issue #3

UNIVERSITY OF TWENTE.

U-TODAY

Science & Technology Magazine

Who wants to live forever?


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So clever

People are so clever nowadays. That thought kept running through my head when the reporters and I sat down to discuss this edition's cover story and we asked ourselves: When it comes to the human body, how well can we recreate nature? We then discussed examples such as head transplants, exoskeletons, and creating heart cells from urine. It certainly is complex material.

'People are so clever nowadays' is also the title of a book written by my fellow journalist Frederike Krommendijk. She wrote her book after her husband was diagnosed with advanced-stage lung cancer. He survived, but cancer still kills circa 40,000 people every year in this country alone. (source: World Cancer Research Fund).

Of course, these 'people' are the scientists who are making all these fantastic discoveries – both within and outside of the medical research field. It is a good thing, too, that they are so clever. Take UT researcher Jai Prakash (interview on page 18). He is one of many researchers trying to find an effective way to combat cancer. 'Instead of focussing on the cells of the actual tumour, we look at the cells that help a tumour grow,' he explains. He uses a special peptide in combination with chemotherapy. The results are highly promising: it disarms more than 80% of the tumour cells.

How wonderful would it be if Prakash actually makes the crucial breakthrough in cancer research?

Even more than their cleverness, I admire the optimism and perseverance of these researchers. Professor Mariëlle Stoelinga (interview on page 46) says: 'I tend to do things that are difficult for me. Things that are just outside my comfort zone.' I believe that it is precisely that attitude, that perseverance, that makes researchers successful.

It is also the only way to ultimately find the perfect cure for any disease.

Maaike Platvoet

Editor-in-chief at U-Today

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Colophon

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This magazine is climate neutral.

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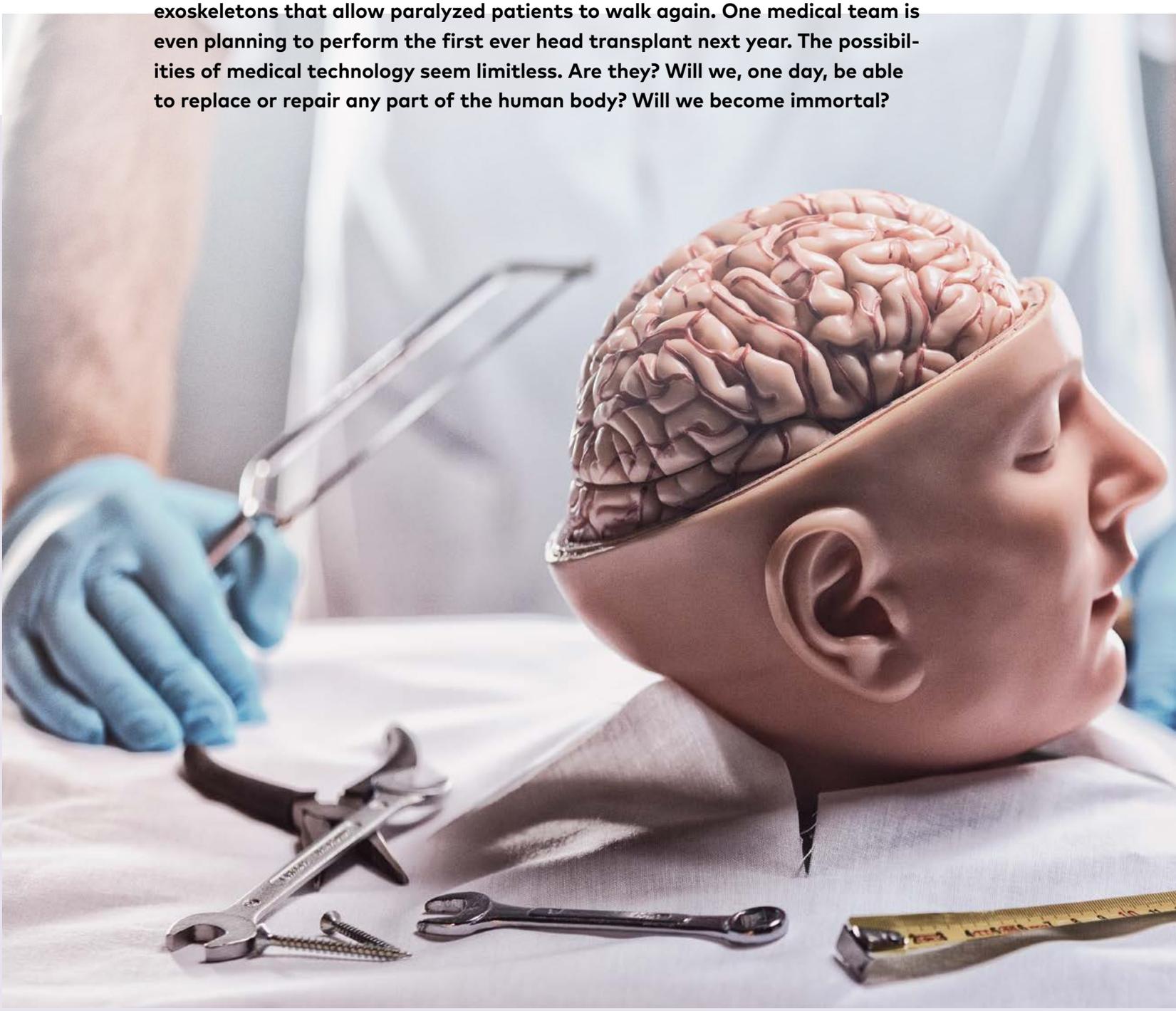
U-TODAY

Science & Technology Magazine

Content

Who wants to live *forever?*

We are already able to 3D print skin, create any organ cells using urine, build exoskeletons that allow paralyzed patients to walk again. One medical team is even planning to perform the first ever head transplant next year. The possibilities of medical technology seem limitless. Are they? Will we, one day, be able to replace or repair any part of the human body? Will we become immortal?



Text: **Michaela Nesvarova & Jelle Posthuma**
Photos: **Rikkert Harink**

Looking at the advancements of science and medicine, it's not hard to imagine that we are only a few short steps away from fixing everything that can go wrong with a human body. We have stem cell technology, tissue engineering, robotics, biofabrication, nanotechnology... All pieces of the puzzle seem to be there, so can't we simply 'recreate nature' and produce organs or devices that make a broken body work properly again? Because such a body could potentially live forever.

Pee in a jar, get a new heart

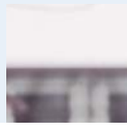
'It might sound like science fiction, but we can actually derive any cell type of the human body from urine,' says Robert Passier, Professor of Applied Stem Cell Technologies, explaining that this method exists thanks to human pluripotent stem cells, discovered in 2007. 'Induced pluripotent stem cells (iPSCs) can be derived, for example, from blood, skin or even urine. This means you can literally pee in a jar, get the cells, culture them and reprogram the urine cells into stem cells. Those can be used to make any cell type, therefore any organ cells. We even use this method to produce cardiomyocytes, meaning heart cells.'

Yes, we can make heart cells from urine. Hearing this, one can't help but ask: can we make the entire heart? 'We know that we can make the right cell types, so naturally you can speculate about their use in regenerative medicine. But that is the next step,' answers Passier. 'Stem cell technology currently focuses on disease modelling and drug discovery. We try to model complex diseases and see if we can find the mechanism that causes the failure, and therefore see if we can postpone the damage or repair it. Stem cells can also contribute to better and safer drugs.'

> *'We can actually derive any cell type of the human body from urine'*

Organ structure

Although Robert Passier stresses that we first need to understand diseases and capacities of stem cells before we attempt to replace or repair organ function, he admits that regenerative medicine comes with exciting prospects. Some of which could eventually lead to the replacement of complete organs. 'There are different types of stem cells and some indeed have a self-organizing capacity to create structure resembling the organ structure and function. For example, you can isolate specific cells in intestines, culture them and make specialized cell types, which are organized in such a way that they form the structure of the intestine. Sadly, not all cells and organs have this capacity. For example, we can't automatically create heart structure.'
'However, we could help nature – for instance by using 3D bioprinting,' adds Passier. 'That way we can make a structure that truly resembles the real organ. We naturally can't start with the



whole organ, but we can start with smaller units and move to bigger ones. In the end, there might be a possibility for structures that are so well organized that we can use them for regenerative medicine. Maybe we can even make an exact copy of an organ or its part.'

We can make tissue. Now what?

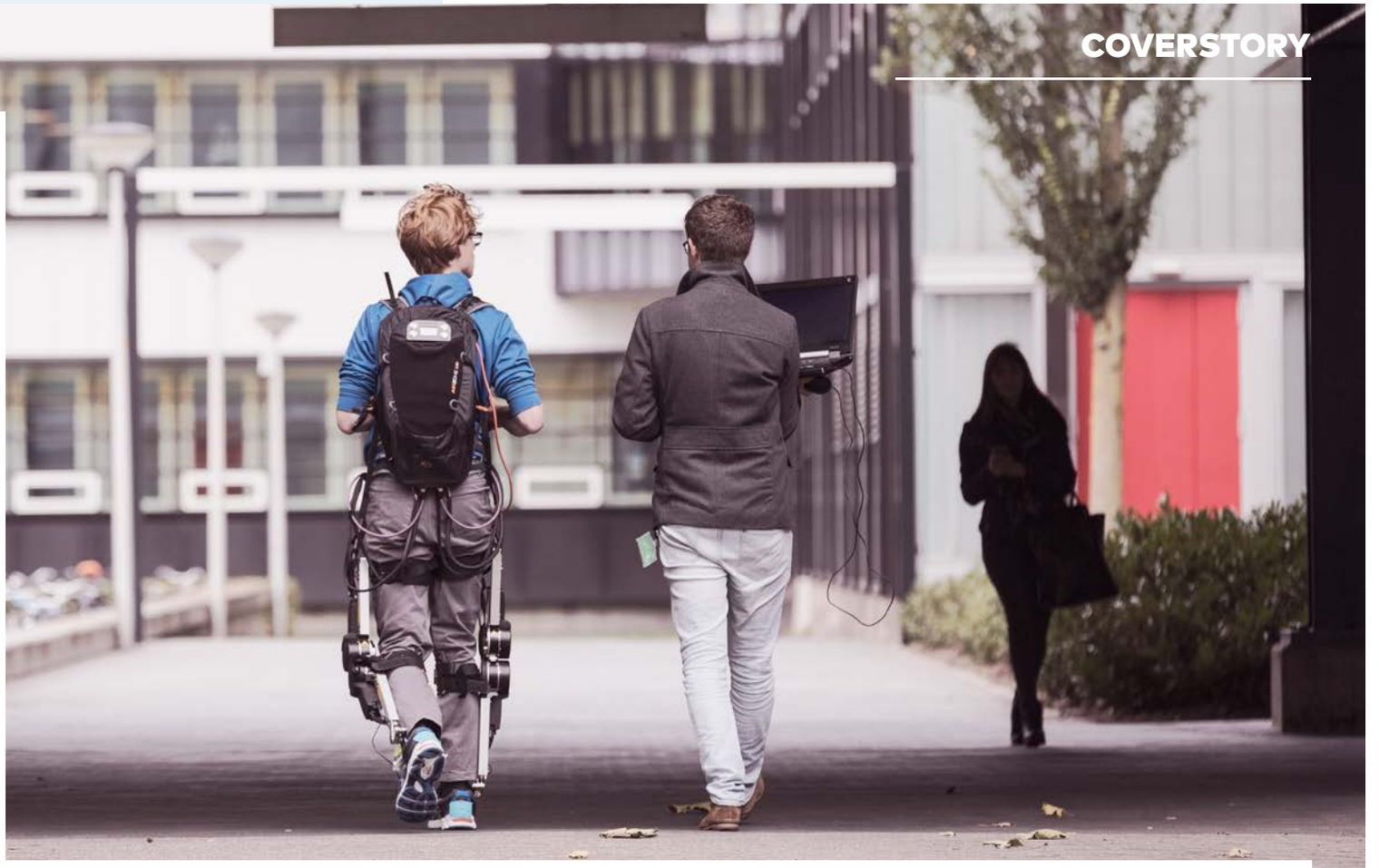
While he mentions that 'reconstructing' and replacing entire body parts that consist of many different structures, such as legs or hands, might always be too complex and costly to accomplish, Jeroen Leijten, Assistant Professor of Complex Tissue Engineering, also believes that the development of organs might be feasible. Feasible, but exceptionally challenging. Because, despite the fact that we are capable of making tissues, the right tissue isn't all you need. The engineered tissues don't necessarily function as well as their naturally grown healthy counterparts.
'There are three types of tissue,' says Leijten. 'First one is flat tissue, for example skin, which we are very good at recreating. The second type is hollow tissue. That includes blood vessels, for instance. We can now engineer blood vessels, we can make a simple bypass graft and that works beautifully. But creating vascular trees within tissues remains tricky. Tissue engineering can contribute to overcoming this, but substantial financial investments would be required.'
Besides the high costs, Leijten points out other difficulties. 'The third type of tissue is solid: liver, kidney, bone, brain etc. To recreate those, we'd have to master a high level of complexity. You'd need multiple tissues at the right place and they'd need to be integrated with each other as well as the whole bodily system. If you engineer an organ, you need a blood vessels network to provide the implant access to the patient's blood, which keeps the implant alive. Furthermore, the tissues should be innervated, compatible with the immune system, and function for decades within the human body. In short, the remaining key challenge is: how do we connect engineered organs to the human body?'

Medicine focused on the West

Integrating engineered tissue or organ parts into the body is one of the main challenges, indeed. Nonetheless, technical challenges don't represent the full picture. Lengthening the human lifespan and being able to 'fix' everything - that also comes with ethical dilemmas. 'Ethical considerations are often framed as drawbacks, and ethics as a brake on new technology,' says Marianne Boenink, Associate Professor in Philosophy and Ethics of Biomedical Technology. 'But the development of new technology already has a moral motive driving it, like the desire to realize better health or wellbeing. Because when we are developing a new technology, we do it because we think of improvement. However, we have learnt

Head transplant: 'The final goal is immortality'

Although you could argue that it should be called 'a full body transplant' instead, a head transplant refers to a procedure in which an entire living head is put onto a new body. This might sound like something for the very far future, but the first head transplant was actually scheduled for the end of 2017. These original plans have changed and this possibly groundbreaking surgery should take place next year. It will be performed by an Italian surgeon Dr. Sergio Canavero, who himself admits that 'the final goal is immortality.' According to the doctor, head transplant could be a solution for rich patients wishing to extend their lives by moving ageing heads onto young bodies.
How will it be done? The donor body and the head are first cooled down to 12-15˚C to ensure that the cells last longer without oxygen. The tissue around the neck is cut and major blood vessels are linked with tubes. The spinal cord on each party is then severed cleanly with an extremely sharp blade. Afterwards the head can be moved and the spinal cords are fused using a chemical called polyethylene glycol. When the muscles and blood supply are successfully connected, the patient is kept in a coma for a month, while electrodes stimulate the spinal cord to strengthen its new connections. After the patients wake from the coma, Canavero believes that they would immediately be able to move, feel their face and even speak with the same voice, and that physiotherapy would allow the patients to walk within a year.

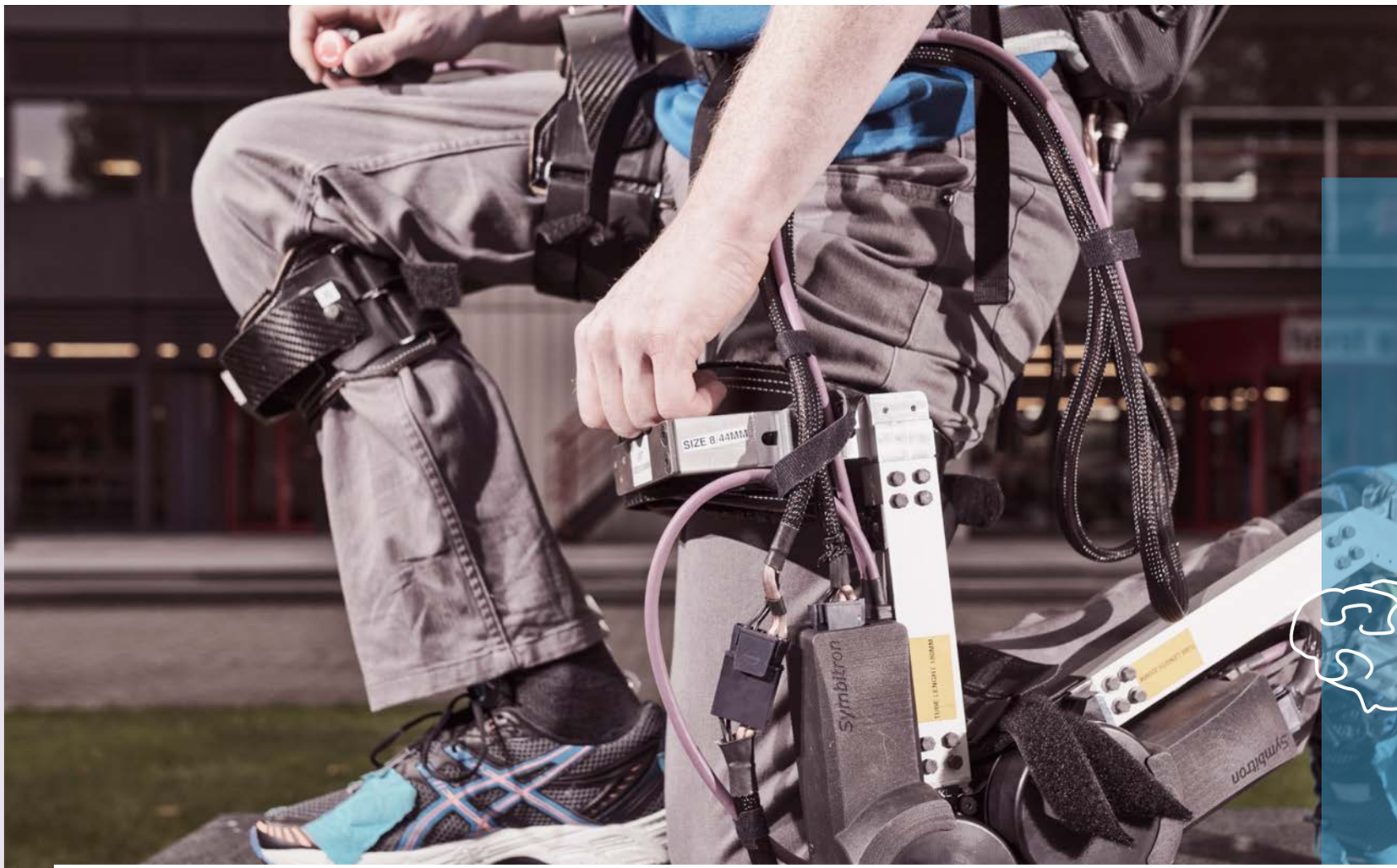


from experience that new things can lead to unexpected consequences, and so it is good to think of these upfront.'
Boenink suggests examining the ethics of medical technology from a different standpoint. What is it we aim to achieve with new technology? 'It's not about limitations, but about the priorities we set. For example, look at developing countries; medical progress has a huge impact on the people there. The issues in those countries are massive, but require a completely different approach. The problem is that medical technology still tends to be geared entirely towards the West these days.'
According to Boenink, we often consider circumstances here in the West to be the default. 'It is important for us to examine the context,' says Boenink. 'Medical experiments are often carried out on young, male students who are not representative of the global population. There is no single standard human body. Of course we draw inspiration from nature, but which kind of body are we trying to 'imitate' in the field of medical technology?'
Boenink herself conducts research into the influences of predictive technology. New technology helps discover potential diseases earlier on and a prediction or diagnosis can have massive consequences. 'It can affect people's self-image,' Boenink explains. 'It changes the way people look at themselves. Moreover, if you can predict illnesses based on someone's DNA, what happens when a potential employer of theirs gets hold of that information? These are highly relevant political issues.'

Biological inks

Even though other scientists certainly don't disregard these ethical and political issues, they are also driven by the prospect of new, innovative technology. And, although it might not have only positive impact on human lives, engineering fully functional organs is a challenge that many researchers want to tackle. 'Perhaps we can't make an entire heart that functions as well as a normal healthy heart, but we can make its different layers,' says Leijten and, once again, bioprinting

> *'Creating the right biological inks to print organs could be the future'*



is mentioned as the possible way forward. However, it also comes with obstacles: 'We can recreate the general shape of the human heart or another organ with some of the right cells in it, for example, using bioprinting. However, we need more than just the macrostructure. You also need the right micro- and nanostructure to allow the engineered organ to function properly. So the question is: can we also make biological inks that have the right nanostructure? Creating the right biological inks to print organs could be the future.'

There are also other approaches scientists are considering in order to fix our failing organs. One of them is so called bottom-up tissue engineering. 'This refers to going from nano- to macrostructures, creating different modules and inserting them into bigger organ systems,' explains Leijten. 'Challenge is: how do we make these tiny modules to reassemble into the right bigger structures? How do we create a self-organized system?' Because this question is unanswered, there is another path to consider: 'It might be better if we let the tissue develop by itself inside the body. After all, we developed from a single fertilized egg cell. If you have the right biomaterials and stem cells, you could perhaps create a suitable organ template and stimulate our bodies to organize and mature the replacement organs. Even though we can't yet say this is the ideal way forward, the human body as a bio-reactor is an interesting and viable concept.'

Cybernetics

Yet, both Robert Passier and Jeroen Leijten agree that biology alone will not cut it – we will need to combine it with technology as well. 'If it comes to recreating parts of a human body, cybernetics will play an important role,' claims Leijten. 'We already have robotic hands, robotic hands that can do beautiful things, but the question is, how do you hook it up to your nervous system so it works as an integral part of your body? Maybe such a seamless integration can't be achieved in the near future, but pursuing this challenge is relevant. Cybernetics is more likely to provide a cost-effective and durable solution for creating complex body parts, compared to engineering of purely biological tissues.'

'Exoskeletons would be such a big help for industrial workers who perform manual labour'

How could the future of medicine impact the society according to science fiction:

- **Passengers** (2016): The story is taking place on the starship Avalon, transporting thousands of colonists to the planet Homestead II. This space colonization and the 120 years long journey to the planet is possible thanks to hibernation pods, in which the starship's passengers are kept for years without them aging or experiencing any discomfort. The starship is also equipped with an Autodoc, a machine that can autonomously perform any medical procedure known to humans, therefore allowing the passengers to perform surgeries on themselves.

- **Elysium** (2013): The movie, set in the year 2154, shows two worlds. One on Earth, where citizens live in poverty with little technology and medical care, and the other one on Elysium, a gigantic space habitat. The technologically advanced Elysium is dedicated to the rich who also have access to Med-Bays: medical machines that can cure all diseases, reverse the aging process, and regenerate new body parts.

- **The Island** (2005): The film depicts characters that are, in fact, only clones of their wealthy 'owners', living in an isolated compound until they are needed for organ harvesting or surrogate motherhood.

- **Gattaca** (1997). The film portrays a future in which eugenics is common practice. Humans are conceived through genetic manipulation to ensure they possess only the best attributes. A genetic registry database uses biometrics to classify those so created as 'valids' while those conceived by traditional means and more susceptible to genetic disorders are known as 'in-valids'.

'Controlling wearable technology is indeed quite a challenge,' says Herman van der Kooij, Professor of Biomechatronics and Rehabilitation Technology. He develops wearable robotics to help patients during the therapy stage, or if they have a permanent handicap. For instance, he works on exoskeletons intended for paralyzed patients. Meaning devices that can fix even 'broken' bodies and help them to move and function like their healthier counterparts.

In fact, there is already a variety of exoskeletons out there that can help fully paralysed patients to walk again. A number of people use such devices in Nijmegen, although they do still need crutches to walk with these exoskeletons and, at 80,000 euros per skeleton, this new technology is still rather expensive. 'Whether this technology will ever be affordable depends on the volume,' says Van der Kooij. 'The first automobile was incredibly expensive at the time, and yet now, almost everyone has a car. This technology too will become cheaper over time.'

Picking up brain signals

There are other challenges besides the price tag. How does the device know what the person wearing it wants, and how can the person know what the device is going to do? 'It is all about the exchange of information,' Van der Kooij explains. 'This interaction can be controlled via brain activity, but these kinds of signals are very hard to pick up.' One solution might be to input the necessary settings into the device beforehand, but that makes it hard for the patient to walk under varying circumstances, because each new situation would require new programming.

The biggest technological challenge is maintaining balance. 'Without crutches, walking with an exoskeleton is still pretty much impossible,' says Van der Kooij. 'That is why we are performing extensive testing on how people maintain their balance. Our dream is to build an exoskeleton that will allow fully paralysed people to walk without crutches, and I believe that we can achieve this within one or two years.'

'If we can keep repairing and restoring everything, ageing is nothing but a curable disease'

Exosuits or Iron Man suits?

Wearing an exoskeleton is like wearing a robot, and so another issue is the hardware. 'In a way, people don't actually need the exoskeleton as long as they still have a skeleton of their own,' Van der Kooij explains. 'That is why we are working on a concept for activating people's limbs using exosuits. An exosuit is a suit you put on and that activates your limbs for you. We are trying to keep the technology as small as possible, so that the suit could even be worn underneath people's clothing.'

In the end, this robotic technology won't make us immortal, but it could help us live much longer, supporting our worn down bodies. 'It would be such a big help for industrial workers who perform manual labour,' Van der Kooij states. 'The additional support from an exoskeleton could really make a difference for them. People get older, but as for our bodies, they really wear and become strained.' Moreover, such wearable devices could be rather fun. Whether healthy or disabled, exoskeletons could give people supernatural powers, like in science fiction. 'Yes, an exoskeleton could help you achieve feats like jumping ten meters up into the air,' says Van der Kooij.

Replacement organs

If you have the funds, you can already get excited about the idea of becoming a real-life superhero, but we must disappoint you if it comes to the prospect of 'replacement organs' created from, let's say, your morning visit to the toilet. Unfortunately it seems that we can't expect any such developments in our lifetime. 'If it comes to replacing whole organs, it certainly isn't possible now,' says Passier.

'On the other hand, you should never say never. If you'd asked me ten years ago if we could make heart cells from urine, I would have said: "of course not". So who knows. It also depends on the specific organ. There are already ongoing clinical trials for repairing eye disease using stem cells and they look very promising, but it is extremely complex to use stem cells in case of a heart failure, for instance. It is of course the dream to use stem cells to replace tissue and really repair organ function, whether that is by replacing the whole organ or parts of organs. But I think stem cell technology shouldn't focus on that right now. There are many steps we need to take first. Because it is also a dream to have really sophisticated models of diseases, and therefore develop better therapies and drugs. This dream is feasible. I believe we can accomplish that within ten years.'

The line we won't cross

Even though we might be light-years away from achieving it, the scientists agree that recreating organs isn't unrealistic. Is there a line we won't be able to cross if it comes to mending human bodies? 'Probably the brain,' thinks Jeroen Leijten. 'Yes, even if – many years from now - we can print brain cells into an engineered brain that is indistinguishable from natural brains, and even if it functions as a brain, it is unlikely we can fully recreate all the unique connectivities that make us into the persons we are, including our memories.' But, with the exception of brains, Leijten doesn't rule out a scenario in which everything in the human body is fixable. 'Everything might become repairable, but not replaceable. Organ systems, such as our vascular system, will be difficult to fix, because they are too vast to be replaced. To fix these issues, we would need regenerative strategies.'

Robert Passier is also naturally skeptical about 'brain replacements', but he doesn't want to put any limits on medical technology. 'I don't want to say "we will never be able to do this", because who knows what might be possible in the future,' he says. 'Will we ever make a brain? That is an extremely complicated challenge. Can we make it now? Of course not. Can we make it a hundred years from now? Yes, maybe. Maybe we can even replace brain.'

Ageing, a curable disease

Even with the head transplant on the horizon, Leijten doesn't think we can replace everything in our bodies, but he quickly adds that: 'We could potentially rejuvenate bodies. There are enticing studies that suggest that we can rejuvenate cell behavior. If that is the case, is ageing only a disease then? If we can keep repairing and restoring everything, ageing is nothing but a curable disease.'

Saving and prolonging lives, providing healthy organs or new limbs.... all that sounds like good things to do. However, nothing is black and white. 'If we could stretch human survival to several hundreds of years, is that really something we should want?' ponders Leijten. 'How much life can we sustain on our planet, what effect would this have on potential food shortages and other issues. If we are able to do it, could longer lifespan become a commodity that is purchasable for the

wealthy? There is a potential risk that we would inadvertently create two financial classes – the nearly immortal upper class and the dying working class.'

Marianne Boenink agrees that conquering old age would have huge societal consequences. 'Imagine a world without old people; what would we be missing out on then?' says Boenink. 'What kinds of implications would the lack of old age have on the notion of wisdom? And should we even consider ageing a problem or a disease? There are plenty of positive sides to ageing. Moreover, the technology might not be affordable for all and might create a new class of privileged people who are able to conquer their old age, simply because they can afford it, unlike others. This could happen on an international level – the West versus developing countries. That makes you think of how we should regulate development in biomedical technology. Now we almost never forbid new developments, but maybe that is something to consider. But what if certain countries forbid a technology and others don't? It is very hard to ban technology on a global level.'

Personalised medicine

Back to the topic at hand, Marianne Boenink doubts whether humankind will be able to 'fix' everything related to its physique. Be that as it may, we are getting increasingly better at visualising diseases and at discovering them in earlier stages. 'We might be able to create personalised medicine and get even better at predicting which diseases people will be affected by,' says Boenink. 'On the other hand, this might also mean withholding medication if we know that it isn't going to make someone better.'

These issues also give rise to the questions of how people see themselves. If everything can be fixed, what is left for people to base their identities on? 'You have to remember that people are very flexible,' says Boenink. 'Our bodies change continuously. People with prosthetics tend to become fully used to their new limbs, as if it were a pair of glasses. I would not rule out the possibility of people being able to get used to, say, a new head.'

Not yet, but...

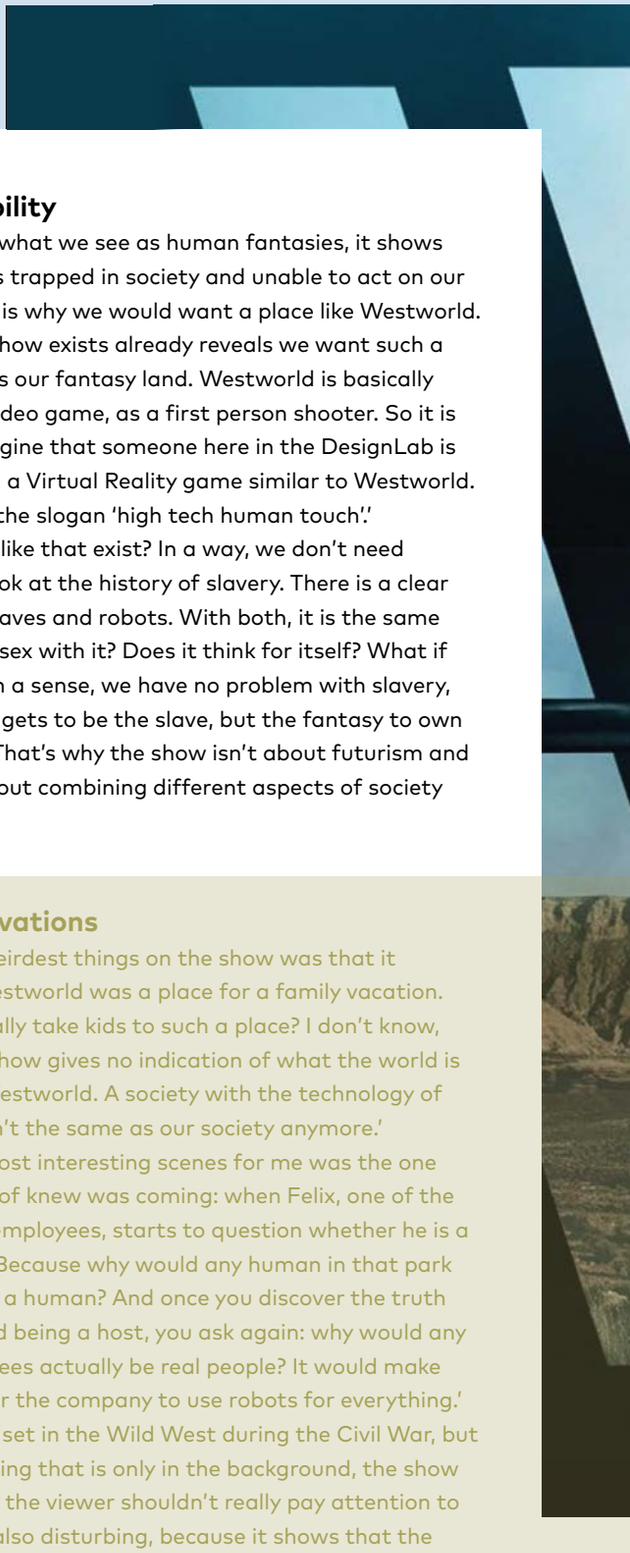
At this point, there are many things we don't understand about the human body, and that we therefore can't fix. Still, ten years ago we didn't have functional exoskeletons walking in the streets, we didn't know heart cells could be derived from our urine and our 3D printers were still in diapers. Research and medical technology are moving at a rapid speed. In fifty years, even our wildest dreams could become reality. Maybe, just maybe, we will have Iron Man suits in our closets, 3D printed hearts pumping in our chests and a tuned brain running it all. ●

Experts who contributed to the article:

ROBERT PASSIER	Professor of Applied Stem Cell Technologies, TNW Faculty
HERMAN VAN DER KOOIJ	Professor of Biomechatronics and Rehabilitation Technology, ET Faculty
MARIANNE BOENINK	Associate professor, specialized in philosophy and ethics of biomedical technology, BMS Faculty
JEROEN LEIJTEN	Assistant professor, specialized in complex tissue engineering, TNW 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.



In this edition, the HBO series Westworld (2016 - present) is analyzed by Nolen Gertz, assistant professor of Applied Philosophy. If you have not watched this TV show yet, beware of spoilers!

The plot

Westworld is a futuristic amusement park with a highly realistic Wild West theme. Inside Westworld, rich guests are looked after by robotic 'hosts' - technologically advanced androids that look, behave and even seem to think and feel like real human beings. Unlike humans, however, these robots can be killed or (ab)used in any way without permanent damage, because their memory can easily be wiped and their bodies repaired. This means the park's visitors can live out even their wildest fantasies through these hosts - without any consequences. At least until the hosts begin to form a consciousness of their own and decide it might be time to take over control.

First impression

Gertz: 'I found it interesting because, from the start, it seemed like a show that wanted to be philosophical. I also liked that it carried analogies with Jurassic Park. It's a story in which attractions in the park start attacking the guests. In Jurassic Park, the basic line said 'Life will always find a way'. In Westworld, you could say that 'consciousness always finds a way'. You can't ever engineer a perfect scenario.'
'It's interesting to think about what type of people would want to go to such a park. The main idea of the show is that you go to Westworld to live out your fantasies, which means having sex or killing people without consequences. But it is not possible to do such things without consequences, because it doesn't matter who you kill, but that you are doing it and what this says about you. For most people, the show is about the difference between humans and robots, about finding and defining consciousness, but for me this distinction isn't that important. I shouldn't need to know if you are a robot before I decide whether or not to kill you.'

Realism/feasibility

'The series reveals what we see as human fantasies, it shows humans as animals trapped in society and unable to act on our instincts. And that is why we would want a place like Westworld. The fact that the show exists already reveals we want such a place. We use TV as our fantasy land. Westworld is basically constructed as a video game, as a first person shooter. So it is not difficult to imagine that someone here in the DesignLab is already working on a Virtual Reality game similar to Westworld. It could even have the slogan 'high tech human touch'.'
'Could a real place like that exist? In a way, we don't need Westworld. Just look at the history of slavery. There is a clear parallel between slaves and robots. With both, it is the same debate: can I have sex with it? Does it think for itself? What if it tries to kill me? In a sense, we have no problem with slavery, it's just about who gets to be the slave, but the fantasy to own someone is there. That's why the show isn't about futurism and technology, but about combining different aspects of society that already exist.'

Stray observations

- 'One of the weirdest things on the show was that it suggested Westworld was a place for a family vacation. Would you really take kids to such a place? I don't know, because the show gives no indication of what the world is like outside Westworld. A society with the technology of Westworld isn't the same as our society anymore.'
- 'One of the most interesting scenes for me was the one that you kind of knew was coming: when Felix, one of the Westworld's employees, starts to question whether he is a robot or not. Because why would any human in that park think they are a human? And once you discover the truth about Bernard being a host, you ask again: why would any of the employees actually be real people? It would make more sense for the company to use robots for everything.'
- 'Westworld is set in the Wild West during the Civil War, but this is something that is only in the background, the show suggests that the viewer shouldn't really pay attention to it. But this is also disturbing, because it shows that the wealthiest people want to go to the time period that was the most destructive in the entire American history. And it once again reminds us of the similarities between robots and slaves.'

Text: **Michaela Nesvarova**

Poster of the TV series ***Westworld***.

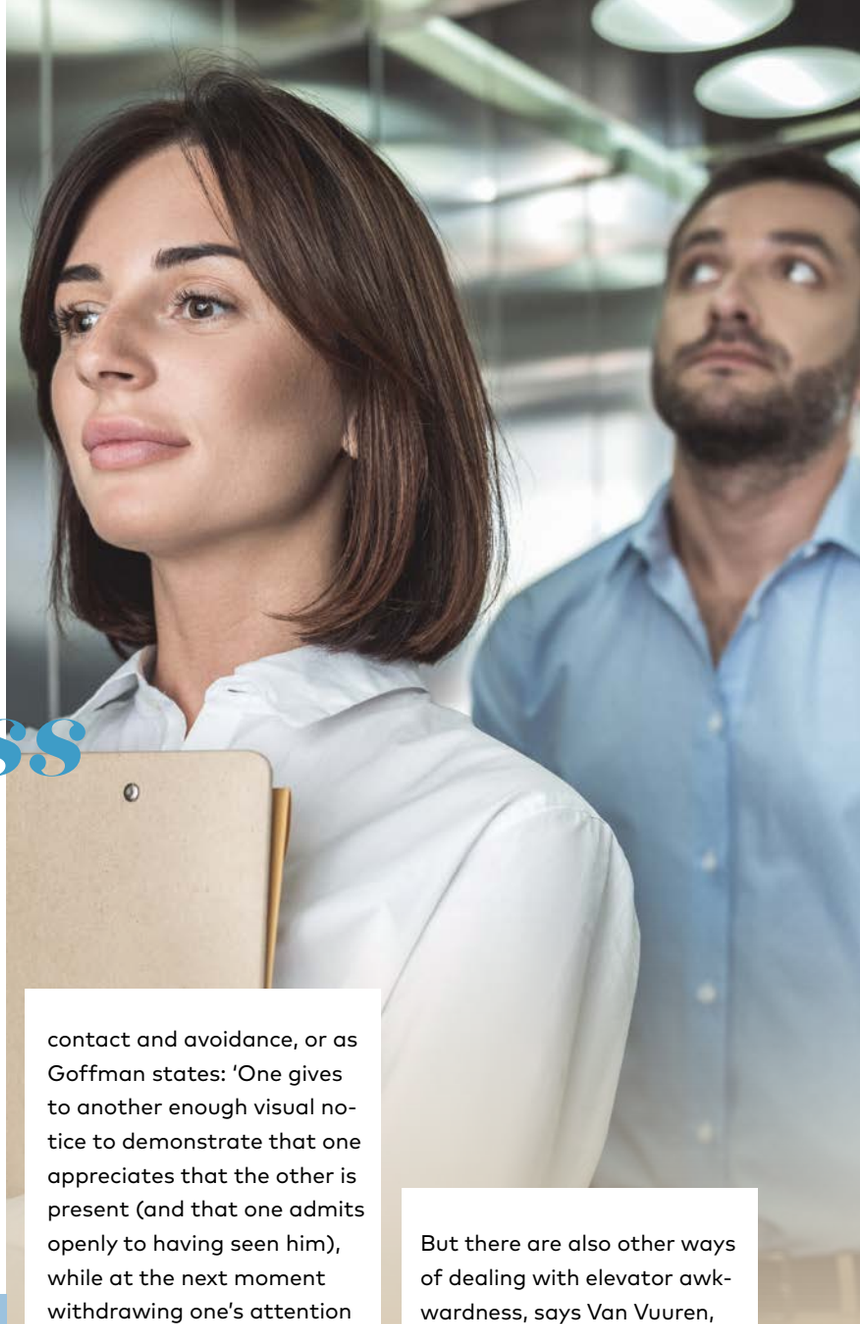
E

Everyday Science

Elevator awkwardness

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.

Tekst: **Rense Kuipers** Photo: **Shutterstock**



It's one of society's weird places: elevators. Packed with people who do not know where to look or what to say. And so we just hope everything is over soon. Communication expert Mark van Vuuren (BMS faculty) explains the phenomenon of 'elevator awkwardness'.
'You could see the elevator as a pressure-cooker,' states the Associate Professor. 'It's a place where two distinct social routines collide. On the one hand, you are in the presence of strangers for a very short time. In such situations, you normally remain silent. On the other hand, you stand so close to one another in a claustrophobically small space, invading each other's private space, that you cannot ignore each other. This is the social dilemma of elevators.'
Generally, we solve this tension by what Canadian sociologist Erving Goffman described as 'civil inattention'. That is the mundane, yet subtle balancing act between contact and avoidance, or as Goffman states: 'One gives to another enough visual notice to demonstrate that one appreciates that the other is present (and that one admits openly to having seen him), while at the next moment withdrawing one's attention from him so as to express that he does not constitute a target of special curiosity.'
For the remainder of the ride you just look into the direction of the door.
'Small talk is difficult in elevators,' says the Associate Professor. 'You cannot talk too loud, as others have to listen to you as well. But whispering suggests that you are hiding a secret. So we cultivated the unspoken conclusion that co-silence is the best solution.' As a consolation, Van Vuuren adds, awkward silences often feel longer than they really are.

But there are also other ways of dealing with elevator awkwardness, says Van Vuuren, in the form of breaching our social conventions. 'It's what Professor Harold Garfinkel was known for in the field of ethnomethodology, the methods people use to understand and produce the everydayness of social life. He asked his students to break those rules to see what happened. So if someone enters the elevator next week and asks if he can stand in your place, you are probably part of an experiment. Compared to these interactions, a short moment in silence is far less awkward. All thanks to our capabilities of civil inattention.'

Body & soul

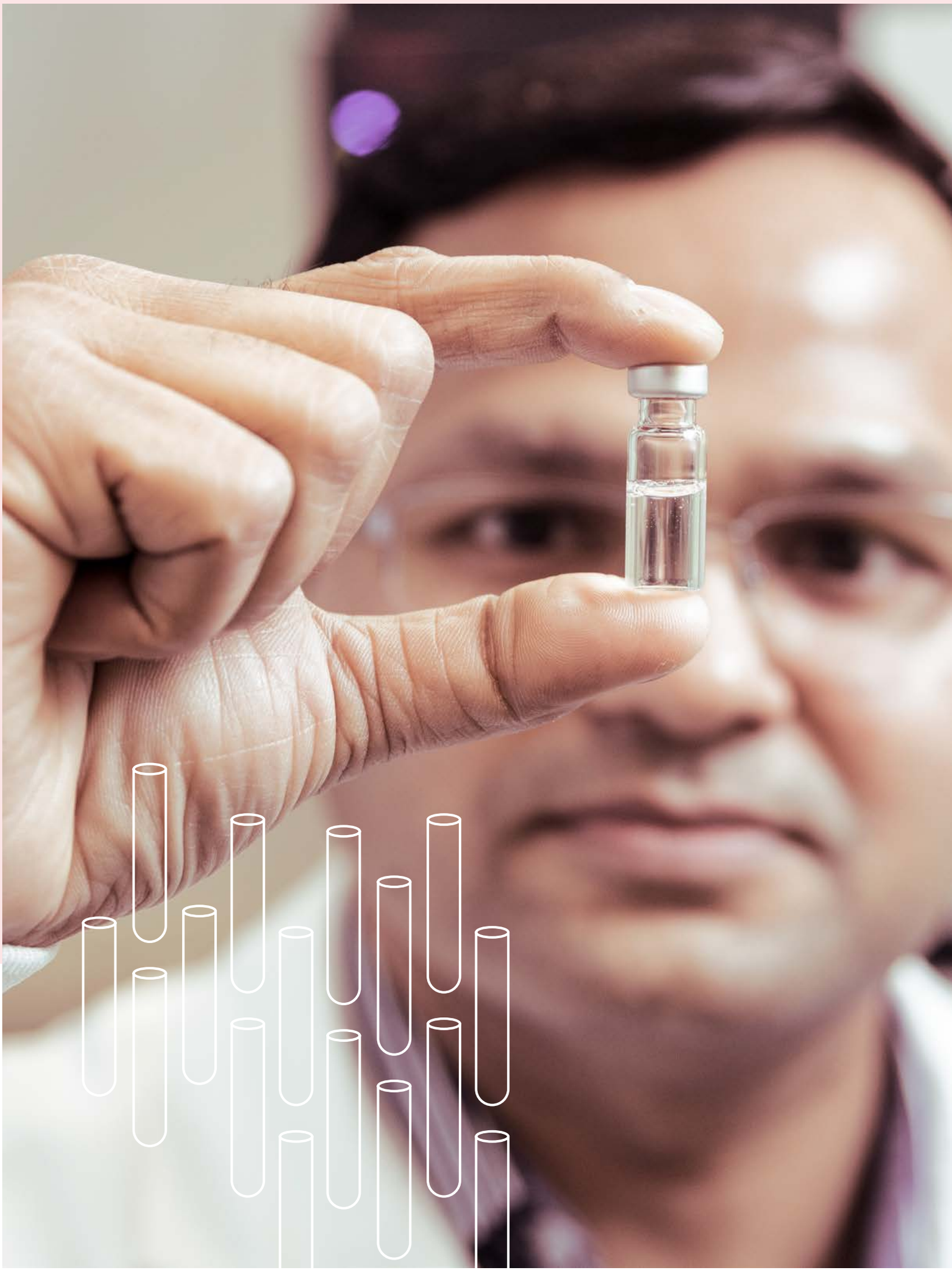
This Science & Technology Magazine contains a remarkable quote about the human body: 'If we can keep repairing everything, death is nothing but a curable disease.' Be wary when a scientist uses the words 'nothing but.' These words are often followed by the application of a necessary simplification that exists within their field of study to a broader concept: love, life, or all of humanity.

That aside, I am curious about viewing death as a 'curable disease.' Because death and life are mutually exclusive states of being, this statement contradicts logic. Curing death is not an option; preventing it would be more realistic in my view. If we replace the word 'death' in the aforementioned quote with 'life,' we end up with something similar to what the psychiatrist R.D. Laing said: 'Life is a sexually transmitted disease and the mortality rate is one hundred per cent.' Although this eliminates the logic problem, it does lead to a more deep-seated issue: life as a disease or a medical condition. If we manage to resolve this problem one bit at a time, we can continue to extend our lifespan.

Will we achieve this? Would it make us happy if we did? The answer to the first question is 'probably.' More and more people will live to reach an advanced age. What age is that, exactly? Mathematicians from Tilburg recently found a clear answer: 115.7 years for women, 114.5 years for men. That is, as long as we do not fundamentally tackle the mechanisms of ageing. Scientific ambitions are loftier, though, and reach all the way to the bizarre claim of immortality made by the visionary Ray Kurzweil.

The second question was whether it would make us happy. Happiness is a tricky thing: the more you try to seize it, the more elusive it becomes. If you are looking for an objective way to measure happiness and how to reach this state of being, Mo Gawdat has the answers. Gawdat – who is on Google's payroll, just like Kurzweil – states that happiness ≥ (your perception of the events in your life) – (your expectations for your life). This equation of happiness is derived from a specific view on the human condition, but it does demonstrate what we know in our hearts: we should keep our expectations in check. Doing so becomes more difficult as we start to play around more with the fundamentals of life. The costs and the promises made are high, so our expectations follow suit. Biomedical science undoubtedly has enormous potential, but will we be able to keep up in a psychological, spiritual, and social sense?

Wiendelt Steenbergen
Professor of Biomedical Photonic Imaging



Text: **Michaela Nesvarova**
Photos: **Rikkert Harink**

JAI PRAKASH DEVELOPS A UNIQUE PEPTIDE AT THE UT

Killing cancer and preventing scars

Cancer and scars. They might seem unrelated, but both could be treated using one unique peptide. A peptide that was developed and patented by scientist Jai Prakash at the University of Twente and that could potentially revolutionize the future of medicine.

Jai Prakash, Associate Professor of Targeted Therapeutics at MIRA - Institute for Biomedical Technology and Technical Medicine at the UT, began working on the peptide only five years ago. Yet, he already knows that his invention is able to kill even an aggressive form of cancer and to prevent scars even in case of severe burns. He plans to bring it to the market within the next five years.

Shutting down the support

When Jai Prakash and his research group started developing the peptide, which they refer to as 'AV3', they were solely focused on battling cancer. However, even though their ultimate goal was to kill cancer, they weren't aiming to kill the cancer cells. 'Our approach is really unique,' explains Prakash. 'Unlike others, we don't focus on killing the tumor cells, but on the cells that help them grow. Using our patented peptide, we are able to shut down the microenvironment that supports the tumor.'

In other words, the UT researchers have developed a peptide that is able to deliver nanoparticles to stroma, the tissue that surrounds the tumor and acts as a barrier and stimulant for the tumor cells. 'This matrix around the tumor has been ignored so far and there is nothing on the market that would be able to get rid of it,' adds Prakash. 'But if we can control its behavior and shut it down, we can kill cancer much faster and easier.'

Killing more than 80% of cancer

And we can. Prakash's radically different approach has proven to be successful recently. 'Our peptide was tested in a pancreatic cancer model in animals. Pancreatic cancer is the deadliest cancer and there is no successful treatment yet,' says Prakash. 'We conducted experiments on mice using human patients' tumors. These were very aggressive tumors, but we applied our peptide in combination with chemotherapy and this treatment inhibited more than 80% of the cancer. These are the first results, however, and a dose

adjustment may lead to a complete eradication of the tumor.' Using this method, the peptide can support traditional chemotherapy. 'Chemotherapy of course works to a certain extent, but it can't fully penetrate the tumor. Our peptide shuts down the matrix that protects the tumor, and the chemotherapy can therefore get inside and work much better,' clarifies Prakash.

ScarTec Therapeutics

Seeing these promising results, Jai Prakash realized something: 'Scars are basically stroma, but without the cancer cells. This means the peptide could also be used for preventing scars and skin treatment.' The scientist therefore tested the peptide on scars and saw it had substantial effect on scar inhibition. From this realization, it was only a small step to action. Last year, Prakash founded a UT spin-off ScarTec Therapeutics BV. Although he still wants to further contribute to the method for killing cancer, his company ScarTec Therapeutics will, at least for now, focus on preventing skin scarring. 'We have developed a special hydrogel that contains the peptide and inhibits scars,' says the spin-off's CEO. 'This gel can be easily applied to skin. It can be used for any patients with injuries that could result in scars, after surgeries and even for burn victims. So far, there is absolutely no similar product out there and our goal is to bring it to the market as soon as possible. Any drug development takes a while, of course, but we believe we could have the gel on the market in 2023.'

'Scarless band-aid'

As a first step, the hydrogel should be used by doctors and other medical professionals, but Prakash would like to turn his invention into a regular consumer product one day. 'I'd like to create a 'scarless band-aid', a simple bandage with the gel inside that anyone could apply on wounds, preventing any scars,' he says. 'We are also testing the peptide on already formed scars and it might be possible to use it to remove a few months old scars.'

Either way, Jai Prakash believes this technology could be a real game changer in the medical field: 'I didn't want to do only fundamental research and wait for someone to pick up on my findings. I want to move things forward. And I really believe in this product and this company. We are still looking for investors, but if everything goes right, we will bring the product to clinical practice very soon. I couldn't be more passionate about anything.'w

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

Master Research

Finding a small piece of an enormous puzzle

'Going where no-one has gone before'

In September, he won the TGS (Twente Graduate School) Award. It served as a stepping stone towards an academic career, which Koen Dwarshuis (23) is about to embark upon now that he has all but finished his master's research and earned a position as a PhD at the UT. What appeals most to him about an academic career? 'Pioneering. Tackling the challenge of enriching our knowledge.'

As part of his Mechanical Engineering master's programme, Dwarshuis conducts research into applied mechanics – not just in relation to the human body, but also robots, windmills, helicopters, etc. The goal is to simulate each individual element – 'every hinge or component' – with a computer programme. For his PhD research, he will create a model of the human foot. 'It will make it easier to simulate a walking motion and accurately predict the effects of, for example, surgery or a prosthesis.'

Swing

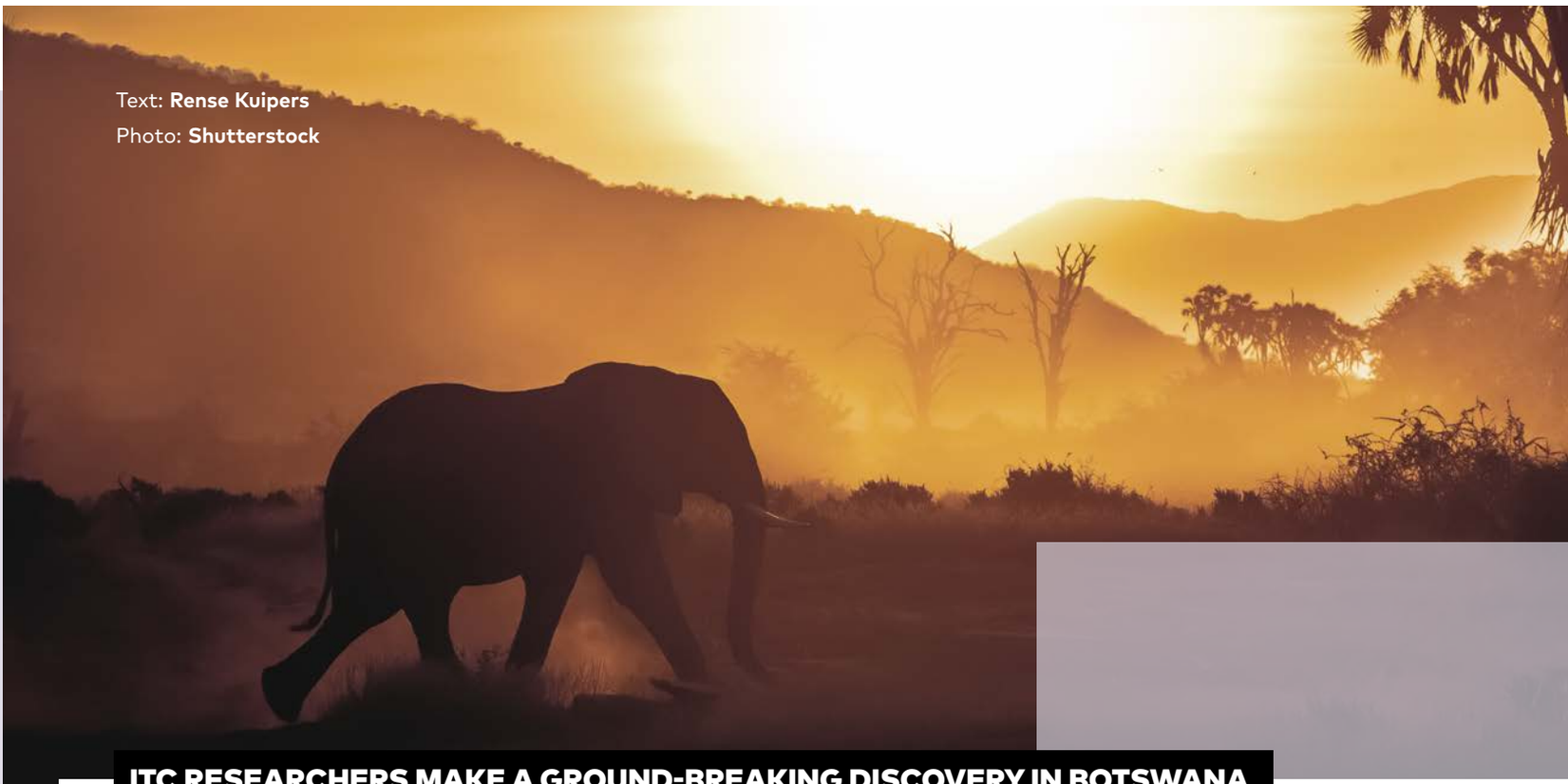
Dwarshuis is delving even deeper into the world of mechanics. 'It is about force versus acceleration, Newton's second law. If you use a computer to describe each individual element, you can clearly see the effects of this interplay. You might compare it to pushing someone on a swing. We describe how the swing reacts to the force applied by the person doing the pushing, as well as how the swing is attached to its frame.'

He calls his master research 'fundamental, but with a hint of application.' 'The practical result will be a computer programme that can calculate how an object will react to a given force much faster.' Dwarshuis maintains some perspective. 'It might not change the world, but that is not what I am after. The great thing about fundamental research is expanding our general knowledge of mechanics a little bit at a time. It is like finding a small piece of an enormous puzzle.'

Pioneering

The master's student enjoys this pioneering aspect. 'Together with a group of fellow researchers, you tackle the challenge of enriching our knowledge. You are working on something that few people know about. You are going where no one has gone before,' Dwarshuis explains. 'In the long run, this new knowledge has to lead to something. While you are still working on your research, its impact is often unclear. In-depth research will absolutely pay off later, though.'

This does not mean that there are no (human) applications for his research right now, however – there are plenty. 'That was a great discovery; apparently, I can use a mathematical representation of the human body to help with medical applications. I did not expect that when I started my studies.'



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

ITC RESEARCHERS MAKE A GROUND-BREAKING DISCOVERY IN BOTSWANA

Africa is splitting up

'In the right place, at the right time' almost never applies to earthquakes. Nevertheless, ITC professor Mark van der Meijde uses this expression when he talks about an earthquake that happened earlier this year in Botswana. It confirmed exactly what his colleagues and he suspected: the African soil is completely unlike what scientists have always believed it to be – which can have major consequences for the continent.

'It is one minute to midnight for Africa as we know it,' says the professor of Earth Structure and Dynamics. 'The continent appears to be splitting up along a fault line that runs straight through Botswana. That means that a piece of Africa will ultimately break away and drift off, exactly like South America did at one time.'
It sounds shocking, but Van der Meijde can put the current generation of earthlings at ease. 'We are talking about a timeline of hundreds of thousands of years. If the age of the planet itself is like a day, that period is like a minute.'

The second most severe earthquake

The fact that the ITC researchers even made this discovery is a stroke of luck. The NWO-funded project was supposed to be over already. However, Van der Meijde and his colleagues applied for an extension and their patience was rewarded.
On the 3rd of April, 2017 – two months after the project was scheduled to end and the equipment was supposed to be shipped back to Enschede – the second most severe earthquake in Botswana's history (6.5 on the Richter Scale, with no fatal casualties) took place.
The project involved a lot of work, Van der Meijde explains. His office is decorated with a map of Botswana with twenty-one pins in it. These mark the exact locations where the researchers, together with Botswana's geological service and Utrecht University, placed seismometers. It took them a year and a half to put all the equipment in the right place.
Van der Meijde visited Botswana frequently during the project. He helped with the installation of the equipment and with finding suitable locations. 'If you leave something in the wilderness unguarded, it will be gone within 48 hours,' the professor says. 'People are motivated as much by bad intentions as

'A piece of Africa will ultimately break away and drift off"

by mere curiosity. All told, every station houses a lot of valuable equipment: a seismometer worth around fifteen thousand euros and another thousand euros' worth of batteries, a solar panel, a GPS modem, and a mobile transmitter.'

Tribal chiefs and lions

The search for safe places to install the sensitive equipment was an adventure in its own right. The researchers did everything from asking tribal chiefs for permission to sleeping in camps that were a bit too popular among the local lion population. 'We first looked at the locations of telecommunication transmitter masts,' Van der Meijde explains. 'Those are fairly well protected, because of the risk of theft and vandalism. The best sites turned out to be primary schools. They are located in large, fenced-off areas. By involving the schools, we could have them share in the responsibility.'

Next, it took the team a few days to install the equipment. At sites with a lot of loose soil, the Botswana geological service dug holes, placed empty water tanks inside, and filled the bottom with cement. The equipment was then placed on top. Above ground, they built small roofs to protect the equipment from the elements, as well as a solar panel on a post. In locations where the soil was firmer, they built small shacks to protect the equipment.

Hide and seek

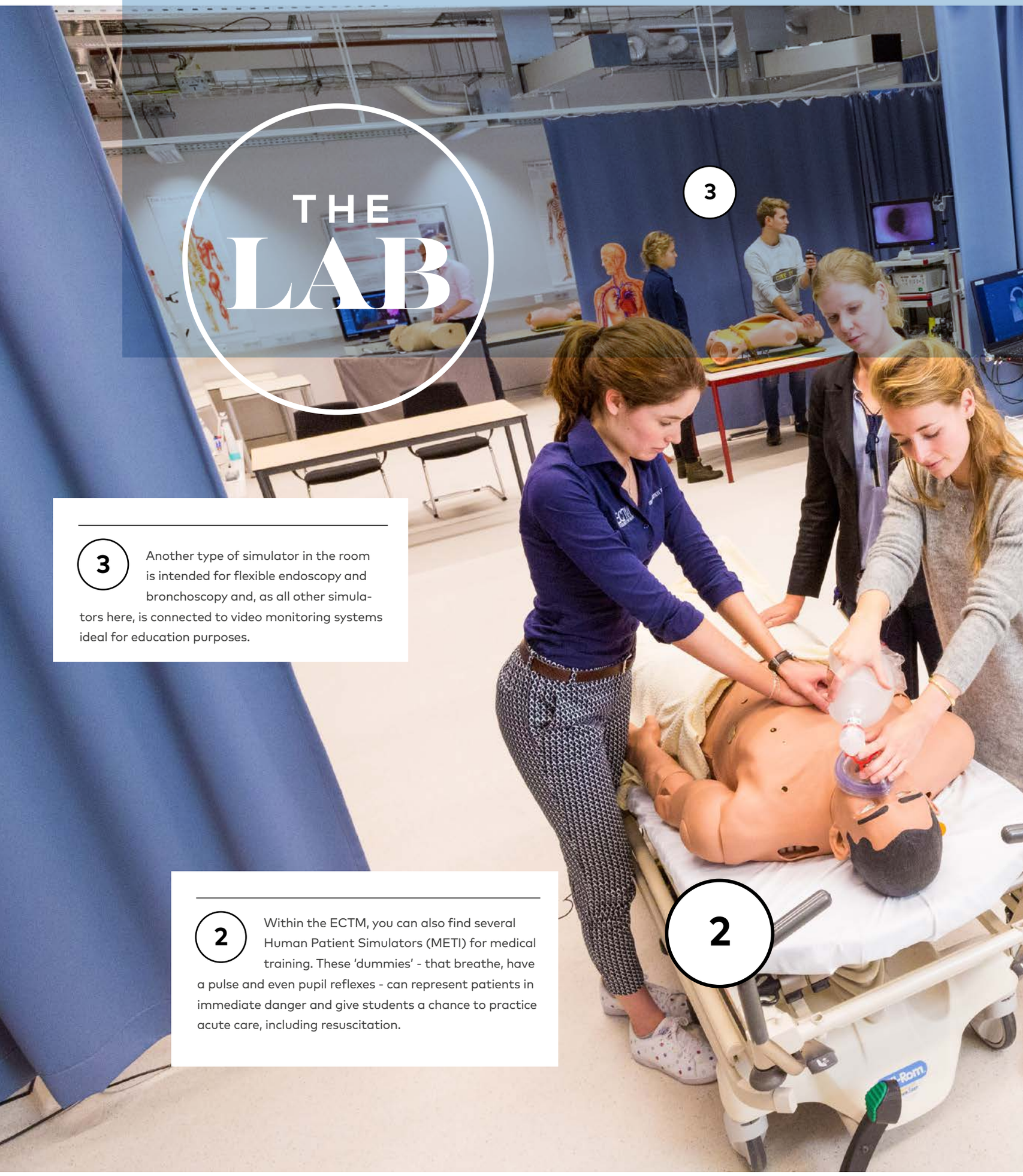
All this effort paid off in the end. The European Space Agency's GOCE satellite picked up a signal in the border region where Angola, Zambia and Botswana meet. The ITC researchers suspected that the entire East-African fault line was located 500 kilometres further south. Van der Meijde: 'We encountered plenty of scepticism when we explained this at conferences. "Where is your seismic activity," our colleagues would ask us. We never abandoned our theory, however. The area we were looking at is practically uninhabited. There are just a few nomadic tribes who travel across it. Small tremors are hard to feel when you are sleeping in a tent. Our patience was rewarded in the end. It was like this enormous earthquake was playing a deft game of hide and seek and we suddenly managed to catch it in the act.'

The ITC scientists will hand over the equipment and the responsibility for the project to the Botswana geological service in 2018. The project is almost over for ITC. The papers written about the team's findings are pending review by prominent journals. Van der Meijde himself is now studying seismic activity on – or rather, under – the Italian island of Sardinia. 'I am using far more advanced seismometers than what we installed in Botswana at the time,' he says excitedly. 'They are eight times more energy-efficient. Compared to the old equipment, the installation process is a breeze. That alone creates so many new opportunities.'

The researcher is gathering a wealth of new data, every small bit of which is enough to write a paper about, Van der Meijde claims. Ultimately, his goal in Sardinia is the same as before: getting to the bottom of it. So we can learn more about the subterranean world beneath our feet. ●

'We never abandoned our theory '

THE LAB



3 Another type of simulator in the room is intended for flexible endoscopy and bronchoscopy and, as all other simulators here, is connected to video monitoring systems ideal for education purposes.

2 Within the ECTM, you can also find several Human Patient Simulators (METI) for medical training. These 'dummies' - that breathe, have a pulse and even pupil reflexes - can represent patients in immediate danger and give students a chance to practice acute care, including resuscitation.

1

1 The room is equipped with simulators for the training of specific clinical interventions, such as endovascular surgeries. In fact, all Dutch vascular surgery residents come here for training and exams.
Equipment at the ECTM is also used for various research, i.e. fundamental research or a project which aims to find out if medical simulators can be used to identify future skills of surgeons.

Advanced Simulation Room

The Experimental Centre for Technical Medicine (ECTM), currently located in the Carré building, covers over 1400 m2 of space specially designed for research, development and education. As such, it offers too many facilities to fit into one picture, but one example of a room accessible to, for instance, students of Technical Medicine and other professionals in health care, is this Advanced Simulation Room.

Text: **Michaela Nesvarova**
Photo: **Gijs van Ouwerkerk**

SUCCESSFUL UT ALUMNA JEALEMY GALINDO CHOSE TO QUIT SCIENCE

‘You just need the balls to switch’

She describes herself as nonconformist and ambitious. Her life and career certainly confirm these words, but another one should be added: courageous. Although she admits that ‘swimming against the current can be difficult’, Jealemy Galindo has always followed her gut feeling. Even when it told her that - after spending her whole adult life in a lab - it was time to quit academia, get an MBA degree in Madrid and work for a start-up in Zurich.

Text: **Michaela Nesvarova**
Photos: **Linda Kastrati, LNDA Photography**

'I knew I wouldn't get where I wanted, I wouldn't become a leader'

Jealemy Galindo (36) is not just another UT alumna. She wants to leave her mark on the world. Growing up in Venezuela, she dreamed of becoming a scientist and leading a research group focused on battling cancer. She followed this goal for quite a while, travelling all the way to the 'farmers' land of Twente', as she calls it, where she studied chemical technology. As a student at the University of Twente, she won the Unilever Research Prize for her Master thesis and the MESA+ Poster Prize. Continuing what appeared to be a promising academic career, in 2012 she successfully obtained a PhD degree in bionanotechnology at the UT and got a postdoctoral position at the University of Padua in Italy. But this is when things began to unfold. 'Reality hit and it became clear that academia wasn't the path for me,' says Jealemy Galindo. 'I knew I wouldn't get where I wanted, I wouldn't become a leader. However, I realized that I had other skills and that there were other paths I could follow. So I quit science.'

'There is life outside academia'

'People said I was crazy, but I knew it was the right decision. The day I decided to quit science was the most important day in my life,' the alumna continues her story, while we sip tea in a café overlooking Lake Zurich, located just next to Galindo's office. 'In science, competition is very tough and positions are very few. Everything needs to align for you, otherwise you don't succeed. And if everything doesn't come together for you, you should leave. It's not about being defeated, but about realizing there is life and career outside of academia. This realization doesn't come overnight, of course. It was a very rational decision, but it took me a long time, because I really loved science and I dedicated all my time to it.'

In her own words, Jealemy Galindo had high ambitions and didn't want to wake up at the age of forty and find out that life had passed her by. So she left research behind and, together with her husband, she took off to Silicon Valley. 'My husband and I actually quit academia at the same time, so it wasn't very handy, but we knew we would find a way. We went to San Francisco, where we met a lot of crazy people doing great things and tried to understand what we could do with our future. After six months in California we both knew we wanted to make a transition into business.'

Searching for the dream job

'As a PhD from Twente I had a good scientific background, but knew nothing about business or

making money,' explains Galindo, who therefore decided to sign up for an MBA program at the prestigious IE Business School in Madrid. 'During one course, we had guided meditations and our task was to imagine where we would be in ten years. When I did that, I could hear people clapping and saw myself as a successful professional at the stock market, ringing the bell during the IPO of the company where I was a CEO.'

Galindo's career path hasn't led her to the stock market, though. At least for now, she is dedicated to start-ups. 'I want to create something from scratch, make it work and then move on,' she says. 'There are several stages of start-ups: chaos, organizing the chaos, fast growth and corporation. I don't know if I have the skills to run a corporation, but I'm fascinated by bringing structure into chaos.'

Bringing structure and building up a new company is exactly what she is doing now, as one of the core members of CyanoGuard, a start-up based in Zurich, where Galindo moved for the job after living in Italy for a while. 'I don't mind moving from country to country, because the world is a global place and you need to know people everywhere,' says Galindo. 'Plus, working in CyanoGuard could be described as my dream job - it combines chemistry and marketing, both my fields of expertise. Because even though I fulfill the role of the Marketing & PR Manager, I'm still in touch with researchers and can visit our lab anytime.'

'You don't have to be ashamed of dreaming big in Switzerland'

A lab in your pocket

CyanoGuard is a chemical technology company that makes kits which allow for naked-eye detection of cyanide in water, food extracts or blood samples. These detection kits are very small and easy to use, enabling virtually anyone to test for cyanide in any liquid. 'We bring a lab into your

'I feel that in Twente you have to be mentally very strong to make it'

pocket,' smiles Jealemy Galindo. 'Thanks to our technology, anyone can monitor toxic substances in a very rapid, simple and safe way. Our product doesn't contain any dangerous chemicals and doesn't require any special equipment.'
You indeed don't need any special training or equipment to use the CyanoKit. Just open the small box, take out a vial, put in a (water) sample and pour the liquid through the sensor. The sensor will instantly change color, based on the amount of cyanide contained in the sample. 'Right now it's like a simple pregnancy test, but we are working on adding an exact number indicating the cyanide level,' clarifies Galindo, showing me the contents of the test kits made in CyanoGuard's own lab.

Horizon 2020

CyanoGuard recently entered the exclusive list of innovative SMEs selected for funding within Horizon 2020. The start-up already supplies to customers within Switzerland and is working on pilot projects in South America, Asia, Africa and Australia. 'In principle, our sensors can be used for testing any liquid, including blood, but we are still in a development phase. We need to continue research and do tests on patients, so we can also supply to the medical sector,' says Galindo, explaining that CyanoGuard currently sells its kits mainly to companies in the mining, electroplating and chemical industry.

'Most people know that cyanide is toxic, but might not know that it is also a very important chemical. It's used while producing plastics, during metal extraction, it is contained in food, such as cassava or apricot kernels. If you think about it, virtually every piece of furniture in IKEA contains plastic and can therefore become cyanide if it catches fire,' describes Galindo. 'That is why it's important to have technology that detects cyanide in a fast and safe manner, which is what CyanoGuard provides. We offer an alternative to other companies that mainly use old-fashioned techniques which haven't changed in fifty years and require you to hire an expert with specialized equipment. With our technology, everyone can contribute to less pollution and poisoning cases.'

'Something is missing in Twente'

Overall, Jealemy Galindo seems very passionate about her job and happy with her life choices. 'I definitely don't miss academia. Everything moves slowly within academia. You never get to see the product of your research hit the market,' she says. 'I also really enjoy living in Switzerland. You don't have to be ashamed of dreaming big here. Almost every discovery at a university turns into a start-up, because there is a great ecosystem for start-ups. In Zurich, you can be ambitious and still have a good work-life balance. I feel that in Twente you have to be mentally very strong to make it. A start-up in Twente can consume you, because getting money without sacrificing a lot is a problem there. Even though the UT claims to be an entrepreneurial university, I never had a business course during my entire study there, and so I had no idea how to turn ideas into a business. I wish that would change, because it is a great university and it could compete at a very high level, but something is missing. The proper ecosystem isn't there.'
According to Jealemy Galindo, this is also one of the reasons why many UT researchers 'get stuck in academia'. 'They don't see any other options but science, because PhD in biology or chemistry at the UT is great, it teaches you a lot, but most of your skills are only useful in a lab,' thinks the alumna. 'So you need a plan B. You need to work on your other skills too and see that there is another side to the coin. Change is really good, you only need to be open to other paths. I was 32 when I switched and I want to show other scientists that there are other opportunities for them besides academia. You just need the balls to switch.' ●

Text: **Ditta op den Dries**
Photo: **Gijs van Ouwerkerk**

PATIENTS CAN PRACTISE IN TRIGGER SITUATIONS WITHOUT RISK

Virtual reality changes forensic psychiatry

Virtual reality will soon play an important role in the treatment of forensic psychiatric patients. Whereas behaviour is now mainly practised in the treatment room, patients will soon be able to learn to control their short temper in a realistic context – all with the help of technology. 'It will change our healthcare forever,' says Lisette van Gemert-Pijnen, professor at the Faculty of Behavioural, Management and Social sciences (BMS).

Forensic psychiatry is a popular field of study at the moment, especially after the recent murder of Anne Faber. How can we prevent people who exhibit aggressive and/or sexual transgressive behaviour from disrupting our society? The University of Twente is working hard on this issue as a partner in a research programme designed to develop eHealth applications and integrate these in the treatment interventions for forensic psychiatric patients and their families. 'The development of eHealth that actively involves patients and their doctors in the process and its contents is new in the field of forensic psychiatry. This participatory approach to eHealth characterises the University of Twente's BMS Centre for eHealth & Wellbeing Research,' says Van Gemert-Pijnen.

'Using technology to improve safety, while putting the patient's interests first'

Triggers

In their everyday lives, psychiatric patients often encounter triggers that bring out irresponsible behaviour in them. Think of a patient who is prone to becoming overstimulated and 'flips out' on a crowded train, an addict who walks into a shop and becomes obsessed with the shelves loaded with alcoholic drinks, or a sex offender who cannot control himself whenever a girl smiles at him. What all these people have in common is that they often cannot control themselves in these trigger situations. Virtual reality will make it possible to simulate a situation, so the patient can experience their own response to it and practise how to react in a controlled environment that does not pose any danger to society. Their doctor can observe and measure how the patient responds to certain stress factors and tailor their treatment accordingly. This is a unique treatment method within the field of forensic psychiatry.

Oldenkotte

The project began in 2014, after the Oldenkotte clinic in Rekken was closed. Van Gemert-Pijnen: 'The closing of this facility was a hot topic at the time. Another psychiatric institution gone! People looked for a way to preserve Oldenkotte without an institute. The Vrienden van Oldenkotte foundation contacted us to discuss eHealth and forensic psychiatry. Back then, we were not active in this field at all. We were able to get started because of the funds that the foundation made available.'
The UT collaborates closely with Transfore, the foundation for

'Virtual reality is more than just putting on a pair of goggles'

forensic psychiatry in the eastern region of the Netherlands, which was set up after Oldenkotte closed its doors. There are also close ties with the Erasmus Medical Centre. A research assistant with clinical expertise was appointed in Rotterdam, while the UT appointed a research assistant with experience in the field of eHealth. Both work closely together.

Research

Lisette van Gemert-Pijnen appointed Hanneke Kip as a PhD candidate. Kip has a degree in Psychology from the UT and hopes to obtain her doctoral degree in 2021. 'For my thesis, I conducted a literature study into the use of technology for the treatment of this specific group of patients. There was nothing to be found,' says Kip. 'There were no existing interventions for me to use, so I had to start my search from the bottom up. What does the patient want? What does the doctor want? How can eHealth be of use?'

In Rotterdam, the research is mainly directed towards the bio-medical aspects, while Twente focuses on behavioural change. 'The research consists of several smaller projects. One of those concerns the use of virtual reality as part of a patient's treatment. Last September, a project group was set up that consisted of two patients, three doctors, two researchers, and a policy officer from Transfore. By now, more than fifteen patients and twenty-three doctors have already participated in the research. That is quite a lot for a scientific study in this kind of setting,' Kip explains.

All sorts of patients take part in the study. 'There are people who live on their own and those who have been admitted into a clinic. Some exhibit aggressive transgressive behaviour, while others struggle with sexual transgressive behaviour.'

Psychology & Technology

Patients are invited to think along and assume the role of a researcher. The UT uses technology in a way that ties in with current beliefs about behavioural change in the healthcare sector. The emphasis is not on what the patient has done wrong, but rather on how they can contribute to their own treatment. 'By closely involving the patients, many new ideas and innovations are developed. We need their expertise,' says Van Gemert-Pijnen and she emphasises that virtual reality should not be seen as a hype. 'Virtual reality is more than just putting on a pair of goggles. We also study how to use virtual reality to achieve behavioural change: a virtual space where patients can practise behaviour with their doctor. We have the BMS lab at the UT, which offers many ways to experiment with VR. It is not easy to design a virtual representation of a forest, a meadow, a living room, or a train. We can even use scents and sounds to make the situations that patients practise with as realistic as possible.'

Hanneke Kip hopes that virtual reality treatments will contribute to prevention and help avoid recidivism. This is a promising avenue of research: using technology to improve safety, while putting the patient's interests first. ●

Harmony

The wild goose often turns its body 180 degrees as it lands. The parasitic wasp Trichogramma is just as likely to land on its legs as on any other part of its body. Hummingbirds can hang suspended in the air in a way that no other living organism can replicate. These are not just fun facts. Scientists would do anything to develop a flying robot that can fly just as well and as energy-efficiently as a bird or an insect. A winged animal can deal with gusts of wind, avoid lampposts, and land on a branch. In a similar situation, a drone is sure to crash to the ground.

When biologist and engineer David Lentink, a researcher at Stanford University, still worked in Wageningen, he happened to look out of his laboratory's window one day. He saw an insect fly around a flower and realised that this was precisely the type of natural behaviour that deserved more scientific attention. He equipped 450 volunteers with high-speed cameras and had them film insects and birds to their hearts' content. That not only resulted in some wonderful footage; it also led to surprising new insights that provided the inspiration for new avenues of research.

The potential of such research recently became clear when researchers from Harvard presented their latest generation of robotic bee. This mechanical creature can dive into water during flight and then soar off again. That is impressive. What about humanoid robots, though? How life-like have those become?

The performances of the latest generation of sex robots are nothing to get too excited about, in any case. Getting a large body to move and react independently is clearly more difficult than getting a few grammes of winged plastic to buzz around. Expectations are also a factor: a robotic bee has people cheering when it flies around without crashing into anything, while a sex robot will ideally assume any position in the Kama Sutra on its own, perform oral sex like an adult film star, and engage in intelligent conversation when all is said and done.

In reality, Harmony, the much-discussed latest generation of sex robot developed by the company Realbotix, can move her mouth, recognise her owner, and give somewhat appropriate answers to questions. She also climaxes loudly every time after straightforward penetration – something most real women would definitely be envious of.

The latter clearly demonstrates that Harmony's developers were not inspired by real-life examples from nature. Wishful thinking and advanced robotics evidently do not mix.

Enith Vlooswijk

Science journalist

From university research to international success

How a startup captured an untapped market in the automotive industry

Today the University of Twente startup TriboForm Engineering is known in the automotive industry as a branch of the software company AutoForm Engineering. But how did TriboForm's international success came to be?

The story begins in humble origins with Johan Hol and Jan Harmen Wiebenga, who were both doing their PhD at the University of Twente. Johan Hol was technically focused, whereas Jan Harmen Wiebenga understood commercial acquisitions. The pair were gutsy, in that they started visiting auto-manufacturers as young consultants. It was their specialty in talks given about tribology that caught the attention of their automotive customers. They were on the verge of discovering an open market.

Auto manufacturers work with simulation software in order to predict the behavior of sheet metal during forming processes. This helps prevent waste in stamping production, reduce time and costs. Johan's study of tribology meant that he could specialize on the behavior of friction and lubrication between metal surfaces, which comes into play once stamping tools are pressed onto metal sheets to produce automotive parts like hoods or fenders.

Johan Hol, Technical Product Manager at TriboForm said: 'People started inquiring after Tribology; and we were invited as key note speakers at conferences. This was the real moment TriboForm started as we received so many requests back then from industry leaders like Mercedes-Benz and Volvo. At that time nobody had specialized in virtual tribology at all, we were the first ones on the scene.'

Indeed the automotive industry was still using fixed friction coefficients in their simulation software which did not account for friction changes and lubrication conditions between the stamping tool and sheet metal surfaces. Naturally a lot can change between the two, as metal temperature increases through repeated use. Sheet metal starts to wrinkle and split in production, costing auto manufacturers hundreds of thousands in reject parts. That is, until TriboForm showed them how to account for these changes in their stamping simulations.

TriboForm started to demonstrate exactly what can happen during simulation of the same manufacturing process, improving the prediction of metal behavior in simulations. This was also noticed by AutoForm, the leading software provider of software solutions for sheet metal forming simulation. Jan Harmen Wiebenga, Managing Director at TriboForm: 'We worked closely together with the Dutch AutoForm office in Krimpen a/d Ijssel from the beginning. Initially we served our customers through consultations, as we didn't have a software product yet. But as demand grew, we knew we had to develop a product as auto manufacturers wanted to have the knowledge in-house.'

Fortunately the pair were resourceful, adapting to the market and developed software that would allow auto manufacturers handle tribology directly. Their TriboForm software integrates with all major stamping simulation software used in the automotive industry.

Fast forwards to today, Enschede-based TriboForm has established itself on the automotive market and has brought serious change to industry practices, especially for metal stamping. Acquired by AutoForm Engineering in 2016, they are now selling their product globally to all major automotive companies with an enthusiastic and growing team of 7 people.

See for more information about TriboForm Engineering on ***www.triboform.com***.

BETTER CHEMICAL DETECTION USING NATURE-INSPIRED ARTIFICIAL SENSOR SYSTEMS

Smelling like a night moth

To improve man-made sensors for detecting chemicals, scientists of the University of Tours (France) and the University of Twente have teamed up to study the role of insect antennas. They are especially interested in the amazing smelling performance of the night moth, which can pick up a scent more than a kilometer away.

Antenna aerodynamics are believed to contribute to an effective capture of scent molecules, adding to the moth's keen sense of smell. However, air flows around the original antennas cannot be tested because of their fragility and complex design, involving large size differences. Therefore, the researchers designed and built simplified and bigger scale models for testing.

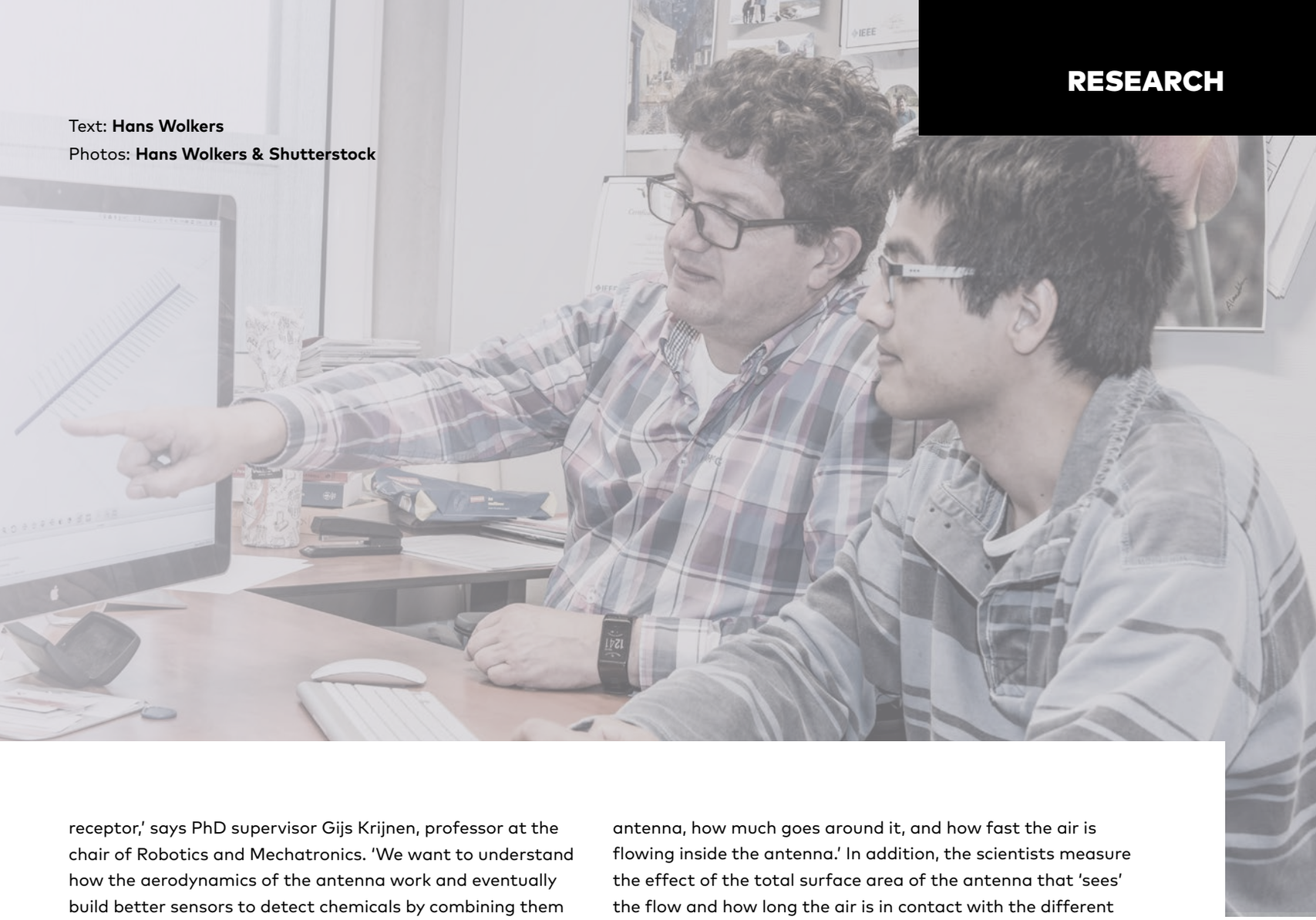
Huge feather-like antenna

PhD scientist Mourad Jaffar-Bandjee carefully positions the head of a night moth into a scanning electron microscope. The machine closes and a buzzing sound indicates that a vacuum is created inside the chamber where the head is placed. After some minutes a spectacular image appears on the computer screen: an almost 3D-looking enlargement of the insect's eye, and a huge, feather-like antenna.

This antenna is the main focus of the scientist's study. Males use these attributes to pick-up the scent from females, sometimes more than a kilometer away. 'This is the main antenna branch,' says Jaffar-Bandjee, while he points at the screen. 'On this main branch you can clearly see the side branches, rami.' When the scientist increases the magnification to 250 times, the image shows that each rami in turn is also covered by large amounts of tiny side branches: hair-like structures called sensillae.

According to Jaffar-Bandjee, even a very sensitive smell sensor cannot explain the incredible sense of smell of night moths. But possibly, the complicated antenna design contributes to the moth's keen pheromone detection. 'We think the antenna is crucial to capture single pheromone molecules and guide them towards the smell

Text: **Hans Wolkers**
Photos: **Hans Wolkers & Shutterstock**



receptor,' says PhD supervisor Gijs Krijnen, professor at the chair of Robotics and Mechatronics. 'We want to understand how the aerodynamics of the antenna work and eventually build better sensors to detect chemicals by combining them with antenna-like structures based on the principles of the moth antennas.'

Capture of molecules

Technically, smell in animals consists of a sensor aimed at detecting a wide variation of compounds in different concentrations. Man-made chemical sensors are based on these principles. They are widely used in biological, medical and industrial applications, aimed at detecting certain molecules, for example for quality control of food, but also for tracking down drugs.

Most of these sensors are built with a strong focus on chemistry: sensing certain scent molecules with high sensitivity and specificity. By using the principles of the antenna design of moths and combining that with the chemical sensor, the sensitivity could be increased by a more efficient capture of molecules, the scientists believe. Therefore, Jaffar-Bandjee studies the air flow in and around the antenna to understand the role of different parts of the antenna structures in the capture of pheromones.

'Suppose the whole flow of air goes around the antenna, the capture of scent molecules will be close to zero; the air has to go through the antenna to some extent to catch the scent,' he explains. 'So, to explain the moth's keen pheromone detection, we want to know how much of the air flow goes through the antenna, how much goes around it, and how fast the air is flowing inside the antenna.' In addition, the scientists measure the effect of the total surface area of the antenna that 'sees' the flow and how long the air is in contact with the different antenna structures.

> *'We want to understand how the aerodynamics of the antenna work'*

Complications

However, this challenging and complex research has some substantial practical obstacles. Studying how air behaves around the antenna is easier said than done. One problem is the enormous size differences between the antenna structures. The main antenna branch is about one centimeter long, the rami on top of that branch about 1.5 millimeter, while the hair-like sensillae are only 0.1 millimeter long. 'There are at least three different orders of magnitude where we want to study the airflow,' Krijnen explains. 'But we are just not able to look at these different scales at the same time, so we can't use real antenna for our studies. In addition, it is not possible to make real-size antennas, so we have decided to build scale

models that are a factor 10 to 300 bigger.'
To understand the influence of the different antenna structures on the air flow, the scientists designed several models of a bigger and simplified antenna using 3D design software. This way, they could manipulate, for example, the number, length and diameter of the branches. Printing the design using a 3D printer and testing it in the laboratory were the following steps.
One of the designs is a ten centimeters long main antenna branch, with rami, but without the tiny sensillae. Krijnen points at his computer screen where he discusses the design with Jaffar-Bandjee. 'These simplified scale models allow us to understand the role of these antenna structures in the overall aerodynamics, especially if we vary size and number of main and side branches together with the distance between the side branches.' In a next experiment the team will design an artificial antenna with no main branch, but with only rami and sensillae in different numbers and sizes, to understand these structures' role in capturing the scent molecules.

'This knowledge could at some time help building better sensor-systems'

High speed camera

But there are more hurdles to take. To measure air velocity around the antenna, it is necessary to use flows with reflecting particles added. A laser illuminates these particles, while a high-speed camera tracks each individual particle. In air, these particles can be hazardous and it requires a quite unpractical experimental setup. It's safer and easier to measure particles in liquids instead. Together with the group of Jérôme Casas, at the Institute of Research on Insect Biology Tours (France), Jaffar-Bandjee studies these fluid flows around the artificial antenna under controlled conditions. 'We place one of our scaled antenna models into an aquarium filled with fluid and create a stream. By adding tiny, hollow glass particles and illuminating them with a laser beam, a high-speed camera system is able to register individual particles,' he explains. 'Then we measure the particle's velocity before and after they reach the antenna model.'
Based on these measurements, the scientists plan to develop mathematical models to track and describe the travel of a single pheromone molecule towards the antenna that eventually reaches the smell receptor. This knowledge could at some time help building better sensor-systems: an antenna based on the moth 'design', that guides the target molecules towards the sensor-sites, combined with the actual chemical sensors. But that's the long-term goal. For now, Jaffar-Bandjee focuses on performing his complicated experiments and modeling his findings. ●

Predicting the aerodynamics of wind farms

Richard Stevens

Text: **Rik Visschedijk**
Photo: **Gijs van Ouwerkerk**

The world is in dire need of more clean energy. Wind energy is one of the options that has the most potential in the eyes of national and international governments. With his research into aerodynamics and turbulence at large wind farms, assistant professor Richard Stevens works at the heart of this field. 'An improvement of just a few percentage points will already have a major effect, in terms of both energy and costs.'

'They are building gigantic wind farms,' Stevens says. 'However, we do not yet know much about the flow dynamics and turbulence that occur there. The goal is to have each turbine catch as much wind as possible. We know how to calculate these factors for smaller wind farms, but larger facilities – the ones with dozens or even hundreds of turbines – create an exceedingly complex interplay.'

Stevens recently returned to the UT as a tenure tracker in the Computational Sciences for Energy Research programme. As the name suggests, he creates computer models to simulate the flow of the wind at large wind farms. 'I developed these models at the prestigious Johns Hopkins University in Baltimore, where I conducted research for 3.5 years.'

What are the biggest challenges? 'An important element is the positioning of the wind turbines,' Stevens explains. 'These days, some models measure 180 metres in diameter. Every wind turbine creates a wake behind it, which means less wind will reach downstream turbines. These wakes all interact with each other as well. Our goal is to understand this interaction.'

There are many other factors to consider, though. 'Take the effect of streams caused by temperature differences in the atmosphere and the influence of changes in wind direction and speed. I want to integrate those elements into my model as well. I use detailed computer simulations for this, which run on a supercomputer located in Amsterdam.'

For Stevens, the social relevance of his research is one of the aspects he enjoys the most. 'The yield of a large wind farm is enormous,' he says. 'Even a small improvement will have a major effect throughout the wind farm's life cycle – in terms of both money and the energy generated by the facility. That relevance and the opportunity to immediately put theory into practice were key reasons for me to return to Twente.' ●

Our 'Rising Star' Richard Stevens:

2011 Cum laude doctoral degree from the Physics of Fluids group, ERCOFTAC da Vinci Award

2012 EUROTHERM Young Scientist Prize, Overijssel PhD Award, National DSM Science & Technology Award

2012-2015 FOM YES! fellowship at Johns Hopkins University

2015 Corrsin-Kovasznay Outstanding Paper Award

2016 CSER Tenure Track Award

2016 VIDI scholarship

2017 Selected as one of the top 25 Scientific Talents 2017 in the Netherlands and Belgium (New Scientist)

E! EUREKA

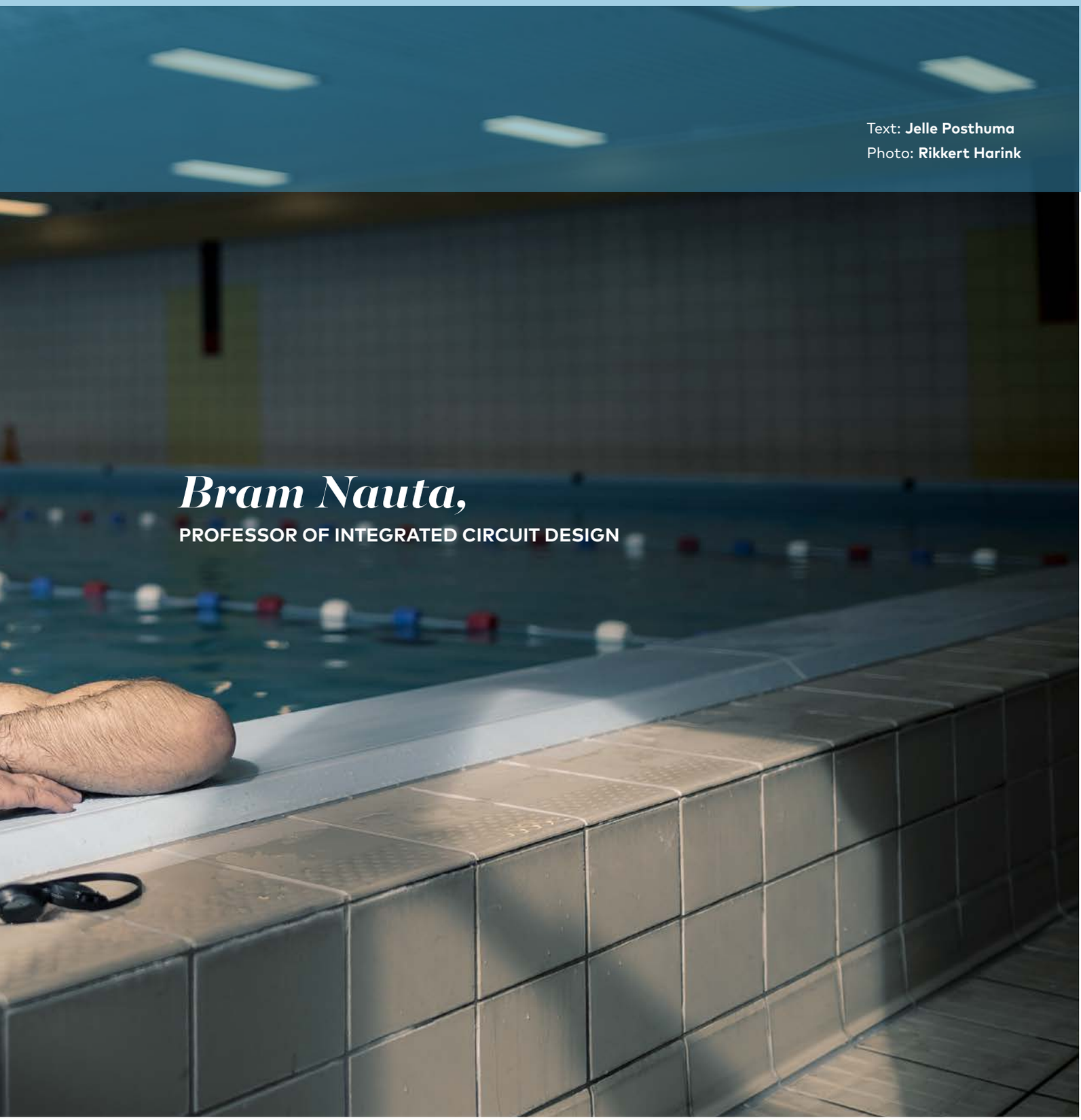
The eureka moment, the moment when you have a brilliant idea or a sudden discovery. We asked UT researchers about their eureka experience.

During my doctoral research, I was looking for a fast filter switch. When I first started my search, I was just playing around a bit. I would do a literature study later; for now, I just wanted to try some things out myself. I simulated a switch on my computer and it turned out that the simulation basically did exactly what I was looking for. It just wasn't very fast yet.

With this switch design on my mind, I went for a swim in the UT's pool. Suddenly, mid-stroke, everything fell into place. What if I could make a switch without nodes? Imagine a city without intersections, through which you can move at high speed.

I immediately climbed out of the pool and asked the lifeguard, Henk Siers, for a pen and a piece of paper. All he could find was a newspaper. Still dripping wet, I drew the switch on some newspaper articles. I knew that this had

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



Bram Nauta,

PROFESSOR OF INTEGRATED CIRCUIT DESIGN

to work. Once I had my finding down on paper, I dove back into the pool.
Once I got back to my room, I simulated the switch. It was a euphoric moment for me: the switch was twenty times faster than state of the art. No matter how awesome my invention was, however, nobody wanted it at first. It was too fast. Eventually, I discovered that a slightly slower version was also much more energy-efficient.

Things happened fast from that moment on. For a long time, nearly all Ericsson and Nokia cell phones had my switch built in. The Bluetooth prototypes were also built using this technology. The other day, a first-year student approached me and said: 'You're famous!' He told me that he was from one of the Baltic states and that the Nauta switch is even featured in high-school physics textbooks there.

Text: **Marc Laan** Photo: **Gijs van Ouwerkerk**

HANS HILGENKAMP ABOUT ELECTRONS JUMPING AROUND IN EGG CARTONS

The hunt for superconductivity

Physicist Hans Hilgenkamp and his team from Twente were awarded an NWO grant worth €425,000 this autumn. His research group will use this money to look for new materials that are to improve the energy efficiency of electronic devices. A hunt in the field of superconductivity.

When asked about his plans for the money, Hilgenkamp first treats his guests to a lecture on superconductivity with a hint of quantum physics. 'In school, you learned about conductive materials, such as copper, and isolating materials, such as plastic. In metal, the electrons are fairly unrestricted and can move freely from one atom to the next. That creates an electrical current. In isolating materials, on the other hand, the electrons are trapped and unable to move.'

'Between isolators and conductors are the semiconductors. These are used in switches, such as transistors, that can be turned on and off. By applying an electrical voltage, the semiconducting material changes from isolating to conductive,' says Hilgenkamp, who views a computer as an ingenious sequence of transistors.

'However,' he adds, 'these semiconducting switches require a lot of power. That is why we will look for new materials that are, for example, superconducting and require less energy to switch from one state to the other. We will use the NWO funds to appoint a doctoral degree candidate and bring two international top researchers to Twente to conduct research into new switchable materials. Our own Interfaces and Correlated Electrons department will also contribute five researchers, so we have quite a team working on this.' Hilgenkamp says that the semiconductor industry is already looking over the researchers' shoulders to see if they achieve their goal.

How can an isolating material suddenly become conductive?

The professor grabs a piece of paper and begins to draw an egg carton. 'To understand that, you should picture an egg carton. Every opening has an electron in it. Generally speaking, electrons can jump from one opening to the next. That creates an electrical current, or conduction. In this example, however, all openings are filled, and electrons do not like being in the same place together. This material is therefore non-conductive or isolating.'

Nevertheless, Hilgenkamp explains, there are ways to get the electrons moving and generate an electrical current. 'You can do this by, for example, adding extra electrons or taking some out. The way to do that is by chemically altering the material or by applying an electrical voltage. In both cases, the electrons will suddenly start moving and the isolating material becomes conductive. In some cases, it even becomes superconductive at extremely high temperatures. The electrons start to make much bigger jumps, as it were. We do not fully understand how this works. With this research, we want to gain a deeper understanding of this phenomenon.'

'We simulate reality with nano-level artificial materials'

'Our ultimate goal would be to discover how to achieve super-conductivity at room temperature'

How do you come up with new conductive materials?
'We use nanotechnology. We simulate the reality of natural materials with nano-level artificial materials. We are basically building an artificial egg carton with openings that measure just 50 nanometres. Mathematically speaking, the physics of our artificial nanomaterials is exactly the same as that of real atoms and electrons.'
Hilgenkamp believes the UT excels at making such nano-structures using lithographical techniques. 'That is what we do here. By experimenting with different configurations of nanostructures, we try to learn more about how the phase transition from isolating to conductive works in natural materials.'

What are these artificial materials?
'We apply a thin layer of gold to a piece of silicon, which is an excellent conductor. On top of that, we put 90,000 tiny grains of niobium, a superconducting element. First, we have to cool this material down to minus 269°C, which is just four degrees above absolute zero. Next, we will examine how changes in the structure of the grains affect the degree of superconductivity of the material. We are looking for new ideas for energy-efficient electronics. Our ultimate goal, of course, would be to one day discover how to achieve superconductivity at room temperature.'

When will I find this technology in my smartphone?
'I do not think that will happen anytime soon. You already see the computational power of computers being moved to the cloud, where you can use more powerful computers for much faster calculations. Your smartphone will increasingly outsource its calculations to such computational centres. Google and Facebook have already built major installations near the Eemshaven and in Sweden and Finland. In such centres, it is easier to work with extremely low temperatures. MRI scanners in hospitals already use liquid helium that has a temperature of minus 269°C.'

Is this fundamental research or will there be practical applications?
First and foremost, our research is fundamental, as the NWO grant stipulates. However, we recognise the practical need for energy-efficient IT technology, such as switches that can turn analogue data into digital information at lightning speed and vice versa. That is important to the telecommunication sector, where networks have to process enormous quantities of data. Turning digital data into optical signals will also become much faster when we start using superfast switches made with new materials. When we discover these materials, they can be used to develop faster switches, but perhaps also for highly sensitive sensors.' ●

Text: **Kitty van Gerven**
Photo: **Gijs van Ouwerkerk**

ANKE LENFERINK OBTAINED HER PHD DEGREE AT TWO UNIVERSITIES

Giving COPD patients room to breathe

COPD patients experience an episode (exacerbation) one to three times per year, on average. During these episodes, their symptoms may worsen to such an extent that hospitalisation is necessary and there is even a risk of death. With the self-management programme that Anke Lenferink developed during her doctoral research at the UT, the duration of an episode is significantly shortened and the chance of hospitalisation is reduced.

Not many people can claim to have obtained their doctoral degree from two universities at the same time. Anke Lenferink is one of them, though. She recently earned her title from the BMS faculty of the University of Twente and Flinders University in the Australian town of Adelaide. Still, if she takes pride in anything, it would be the Longfonds Audience Award, which she received for her research during the Longdagen in April 2017. This award was given out by actual COPD (Chronic Obstructive Pulmonary Disease) patients. 'It is wonderful to receive recognition from your target audience, because these are the people you are doing it all for.'

With 'all,' Lenferink refers to the more than five years of work she devoted to a study of the effects of self-management for COPD patients with comorbid conditions such as heart disease, diabetes, fear, and depression. She started her research in 2012 after completing the Biomedical Sciences programme at the Radboud University in Nijmegen. Lenferink, who now works as a researcher in the Pulmonary Medicine department of the MST hospital in Enschede, received financial support from the Longfonds, among other parties, to conduct her doctoral research. In addition to the UT and the MST, the Canisius-Wilhelmina hospital in Nijmegen also collaborated, as did Flinders University and three hospitals in Adelaide, with which prior relations pertaining to the field of pulmonary medicine had been established.

'More than half of the COPD patients experience comorbidity'

Customised solutions

In total, 201 patients participated in the project; 145 Dutch people and 56 Australians. 102 of them followed a self-management programme with a plan of action, while the remaining 99 received standard healthcare. 'The plans of action were customised to suit each patient,' the researcher explains. That means that their comorbid conditions were taken into account. 'More than half of the COPD patients experience comorbidity; in addition to COPD, they also suffer from conditions such as heart disease, depression, fear, and/or diabetes.' The participants in the self-management group used a special 'symptoms diary' to record whether or not their symptoms, including shortness of breath, coughing with mucus, and wheezing breath, exacerbated. If that was the case, this form referred them to their plan of action, which contained advice on how to start their self-management, depending on the nature of their symptoms. 'They could, for example, take medication at their own initiative. If the diary revealed that it was mostly their fear that increased, there were some relaxation exercises for them to do. It was also possible to contact a case manager (nurse) or other caregiver,' Lenferink explains. Additionally, four meetings were held for the participants, during which they were trained to e.g. recognise symptoms and increase their knowledge of illnesses, a healthy diet, exercise, breathing techniques, etc.

More confidence

After a year, it was clear that the self-management programme was doing great things for the participants. 'The episodes in this group lasted for 5.8 days, on average, compared to 7.9 days in the control group. Furthermore, the self-management group had fewer hospitalisations due to lung problems.' Lenferink believes this is mainly due to the fact that symptoms are recognised sooner and appropriate action can be taken at an earlier stage. Another important effect is the increase in confidence that the patients feel. 'Patients liked knowing what to do when their symptoms exacerbated.' Lenferink achieved a world's first with her doctoral research. The effects of self-management on COPD patients with comorbidity had not been studied before. 'Although there had been studies of self-management for COPD patients, people with comorbid conditions were left out or the plans of action only focused on COPD symptoms.'

The newly-minted doctor believes that it is of the utmost importance to take patients' comorbid conditions into account as well. 'There is a significant overlap of symptoms. COPD can cause shortness of breath, but so can heart disease and fear. If you only use COPD medication to counter shortness of breath, you are administering the wrong treatment if the symptom is caused by the patient's heart disease. That results in higher risks of hospitalisation and death. It is therefore necessary to monitor symptoms in various areas of health and to treat the patient, rather than any specific disease,' Lenferink says. She also emphasises the importance of properly training and supervising patients.

Follow-up research

To make self-management at home more accessible for larger groups of COPD patients in the future, a follow-up study will soon commence. As part of this study, the programmes will be digitised and innovations will be implemented. This four-month pilot, in which twenty patients take part, will start next year. Besides the UT, the ZGT and MST hospitals, the Roessingh rehabilitation centre and Amiko (sensors for inhaled medication) also participate in the project.
The study will bring a widely accessible self-management programme for COPD patients one step closer. That is not all it will do, Lenferink believes. 'It is also feasible that self-management programmes will be developed for other patient groups, such as cancer patients. Just imagine how many people all over the world might benefit from that.' ●

COPD #3 cause of death

Chronic Obstructive Pulmonary Disease (COPD) is a collective term for chronic bronchitis and pulmonary emphysema. This condition, which is usually found in elderly patients, is mainly caused by smoking. In our country, 600,000 people suffer from COPD, which is currently the #6 cause of death in the Netherlands. Globally, it holds the fourth position. The World Health Organisation predicts that COPD will become the #3 cause of death by the year 2020.

Wie wij zijn?

First Consulting is een snelgroeiende no-nonsense consultancy organisatie met een passie voor operationele processen. Wij helpen toonaangevende bedrijven bij het verbeteren van hun operationele performance. Deze verbetering is meetbaar, levert duurzaam resultaat op en wordt bereikt door het aanpassen van processen, technologie en organisatie. Dit resultaat bereiken onze medewerkers samen met de werknemers van onze klanten. Onze opdrachtgevers zijn bedrijven in de infrastructuur, telecombedrijven, banken en verzekeraars, bedrijven in de retail & industrie en energiebedrijven. Wij onderscheiden ons in de markt door diepgaande proces- en systeemkennis constant te combineren met operationele realisatiekracht.

Het maximale uit jezelf halen?

Persoonlijke ontwikkeling en plezier staan bij ons hoog in het vaandel. In onze platte organisatie geven wij je zowel als startende als ervaren consultant snel veel verantwoordelijkheden en daarmee een steile leercurve. Hierin kies jij samen met je mentor je eigen ontwikkelpad: doorgroeien naar een projectmanagersrol, een verbreding als consultant of juist een specialistische rol. Training on the job vinden we belangrijk, maar we bieden ook groepstrainingen op allerlei vlakken. Daarnaast organiseren we zes keer per jaar sportieve en uitdagende events. Wil jij het maximale uit jezelf halen en dagelijks slim resultaat realiseren met een enthousiaste groep collega’s? Neem dan contact met ons op.

Join first!

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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 take a look back at the acid rain phenomenon from the 80s and the efforts to 'clean up' energy gained from burning coal.

Fighting acid rain with microorganisms

Text: **Rik Visschedijk**

Forget about the ozone layer or global warming. The biggest environmental issue of the 80s was acid rain. It is caused by, for example, toxic sulphur dioxides, which were propelled into the atmosphere out of the chimneys of lignite and coal-fired power plants.

During the height of this panic, UT professor of Practical Science Philosophy Mieke Boon joined a European project. A sum of circa three million euros was available for the research. Boon, a philosopher and a chemical technologist, conducted research into the development of technology that would use microorganisms to extract sulphur from coal. 'If we achieved that, coal-fired power plants would become a lot cleaner,' she reflects. 'I felt an immense drive as I got to work, because I, too, realised the enormous danger that acid rain posed to the environment.'

After only a year, however, she pulled the plug out of her project herself. 'Once I looked at the process design as a whole, it did not reveal a positive picture. An industrial process designed to extract sulphur from coal would require at least as much energy as the coal itself would provide.'

That result came unexpectedly: the work was to be done by microorganisms, after all. However, the process required the coal to be pulverised in sulphuric water and this sludge had to be stirred and aerated in massive tanks for two days. 'That takes an enormous amount of energy,' says Boon. 'There were other problems as well. Supplying a single power plant would require a space the size of circa forty football fields to process the coal. On top of that, the sulphuric coal sludge is extremely corrosive. A test setup proved that the tanks would be destroyed in no time at all.'

Boon expected that the unfeasibility of the project would be enough to put a stop to the entire European project as well. 'That shows my own inexperience. The research was already underway, there were interests at stake. A pilot plant was built in Italy. It was soon decommissioned, however, because it was destroyed by corrosion.'

Her research did get a second lease on life, though. 'The application of microorganisms proved to be feasible in the mining industry for the extraction of copper and gold,' Boon explains. 'I obtained my doctoral degree with research in this field.' ●

'I tend to do things that are difficult for me'

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

UT SENIOR LECTURER CALCULATES ODDS TO LIMIT RISKS

Mariëlle Stoelinga: mathematical detective

Mathematics rules everything around us; from the car we get into every morning to the films we stream on Netflix in the evening. This complex world of countless variables is brimming with risks. How can you calculate and, more importantly, deal with these risks? Mariëlle Stoelinga (45) knows that is no simple task. She works in the field of risk management. 'Shit happens, but you can do your best to limit the risks.'

What gives her energy? Computer scientist Stoelinga, a professor at the Radboud University and a senior lecturer at the UT, immediately puts on the modern-day classical music of Michael Nyman. Her finger deftly moves along as she says: 'It is a lot more energetic that Mozart or Bach and more original than pop music. Pop is much less surprising and refreshing to me. It never strays off the beaten path.'

Stoelinga herself loves to travel the roads less taken. She tries to find her own limits and exceed them one step at a time. 'I tend to do things that are difficult for me. Things that are just outside my comfort zone,' she says. 'When I climb a mountain, it is always one that is just a bit too high, too steep, and too long.' The researcher knows that it usually comes down to simply doing something. 'I prefer to meet a task head on. Just do it. No risk, no fun!'

That conviction would appear to be directly opposed to her field of research: risk management. When Stoelinga first started out as a researcher at the UT thirteen years ago, she had no idea that this field would take off like it has. She is currently involved in five major research projects. 'The great thing about this field is that it is so broad. It often concerns the interplay of technical aspects and human factors. These two can certainly clash, but it is also possible to use clever designs to solve human problems. Risk management is the perfect embodiment of "high tech, human touch."'

Fewer problems on the railways

One of the projects that Stoelinga and her colleagues from the Formal Methods and Tools department are working on is about gaining more insight into the causes of problems with the Dutch rail network. 'Train drivers who pass a red signal are a major risk factor. In many cases, they are distracted and fail to notice the red signal. The question is what causes their distraction. Is it the inattentiveness of the driver or are they distracted by the bells and whistles on their dashboard? If the latter is true, a train driver would be unjustly blamed for mistakes that are the result of a poor technical design.'

Another way to reduce problems on the railways is through predictive maintenance, Stoelinga says. 'This is a very interesting optimisation challenge. If your maintenance is poor or if your efforts come too late, you increase the risk of accidents. If you carry out too much maintenance, the costs can rapidly spiral out of control. We are striving towards just-in-time maintenance: reacting to worn and ageing materiel at just the right moment. By placing smart sensors along the tracks and analysing a wealth of big data, you can gain clear insight into where and when to act. This allows us to reduce the number of operational malfunctions that occur.'

Mathematical detective work

The associate professor says that risk management is about improving safety and security. That requires mathematical

detective work: calculating odds, finding risks, putting these in perspective, determining the connections between factors, analysing all this information, and then taking appropriate measures. 'Almost without exception, there is a huge number of factors in play. What are the major causes? Which are the most common? Risk management is about properly handling uncertainties.'

'People fear things that they do not have to be afraid of'

The researcher takes things one step further. Once you have identified risks and implemented measures, said measures can lead to new risks. 'We then have to re-evaluate the measure itself,' Stoelinga says. 'Compare it to emergency exits in a building. These are definitely useful when the building is on fire, but they are also a way for burglars to get in.' In short, Stoelinga is caught in a complex web of causality. Cause and effect and cause. 'Shit happens, there is no way around that. You can do your best to limit the risks, though.'

Preventing incidents

If your research is all about finding risks, does that bleed into your everyday life as well? 'Absolutely,' Stoelinga agrees. 'When I read about incidents in the paper or see a news report, I often catch myself thinking that with proper risk management, the incident could have easily been prevented. One example is what happened in Mali: two Dutch soldiers were killed during a training exercise with unsafe mortars. This ultimately led to the resignation of Defence Minister Jeanine Hennis-Plasschaert. If you do not follow the safety procedures, you are asking for accidents. An incident such as this has a major impact on society, even though it could have been prevented entirely. Everything starts with a proper safety culture. That also goes for hurricanes like Irma and Harvey. We know that hurricanes are more common now because of climate change, so it is crucial to ensure your communication systems are in order in the event of a disaster.'
Stoelinga sees a world in which we are constantly faced with incidents. As a result, people feel afraid. 'Fear is overrated,' she says. 'People fear things that they do not have to be

Mariëlle Stoelinga in a nutshell:

2017:	appointed as full professor Quantitative Risk Assessment of Software Systems at the Radboud University Nijmegen (part-time)
2011:	Associate Professor in IT Risk Management
2004:	Assistant Professor in Computer Science
2001-2004:	Postdoctoral researcher at the University of California
1997-2001:	PhD in Computer Science at the Radboud University Nijmegen
1997:	MSc in Mathematics and Computer Science at the Radboud University Nijmegen

afraid of. Risks are exceptions. Sure, if you are being chased by a lion, it is a good idea to run – but you have your survival instinct to take care of that. However, we should try to maintain some perspective and not jump at every shadow. If you want to avoid all risks, you would never get anything done at all.'

Revelation

That attitude characterises the researcher. She is concise in her speech, quick-witted, and sometimes even a bit impatient. Stoelinga focuses on the heart of the matter and knows what she wants. Perhaps she has always been like this: always wanting to move forward and understand the world better. 'Whenever I failed to understand something, lacked the insight or the big picture, I would do whatever it took to gain that insight. I still remember a revelation I felt as a small girl: when you are on an upper storey, you are standing on the ceiling of the floor below you.'

Now, decades later, she has three children of her own: two boys and a girl. Being a parent has made her more confident, she says. 'When I started my work at the UT in 2004, there were no other female senior lecturers in this faculty. Add the two female part-time professors and the only conclusion is that it was an extreme example of the 'old boys network.' That situation has improved, but I think it is still an issue to this day,' says the former board member of the Female Faculty Network Twente. 'Back then, I was motivated to show that there was another way. Having my children also helped me develop my leadership skills, I believe. It is about seeing and then taking responsibility.'

No room for distraction

Stoelinga definitely assumes responsibility in her work, because science is serious business to her. There is no room for distraction. She is rigidly organised and structured and maintains a clear focus, all in an effort to perform. 'I do not schedule any appointments before eleven in the morning. That distracts me. I also work out a lot, because that is the only way for me to maintain my position at the scientific top. Exercising gives me far more time and energy than it costs. It stimulates the circulation in my brain and I sleep better because of it. That is not to say that I never do anything to relax. I love going to concerts – with or without my kids – and I enjoy going for walks and visiting the sauna. It is important that we scientists also take the time to enjoy all our wonderful achievements.'

When it comes to her research, the senior lecturer has no time to stand still. Her field is becoming ever more complex – and therefore more interesting. More complex systems, more data, and new technological developments create more uncertainty and therefore more risks. Stoelinga certainly has her work cut out for her, but she would not want it any other way. Her motto is 'go with the flow.' Stoelinga now devotes all her focus to the world of risk management. She moves forward with purpose, while keeping every possible risk clearly in the back of her mind. ●

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Captured on Camera

Text & photo:
Gijs van Ouwerkerk

BatMag

The water-filled cube in this laboratory setup contains tiny star-shaped microrobots that will revolutionize minimal invasive surgery. These microrobots can be moved by electromagnets and have the ability to grab and cut tissue within a patient's body. BatMag has been developed by PhD candidate Federico Ongaro, as part of research conducted by the Surgical Robotics Lab (Department of Biomechanical Engineering - Prof. Sarthak Misra) and Johns Hopkins University (USA). In the future, larger versions of BatMag will be developed to perform a range of minimally invasive surgeries, such as biopsies and targeted drug deliveries.

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