHERS ARE WORKING ON AN INTERACTIVE FLOOR

Putting technology into volleyball practice

Since practice makes perfect, researchers Dennis Reidsma, Robby van Delden and Dees Postma from the Human Media Interaction (HMI) department are working on a project called 'Smart Sports Exercises'. The goal: creating an interactive volleyball floor that helps players and coaches improve their game.

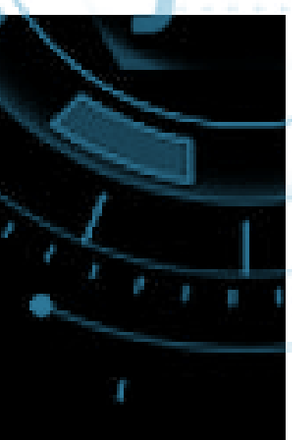
Text: **Rense Kuipers**
Photo: **Shutterstock**

What is Smart Sports Exercises about?
Reidsma: 'Through feedback, you can steer the behaviour of people playing a game. We try to translate that to volleyball – specifically volleyball practice. Feedback can be either quite crass – 'Run to the X if you don't want to lose a point' – or subtle: 'You can choose between multiple options if you want to block an opponent's ball'. The goal is to train players in exercises that would be hard to do without an interactive floor.'

Why volleyball?
Reidsma: 'The sport has a lot of advantages for our research: it's indoors, the floor isn't that big, players are on separate sides of the net and the goal of volleyball is to literally get the ball on the opposing team's floor. It's also quite easy to track the specific movements of players: using sensors, you can determine actions like jumping, turning, taking off or choosing position.'

What kind of technology do you use?
Van Delden: 'An LED floor that's pressure-sensitive, inertial measurement units to record the movements of players and a tablet to easily transfer the training exercises to the interactive floor.'

Isn't it up to the coach to help the players?
Postma: 'The floor can be an extra toolbox for the coach. It's not meant to replace a coach, but to enrich the way a team practices and plays volleyball. That way, you can enhance the players' awareness during the game.'
Reidsma: 'That's why we're looking for exercises in which a floor offers instructions that a coach isn't able to give. Imagine players having to aim their smashes at a certain goal; they have to make that decision while being airborne. At that point, you don't want to hear from your coach where you should smash the ball to. You would rather have a visual cue.'



'The floor can be an extra toolbox for the coach'

Postma: 'To add to that: in volleyball, players are never equally divided on the court. The game has a variety of defending and attacking strategies, which all require different formations. An interactive floor can help players being more conscious about where they are standing and why.'

What is the current status of the project?
Van Delden: 'We've just started, but the technology looks promising. Researchers at the Biomedical Signals & Systems group showed that you can get a lot of valid feedback from even a simple motion sensor. Besides that, we're talking with coaches from different levels of the game. Their first reactions are positive: several of them have already come up with exercises that could benefit from an interactive floor, like balancing out teams by increasing or decreasing the size of one side of the court.
It also helps that we've teamed up with Windesheim University of Applied Sciences, Sportservice Veenendaal, InnoSportLab and the company LedGo in this project. The Dutch national volleyball association is also eager to find out if a floor like this can benefit the sport. But we will have to find a suitable partner that wants to be the first to put a floor like this into practice.'
Reidsma: 'The duration of this project is two years, which isn't that long. But within those two years, we want to at least have actual volleyball players test different exercises on our prototype floor.'

What's your view on the potential use of this kind of technology?
Reidsma: 'It's a different approach than your average sports data research. What you usually see is researchers gathering large amounts of data that they use to help athletes to improve their performance...'
Postma: '...While we try to use technology first as a tool to improve the athletes' performance. When the technology is in place, we can start measuring the effects. A simple example of technology playing a role is carrying a smartwatch while running: you use the information on your smartwatch to improve your personal bests. Maybe an interactive floor can influence volleyball in a good way – of course without letting the game lose its charm.' ●

'You cannot imagine how much physics and chemistry are involved in baking cookies'

Text: **Rense Kuipers** Photos: **Rikkert Harink**

KERENSA BROERSEN AND HER NEVER-ENDING QUEST FOR CURIOSITY

Always wanting to dig deeper

She is mostly known as an Alzheimer researcher, but Kerensa Broersen does not want to rely too much on that title. Curiosity and intellectual challenge determined her course in the past and will continue to do so far into the future.

For most of 2018, Broersen was nowhere to be found at the UT. Instead, she spent her time in the laboratories and lecture halls of the University of California in Berkeley. A Fulbright scholarship made it possible for her to work in the Bay Area from January to August under the wing of Nobel Prize winner Randy Schekman. She had no special desire to visit the American west coast herself, but her husband and her two young children (ages 3 and 5) were certainly up for the adventure. 'There was only one research group I even wanted to join: Schekman's,' Broersen says.
It turned out to be a time of revelations: from day one, she worked in the lab of a research group that was extremely well funded, partly because of the presence of a Nobel laureate. 'Even more important than that was the immense faith that the university had in Schekman to put that money to good use. They understood the urgency of his research. Under his supervision, I was free to do what I wanted. That was truly a liberating experience, compared to the many rules and regulations in the Netherlands.'

Hippie town

Outside the lab, a new world opened up to Broersen as well: running between the sequoias on the Berkeley campus, living in the 'hippie town' of Berkeley – right on top of a fault line –, teaching a select group of highly talented students, sending her kids to a school where they had to learn the English language from scratch and going on daytrips to national parks on the weekends. Above all, she remembers her weekly walks with Schekman from the lab to the lecture hall. 'It was only a short distance, so I tried to challenge him with a new topic every time. He turned out to be interested in the tenure track policy. "Why the need for an evaluation committee?" he asked. "Can't you recognise talent when you see it?" Do I consider myself to be talented? No, there are people who possess far more talent than me. I see myself as someone who wants to chase her passion.'
If you had told a young Kerensa Broersen that she would have daily conversations with a Nobel Prize winner years later, she would have called you crazy. 'I was terribly uncommitted in school. I was interested in the subjects, but I only did what I had to do to get by. My father owned some statistics books and I always thought it was cool to see if something could be calculated. I was very restless as a child.' She laughs, 'You might ask yourself how I turned out like this in the end.'

Baking cookies

Broersen chose the Nutrition and Dietetics programme at Amsterdam University of Applied Sciences. She graduated as a dietician in 1997, but an internship gave her the idea that she would spend most of her days helping obese people lose weight. She wanted more depth and opted for a master's degree at the British University of Huddersfield. 'Even then I was toying with the idea of obtaining a PhD. After completing my master's, I first spent

some time working in the R&D department of cookie company United Biscuits in London. Believe me when I say that you cannot imagine how much physics and chemistry are involved in baking cookies. That would not help me save the world, however, and the job never did much to satisfy my intellectual curiosity.'

The call of the academic world became increasingly loud. A year of analytical work in the laboratories of the University of York ultimately led Broersen to a PhD in Wageningen. 'My research was still focused on nutrition, specifically the structure of proteins. One day, I saw a postdoc position at the Medical Research Council in Cambridge that had my name written all over it. Still, this was Cambridge; how would I ever get in? I did it, though, and spent the next two years delving into the world of hardcore cellular biology. It was so much cooler than studying food products.'

Brussels and Nico

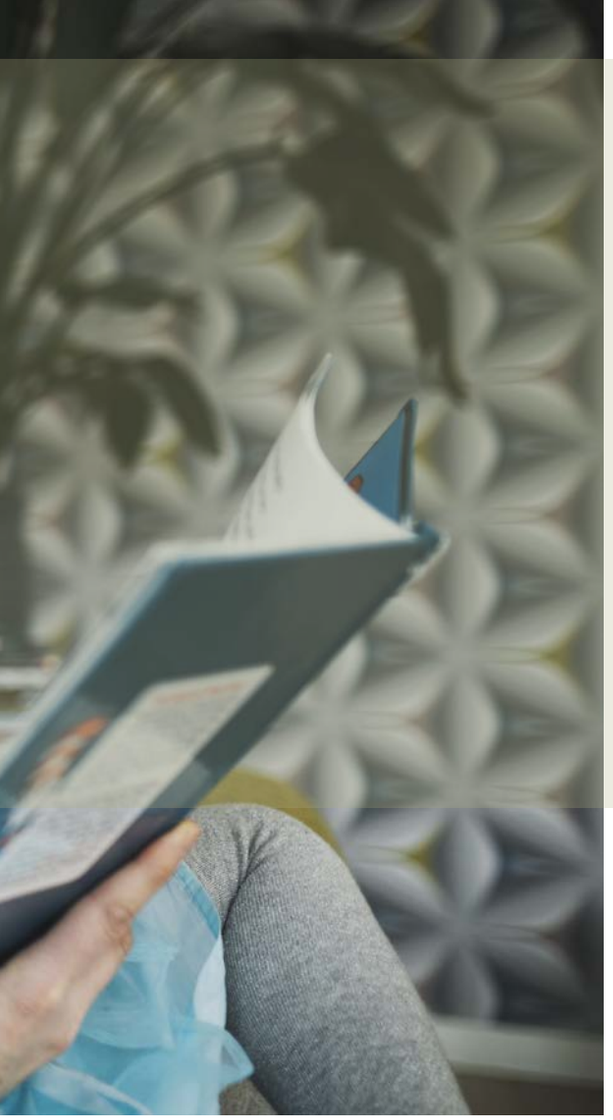
After Cambridge, she headed for Brussels to continue her postdoc at the Vrije Universiteit Brussel in the Switch Laboratory. In Brussels, she met professor Nico van Nuland, together with whom she conducted in-depth research into Alzheimer's disease. She continued her work in that field when her husband and she agreed that it was time to return to the Netherlands and she found her way to the UT in 2011.

Things did not turn out well for Van Nuland. He was diagnosed with ALS in 2012. The two stayed in touch over the years, although it became increasingly difficult to do so. Broersen ran a half marathon for the ALS Foundation in his honour in 2016. 'It was fantastic that he personally made sure that I passed the €1,000 line.' The cruel reality was that they both knew the money would never reach Van Nuland – that is how destructive ALS is. He passed away shortly before Broersen left for the US. Because the funeral was held for close family only ('Something I respected, but found difficult to accept'), Broersen could only attend a tribute some time later: a symposium in Liège, dedicated to Nico van Nuland (1961-2017).

Nanopill

Since her arrival in Twente, Broersen has dedicated herself entirely to Alzheimer's, just like countless other scientists all over the world. Nevertheless, the disease is as elusive as ever. Broersen knows that, despite the best efforts of all those brilliant researchers, Alzheimer's disease is still almost impossible to predict and cure.

Together with her colleagues, she is working on a nanopill that contains a cocktail of medication that has to find its way to the right location in the brain. One of the major culprits involved in



Kerensa Broersen in a nutshell

1997	Graduated from Amsterdam University of Applied Sciences
1998	Master's degree at the University of Huddersfield (UK)
2005	PhD degree at Wageningen University & Research
2005-2007	Postdoctoral research fellow in Neurobiology at the Laboratory of Molecular Biology (Cambridge, UK)
2008	Professor/team leader biophysics for neurodegenerative diseases at the Switch Laboratory (VU Brussel)
2011 – 2019	Assistant Professor until 2016, since 2016 Associate Professor at the Nanobiophysics Group
2019 – now	Associate Professor at the Applied Stem Cell Technologies group

the development of Alzheimer's, Broersen says, is the amyloid beta protein. It accumulates in the brains of people with this disease. 'If we assume that Alzheimer's mostly develops in the brain – a reasonably safe assumption, based partly on the results of tests on mice – we try to deliver the medication to the exact location where the disease begins to develop.'
It sounds deceptively easy: develop a nanopill, stuff it full of medication, inject it into a patient's body and send it on its way to the brain. In practice, however, the situation is infinitely more difficult, Broersen knows. 'What targets do you focus on? What substances do you need in the pill? You have to base your dosages on assumptions and account for the active life of the various substances – assuming they can even reach the right location to begin with. Before the pill can reach the brain, it has to pass through the blood-brain barrier. It acts as a gatekeeper and is highly selective in what it will and will not allow to pass through.' Nevertheless, this approach has a lot of potential, the researcher says.

Digging deeper

Down to earth as the native West-Frisian researcher is, she says her study of Alzheimer's disease has never been inspired by a personal mission. 'Of course, any motivation is good, but the disease is not found in my family. To me, the main criteria are curiosity and intellectual challenge. I simply get excited about everything that goes on inside cells. The quest to dig deeper into the core of the human body brings out the best in me.'
She cannot predict what the future holds in store for her. Initially, she will join the project of professors Albert van den Berg, Christine Mummery and Robert Passier. All the more reason to join the latter's department this past February. 'This is something completely different from Alzheimer's research. We are studying the effects of intestinal flora on the brain by simulating them on a chip. We eat all kinds of food that contain proteins that are structurally similar to those in our brain. There are many studies that suggest a connection between our intestines and our brain. However, no one knows exactly what those effects are. That is why we are working on something called 'gut-brain axis on a chip.''
Would she eventually like to return to Berkeley? 'I don't know. At the moment, I am still enjoying the experience fully and have devoted myself entirely to the research I am doing here. I'll admit that Enschede feels a lot safer and more familiar than the forest fires, earthquakes and night-time gunshots I encountered in the US. On the other hand, the freedom I had there to do my research as I saw fit was fantastic. I definitely want more of that, but I know that I cannot simply disregard the rules that apply here in Twente.' She concludes with a smile: 'Although I am the kind of person who would do that.'

'I simply get excited about everything that goes on inside cells'

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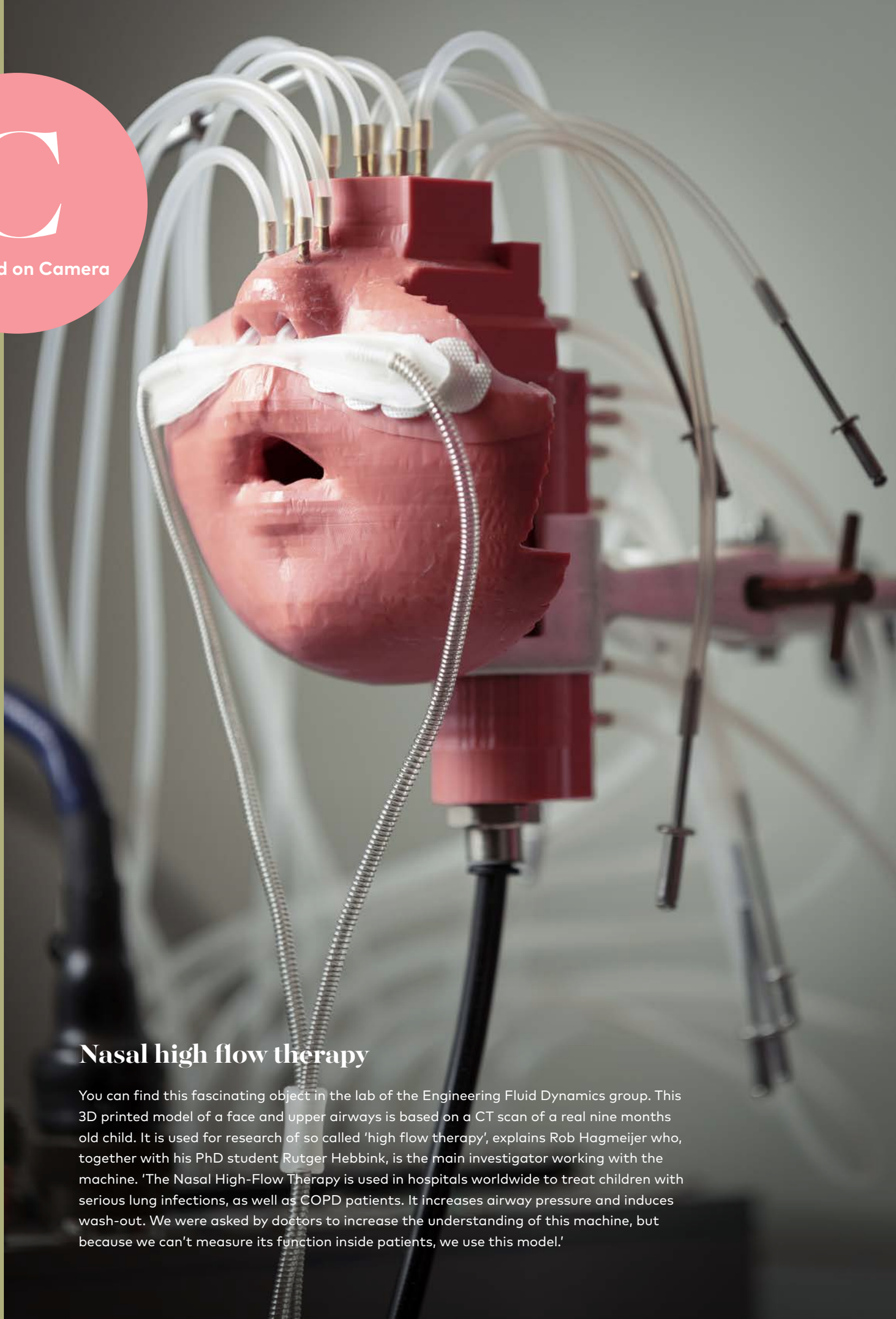
Captured on Camera



Nasal high flow therapy

You can find this fascinating object in the lab of the Engineering Fluid Dynamics group. This 3D printed model of a face and upper airways is based on a CT scan of a real nine months old child. It is used for research of so called 'high flow therapy', explains Rob Hagmeijer who, together with his PhD student Rutger Hebbink, is the main investigator working with the machine. 'The Nasal High-Flow Therapy is used in hospitals worldwide to treat children with serious lung infections, as well as COPD patients. It increases airway pressure and induces wash-out. We were asked by doctors to increase the understanding of this machine, but because we can't measure its function inside patients, we use this model.'

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