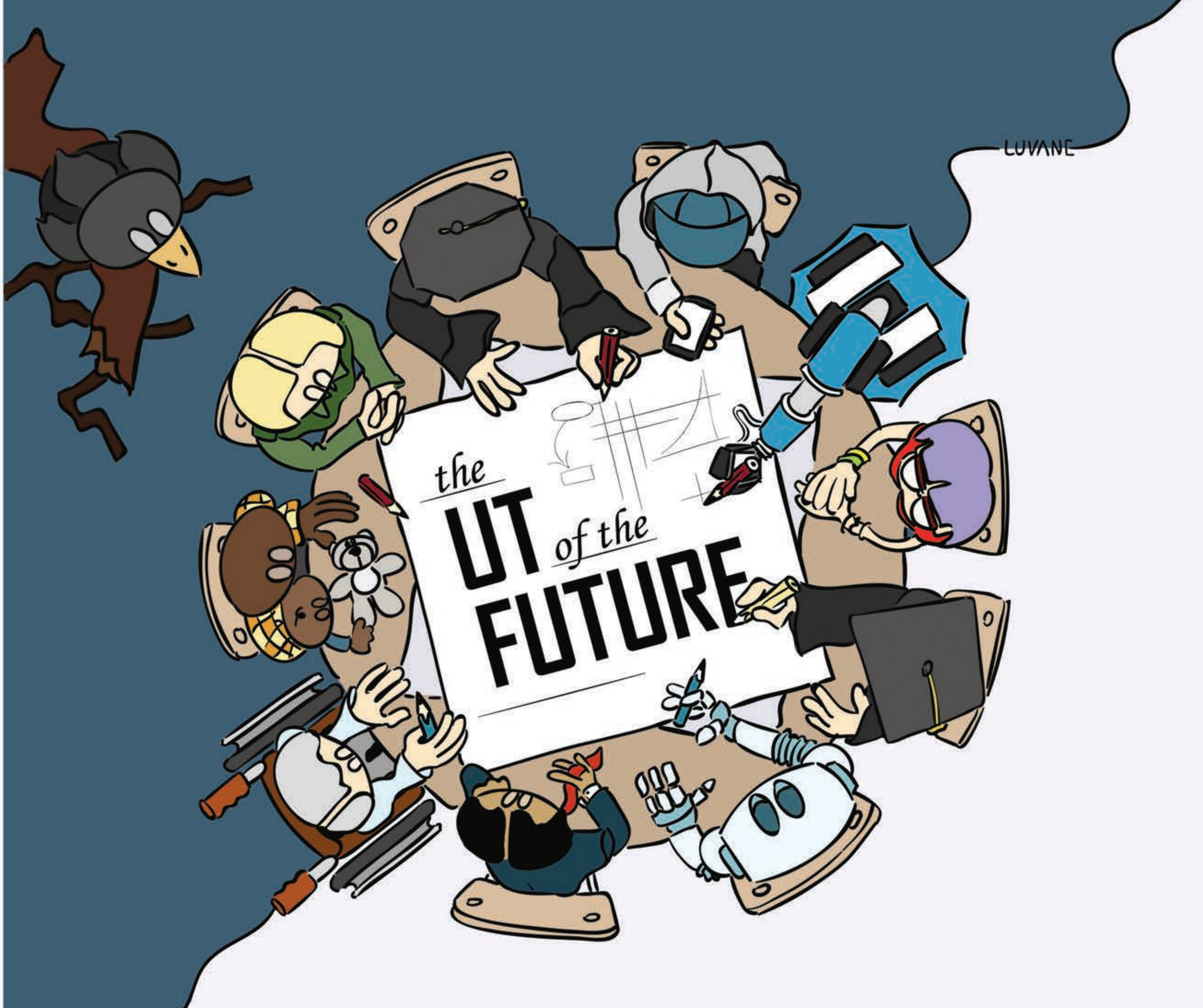
issue #9

UNIVERSITY OF TWENTE.

U-TODAY

Science & Technology Magazine



Farewell

To cut right to the chase, this is the last Science & Technology Magazine. A magazine in which I, my newsroom, our photographers and freelance writers invested a lot of love and creativity for the last three years. A magazine that's also well-read, as shown by our reader survey last spring. But our ambitions reach further. They take shape in the new magazine, called 'Campus'.

We love to try out new things. Every day, we work on original and involved journalism, both digital and in print. And we look for ways to reach our audience even better. The magazine that is in front of you appears on campus and is being read by students and employees. Yet, we feel that alumni and affiliates of the UT are also interested in research stories, interviews and reports.

The Marketing & Communications department feels the same way. They see the value of our stories and want to share them with their partners. That's why we decided to join forces and create a new magazine. It's an exciting collaboration. We spoke at length about the content of the new magazine and the roles and responsibilities of both parties.

As it should be. Because journalism and communication regularly cooperate, but sometimes have different interests at stake. We've made proper agreements about the way of working and see one common goal: to make the best possible stories for the entire UT community of students, employees, alumni and affiliates.

What about journalistic independence, you might think? That's solid as a rock and safeguarded in our Editorial Statute. We provide you with critical journalism online, every day of the week. Campus is a different kind of medium. This is where our human-interest stories, background articles and reports find a place. These are comprehensive stories that come into their own on paper. With a joint editorial team, we have everything we need to collect, tell and spread these stories.

So it's not a true farewell. I hope you enjoy reading this final issue of the Science & Technology Magazine and I wish you a good end of 2019. On to 2020, with fresh ideas and new collaborations!

Maaike Platvoet

Editor-in-chief at U-Today

u today

Colophon

This University of Twente Science & Technology Magazine is made by U-Today, an independent journalistic medium at the University of Twente (UT). This magazine with a unique focus on UT's research and scientists is currently published three times a year.

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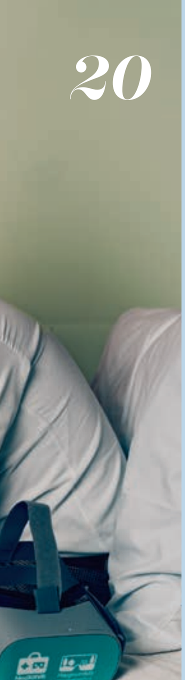

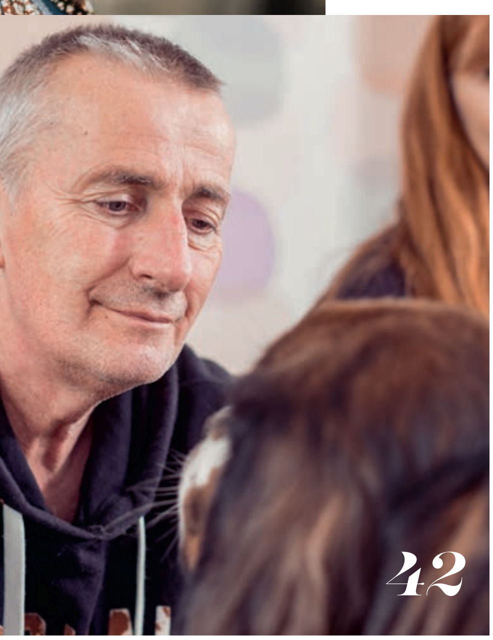

U-TODAY

Science & Technology Magazine

Content

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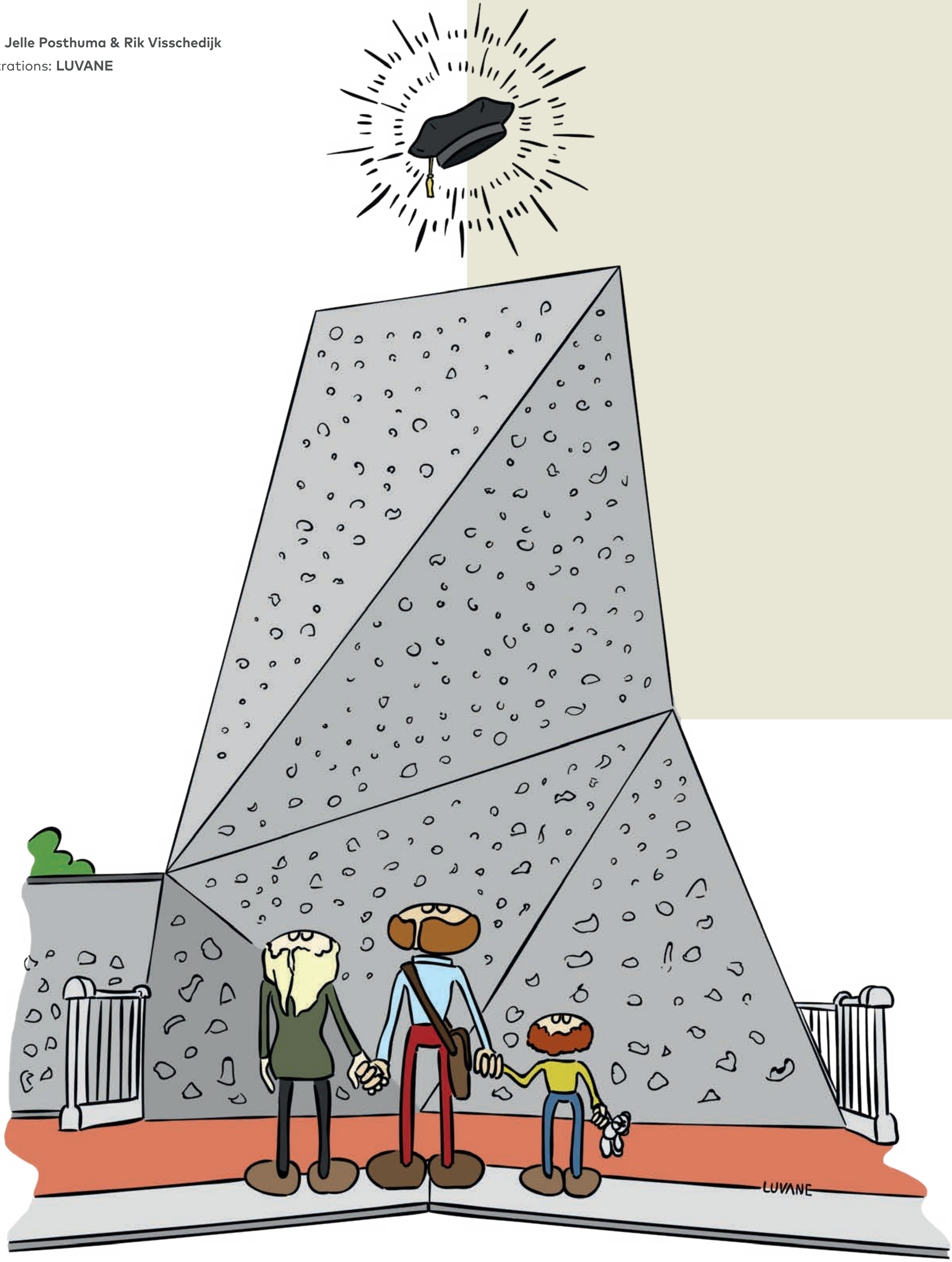


'LET'S TRY TO STAND OUT BY BEING UNIQUE'

The future of the university

Armed with its new vision, the UT is ready to face the future on the road to 2030. The University's creed for the years to come – in terms of both education and research – is 'People first'. Its ambitions are lofty and the bar has been raised high. U-Today asked four prominent scientists what the UT needs in order to excel in the coming years. Professors Albert van den Berg, Peter Paul Verbeek, Suzanne Hulscher and Wiendelt Steenbergen talk about great opportunities for the future.

In the years to come, the UT should focus more on its social responsibilities. 'A large degree of social responsibility and involvement is crucial,' says university professor and technical philosopher Peter-Paul Verbeek. 'If anything, because we are a public institution.' He believes the challenge lies in getting the public involved in scientific research. 'All scientists want their research to benefit society, whether it be fundamental or applied research. However, we are currently in the age of populism. People's faith in the elite is fading away. When the professor clears their throat, not everyone will automatically sit up and pay attention, like in the olden days. As scientists, we must therefore descend from our ivory tower.'

Verbeek: 'Of course, science is more than an opinion and every scientist has their own unique expertise. Nevertheless, a second opinion and a different perspective are part of the scientific debate. It is a constant quest for truth. In this day and age, scientists have more accountability towards society. Take farmers, for example. They say: "RIVM, your nitrogen measurements are incorrect." Farmers and researchers can have a conversation about that. I do not particularly like the way they choose to say it and I think there is a better way to go about it, but we can at least communicate with each other. Doing so will emancipate citizens without disregarding the scientist's expertise.'

Citizen science

According to the professor, citizen science might be the answer for the future. 'This scientific method goes much further than having people count birds in the dunes in the name of science. With that kind of research, the researcher is clearly in charge. With citizen science, on the other hand, the stakes are even. Citizens think about a scientific issue at a substantive level. This form of science takes the citizen's perspective seriously. It is befitting for the 21st century.'

For Wiendelt Steenbergen, professor of Biomedical Photonic Imaging, social responsibility is also about the manner in which research is organised. 'The world of science funding is averse to risks. We appoint doctoral candidates for four years and offer them an attainable track. However, often there is no real room for truly daring research, because most funders crave a degree of certainty. I say as a university we should allocate a sum of money to allow talents to experiment for a year to see if their idea is viable. If it is, you can then write a well-substantiated research proposal. It benefits the researcher but also our society as a whole, because it gives yet unexplored forms of research a chance as well.'

People first

Peter-Paul Verbeek sees the appeal of the new path towards becoming a people-first technical university. 'The UT excels at the technical and natural sciences, but we are also great at the social sciences. That is reflected in our research and education. At the UT, we are good at bringing different strands together. However, this bridging of technology and society has become somewhat overlooked in recent years,' Verbeek says. 'In the past, we presented ourselves as a dual-core university: one core was about technology and the other about the social sciences. The bridge between the two was never explicit. We are going to do things differently now. With our new vision document Shaping 2030, the link between technology and society has once again become a key concern. We are entering a new phase and adopting a recognisable profile that suits us, which we can project with much self-confidence.'

Some scientists need a little time to get used to the reinvented profile. Professor of Water Engineering and Management Suzanne Hulscher felt at home with high tech, human touch. 'We presented ourselves as a technical university that cares about social applications and the social sciences. That kind of profile best reflects what we are. Although our university does not offer every social science, the technical sciences are almost all present and accounted for.'

'Real top scientists put their teams first'

- Peter-Paul Verbeek

According to Albert van den Berg, university professor and scientific director of MESA+, the UT's profile is mainly anchored in its mentality. 'The UT has always been known as an entrepreneurial university; not just in an economic sense, but in terms of our attitude as well. Our motto can be neatly summarised in two words: be bold. We simply do things, undertake activities. Less talk, more action. I also believe we should be a little bit "proud to be stout" [proud to be naughty]. We are a university, not a bank.'

Steenbergen agrees entirely. 'Almost every university is involved somehow in the field of e.g. healthcare technology. That is a tough area to stand out in,' he says. 'A small university like the UT can afford to be a bit bold. Let's try to stand out by being unique and involving society in our largely practical research.'

Quality education

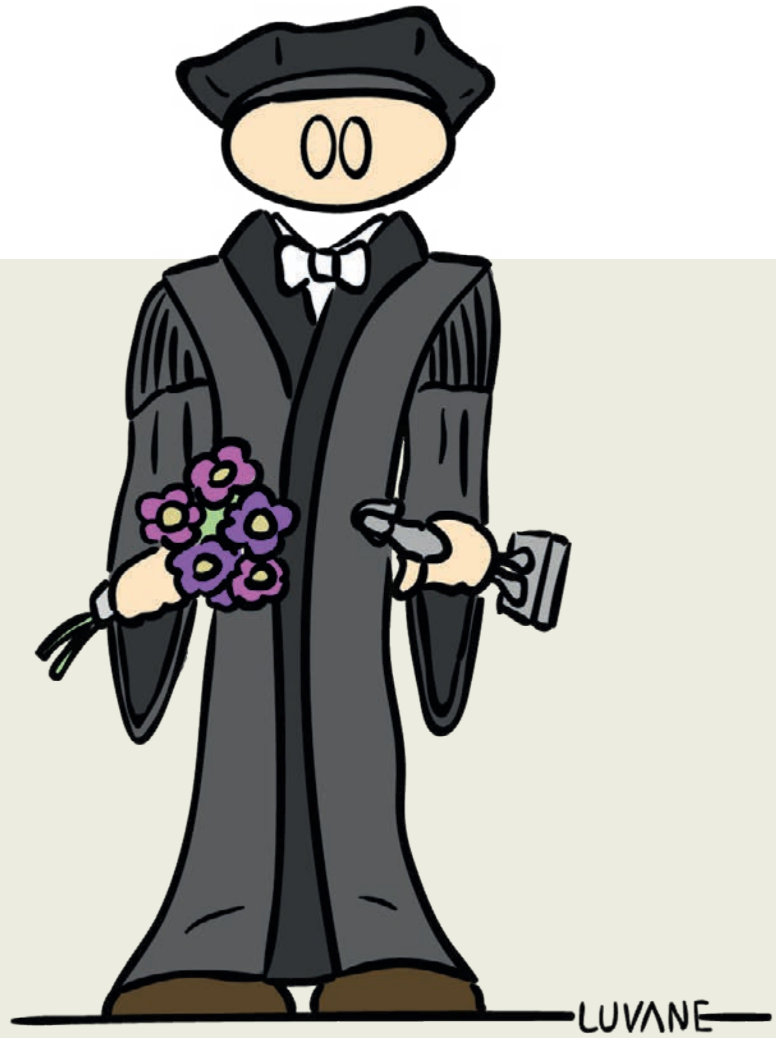
The professors believe the quality of its education is a major factor in the university's profile. Hulscher: 'A good education is crucial. Young, talented people are essential to a university. That sets us apart from research institutes. Those lack the constant influx of new students, which creates different dynamics. The interaction between students is very important for my own research as well.'

Hulscher says quality education should be rewarded. 'People should be able to excel in different areas, both in terms of research

‘Young, talented people are essential to a university’

\- Suzanne Hulscher

and education. Excellence in research is fairly easy to measure, but that is not the case for excellence in education. On the other hand, good educators also tend to be good researchers.' Verbeek believes the UT offers a unique form of education. 'At the UT, we offer research, design and organisation. Any university conducts research, design is the domain of technical universities, but the organisation aspect – the embedding in society – is unique to the UT. We train engineers who possess a degree of sensitivity for our society.'



Rankings

Our unique form of education – the TOM model – has been paying off, as shown by the excellent scores in the Higher Education Guide these past few years. Although the UT consistently scores well on such lists, the international and more general rankings tell a different story. For example, the UT lost its place on the global top 200 list of the British Times Higher Education magazine. According to Albert van den Berg, dropping in the rankings is not that big of a deal. He believes a top position on such lists is ultimately untenable. 'We should get used to taking a hit now and then and be realistic about it. We are a small university in a world where countries like China are on the rise. A place in the top 400 is still very good. We continue to excel in niche fields. Detlef Lohse's Physics of Fluids group, for example, is in the global top five of its field. The same goes for our organ-on-a-chip research. We should focus on and invest in those peaks in the landscape.'

Hulscher agrees with the statement that we should not rely too much on the rankings. 'I actually find that need to perform quite funny,' she says. 'At the same time, foreign students – who can only invest their money once – do rely on these lists to some extent. They want to make sure they choose a good university. That certainly affects us, especially at the student level. At the higher levels, e.g. for doctoral candidates, a department's reputation is far more important.'

Steenbergen has also noticed that divide. 'I believe everyone is sceptical about rankings and how they are drawn up. Still, we hate to see ourselves lose points. What is more important are the prizes that researchers and departments win: thanks to those, talents receive acknowledgement and research money. For a small university, it is very difficult to compete on the rankings. Prizes are more interesting, because they directly benefit established scientists as well as talented researchers.'

Despite the lower position for the University as a whole, Verbeek points out the excellent results achieved by the social sciences. 'The UT's social sciences department is climbing the Times Ranking: from position 86 last year to position 75 in this year. That tells you something about the success of the new style. Our peers from all over the world see it as an important new development, which I find particularly

> *'We are a university, not a bank'*
>
> \- Albert van den Berg

encouraging. With this new strategy, which involves bringing technology and society together, we have rediscovered our strength. At the same time, we should not care too much about the rankings. How do you define the best? On top of that, money is a major factor with these lists. Universities with a lot of funds have a higher position. I'm glad the UT is a public university where anyone can work and study.'

Standing out

One of the most important ways in which the UT's campus can stand out from other universities is by offering people a great place to work. 'If we can offer young scientists a safe place in which they can develop, that makes us an appealing employer,' Steenbergen argues. 'The UT likes to see itself as a flat and informal organisation. The reality is different, however. Employees have a high workload and are under pressure to perform. There is room for improvement there in terms of how the university is organised. Make it easier to advance, be less rigid in terms of the hierarchical steps that lead to professorship and give promotion rights to university lecturers, for example. I would also like the tenure track to be less rigid. Not making it is seen as failure. We should be more flexible about that. Just because someone is not a good match for the tenure track does not mean there is no role for them at the university. It is about tailor-made solutions.'

As a small university, the UT could be a testing ground for a new form of scientific organisation, Steenbergen believes. 'If we're honest, we have to admit that not all professors are equally good at everything. One might excel at generating creative and original ideas, another in doing in-depth research, and yet another is a better

> *‘Women choose positions where they think they can thrive’*
>
> - Suzanne Hulscher

educator. A fourth thrives when managing a group, while the fifth is best at valorisation. Why not acknowledge that? At the moment, everyone has to jump through the same hoops to become a professor. Instead, we should consider each individual’s unique set of talents and the optimal composition of a team.’

Steenbergen’s plea to focus much more on the optimal composition of a team is supported by his colleague Hulscher. ‘I have always thought that you can only truly excel when you are part of a team. I am glad to see there is an increased focus on that. The UT should consider the performance of the team as a whole, instead of looking only at excellent individuals. After all, is a scientist with a long list of publications on his name truly a model of scientific excellence?’ Hulscher asks rhetorically. ‘I was on a jury once that got to award a major prize. One nominee had published a lot and did everything on his own, while another had supervised major projects in various teams and worked a lot on outreach, e.g. on television. According to the criteria, which were entirely based on the classical image of what an excellent top scientist should be, we had to give the prize to the former. I did not agree with that. To be honest, I thought the second scientist was the model of a good researcher. I much prefer someone who knows how to inspire a team.’

Verbeek strongly agrees with this statement. ‘Real top scientists put their teams first. That is how it should be. Luckily, there is a social development going on as well, which is less focused on unique experts. From next year, for example, the Spinoza Prize can be awarded to teams as well, which is an excellent development.’ Van den Berg acknowledges the importance of working in teams, but also stresses the importance of individual prizes. ‘We have to praise talented young individuals, because winning prizes strongly motivates the researcher and stimulates the development of their group.’

Attracting talent

Another issue is attracting talent: how do you get people to choose a career in Twente? Van den Berg: ‘Part of it is simply about money: we need the financial means to retain good people. I believe we are sometimes too slow: an appointment has to go through a lengthy process before a decision can finally be made. I sometimes have that discussion with our Executive Board. Put the right of initiative in the organisation, so we can make a proper offer to outside talents.’

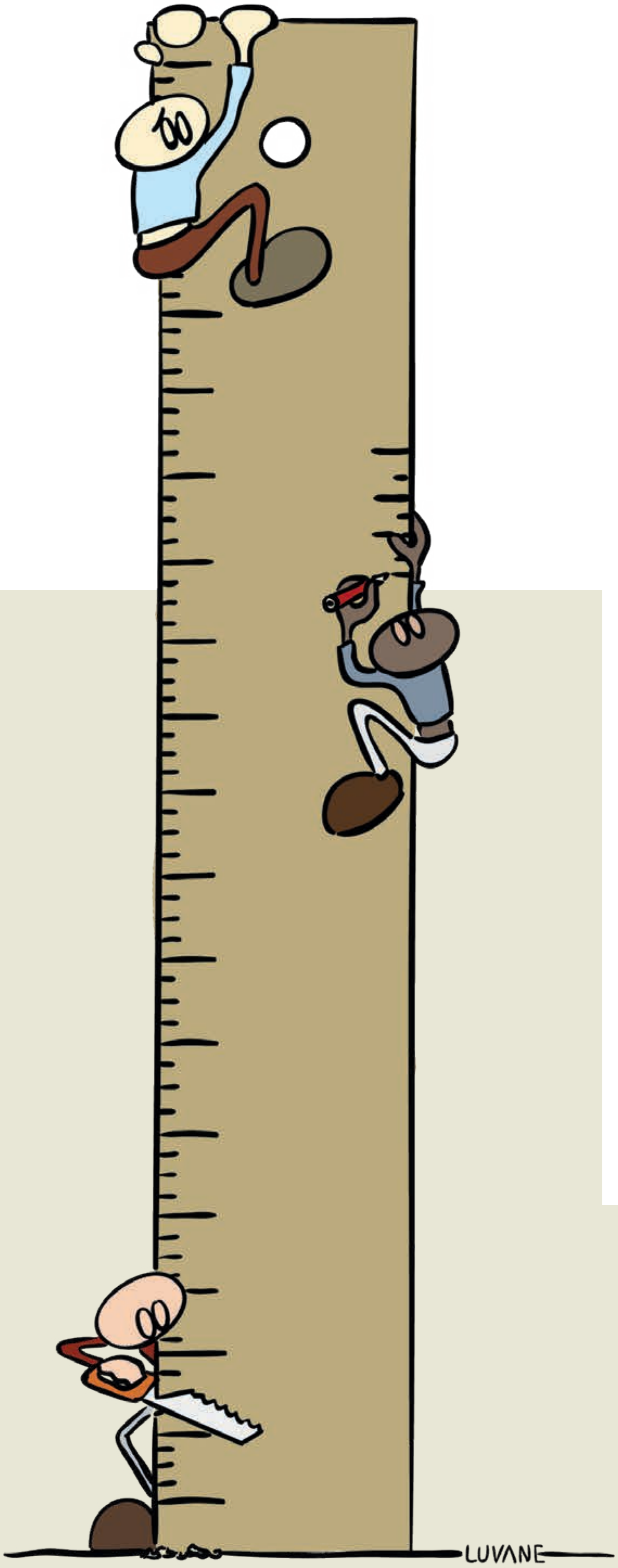
Steenbergen believes the UT can present itself as an appealing employer by utilising the human dimension. ‘We can make a professorship easier to attain. At the moment, a candidate has to complete a few postdoc positions after obtaining their doctoral degree – one of which is preferably conducted abroad – before they are eligible for a faculty position. You can see talented individuals drop out because they want more security and are eager to settle down. You also lose people to other universities during this process.’

Getting talent to come to Enschede continues to be a challenge, Hulscher believes. Especially if they are not originally from the region. ‘The problem is a geographical one: Twente is too far away, or so people believe. We should avoid a situation where we reel someone in with a great offer and pamper them for five years, only to see them leave for where the grass is greener.’

The human dimension can be a solution here as well, Hulscher thinks. ‘Let’s invest in dual careers. If we offer the prospective candidate’s partner a career perspective as well, we can retain people in the region for a long period of time. I know plenty of examples of employees who ultimately left, no matter how much they wanted to stay. We spent years investing in those people. This issue has become more prevalent in recent years and that trend will continue in the future.’

Diversity

In its efforts to attract new talent, the UT should focus even more on diversity in the future, Hulscher states. This topic is close to her heart, since she was the chair of the UT’s Ambassadors Network for over a decade. The network advises the Executive Board on matters pertaining to the



UT's diversity policy. 'As long as it still matters whether your name is Joost de Vries or something exotic and foreign, diversity will continue to be an important theme. There is also still a difference between men and women who apply for jobs. That is a terrible shame, because what we are looking for in the end are the best people and the best teams.'

Diversity is a complex issue, Hulscher knows. 'The problem lies with the women themselves, the university and the image involved. Women often dread the enormous competition they see before them. To be a successful scientist, you have to perform. You have to acquire grants, publish articles – all of which involves an element of competition. A scientist has to have a competitive mindset. To women, it must be abundantly clear that they can win too. They have far fewer role models than men. When you see other people being successful, you will start to believe in it yourself. It is so important to know what it means to have a scientific career. I had never considered one myself, until someone asked me if I was interested in obtaining a doctoral degree. Women choose positions where they think they can thrive. The UT should attract someone who makes sure we handle this issue carefully at every level.'

According to Hulscher, there is another group that the UT should pay more attention to: people with a migrant background. 'That group is truly under-represented in the scientific community. We act like our efforts with regard to internationalisation are sufficient by bringing in people from far-off countries, but that is not true. I think the UT can play a leading role in this area.'

The contributions from these four scientists, each of whom has shared their own vision of the future in this cover story, show that there is still a whole lot of work to do at the UT in the years to come. It is time to roll up our collective sleeves. If readers take away anything from these stories, let it be this: we must do it together. 'People first' does not sound so crazy after all. ●

'Citizen science is befitting for the 21st century'

- Peter-Paul Verbeek

POP CULTURE

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

This time we go see the movie 'Joker' (2019) together with Mirjam Radstaak, Assistant Professor at the department of Psychology, Health and Technology, whose research focuses on mental health. We have popcorn. We have a bottle of soda. We both have a notepad and a pen. We are prepared for the screening. What does a psychologist think as she watches a story of a mentally-troubled man turning into a supervillain in Gotham City?

The beginning

We meet Arthur Fleck (played by Joaquin Phoenix). Recently released from a mental hospital, he is working as a clown and struggling to provide for himself and his sick mother who is essentially the only person in his life. Arthur gets repeatedly beaten and humiliated on the streets. His condition that forces him to laugh uncontrollably at random moments certainly doesn't make his life easier. He attends therapy but the funding gets cut and Arthur is left without access to medication. After losing his job and after yet another beating on subway, he – dressed as a clown - shoots his attackers.

First impression

Ten minute break in the cinema gives us time to discuss first impressions. Radstaak, scrolling through a PDF on her phone, says: 'I'm looking at various personality disorders, but I'm not sure if he has any yet. However, the laughing condition is a real thing. It is called involuntary emotional expression disorder. It is associated with several different neurological disorders related to the prefrontal cortex. What strikes me the most is Arthur's lack of elemental social skills. He writes down notes of having to make eye contact and why certain jokes are funny. He is not really capable of understanding others, but the thing is: he is trying. He is really doing his best.'

The end

The movie continues. The media interpret Arthur's murders as an act of 'revenge against the rich of the city' and the (to the public unknown) 'clown killer' becomes idolized by the masses. And thus begins Arthur's transformation into Joker, a change that is accelerated by the discovery that he was adopted and that his mother mistreated him as a child. A few murders further, Arthur begins to accept his dark alter ego and once he kills a TV presenter during a live show, there is no going back. Joker is born.

Realism / feasibility

Radstaak: 'Now I can think of a whole bunch of diagnoses. He was abused so he could be suffering from a trauma. He has depressive symptoms. What fits very well, however, is an antisocial personality disorder. He shows no remorse for the killings. He lacks conformity. He demonstrates recklessness to safety of himself and others. All descriptions of antisocial personality.'

'However, you could argue that his actions were a result of his surroundings. He was probably adopted. Adoption is a break in the relationship with your mother. It can influence your attachment style, you might get difficulties bonding with people. He was abused as a child. His medication is taken away. Those are all risk factors for pathologies and his environment is certainly not supportive. It pushes him to the murders. He loses his social support. He loses his mom and his dream dad, all parental figures.'

'In this context, I'd say the transformation into a villain makes sense. It could be realistic. Because there is not one particular moment, it is a gradual process. He is vulnerable, he gets humiliated, he loses everyone. And then he seems to accept who he is. At the start of the film he sees himself as a person with inappropriate laughter, but as he develops he accepts himself as normal. He doesn't try to fit in anymore.'

Stray observations

'At the end, I personally felt he was crazy. I feel a bit sorry for him. He is a victim of circumstance. Things might have been different for him if he was adopted by someone else, if he found a different therapist, if he had a healthy social environment. But he is also a villain! He is both. Because almost all people with mental illness don't go around killing people.'
'The society's reaction to his actions was also interesting.

Text: **Michaela Nesvarova**

Still from the film Joker.

The admiration showed it was a disturbed world. This murderer is seen as a hero, as a symbol. That is a clear sign that something is wrong in the society. And as Arthur goes more and more insane, the city follows.'

'Did I like the movie? Is it a movie to like? It gets under your skin for sure, so that could be considered good... but did I like it? I don't know.'

The second Matthew effect

The prizes have once again been awarded: six consortia of top scientists have received hefty sums of money from the Dutch Research Council's Gravitation programme: 18-20 million euros for ground-breaking research, while fifteen consortia were left empty-handed.

Were the winners really that much better than the losers? Barring a trip into a parallel universe, there is no way to find out. Perhaps the winners did better with regard to one objective criterion: their wealth. In the Gravitation programme, the Matthew effect is in full swing. The Matthew effect is the sociological term for the phenomenon that money tends to come to those who already have a lot of it: '...whoever has will be given more...' Jesus says in Matthew 25:29. In the Gravitation programme, the Matthew effect has almost been made into a principle. For the assessment of the quality of applicants, their previously acquired subsidies were taken into account. The Gravitation programme is like a volcanic eruption, where the Matthew effect pushes money towards top Dutch scientists.

The wealthy sometimes have no idea what to do with their money. Perhaps the same goes for the Gravitation consortia. In some cases, the money ends up in hands outside the consortium itself. To give a name to this phenomenon, we must open the Bible to Matthew 15:27, where a heathen woman asks Jesus for help, reasoning that 'even the dogs eat the crumbs that fall from their master's table.' This is the second Matthew effect: those outside that elite club of top scientists can feed on the crumbs of their wealth.

It would be good if this occurs more often and more money flows down from the top towards less fortunate researchers. Surely that is not too much to ask during the ten years that a Gravitation project takes, or has every last euro been allocated already? I should hope that the applicants were not asked to specify what PhD candidate 11 plans to do in the 37th quarter. In fact, I believe it will become clear over time that other partners are needed in order to achieve the final goal. During the next Gravitation round, the Dutch Research Council should require the lucky winners to look around them and let others share in their wealth. The second Matthew effect should be made into a principle as well. Instead of measly crumbs, let it be lavish portions. Noblesse oblige.

Wiendelt Steenbergen

Professor of Biomedical Photonic Imaging

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Everyday Science

Intimate technology

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

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

Whether you're Skyping with a friend at the other end of the world, texting a classmate during a boring lecture or scrolling through holiday pictures of your crush, all these activities fall into the spectrum of intimate technology. The same goes for – not unsurprisingly – sex robots and teledildonics, says Philosophy researcher Nicola Liberati. 'I always like to draw a comparison between Skype and teledildonics. Skype allows us to communicate face-to-face with other people over a distance, while teledildos allow us to have a tactile connection with someone over a distance, sometimes even at the other end of the room. It's basically a different way of touching another person and thus being close to them. The question here is not whether the one form of communication is more intimate, better or even weirder than the other, but how they alter and shape the value you give to that situation.'

According to Liberati, people usually see intimacy with digital technology as something bad. 'There are people who say that communication through texting is not something intimate. I think there is always a level of intimacy to it and it always reshapes our values. Whether you're trying your best to arrange a date with someone, just sharing something funny, or break up with someone by ghosting. In the end, it's all a form of communication. And in essence, communication is nothing more than a game of sharing and not sharing. That is a game we've been playing for ages. There are still human conversations that can be completely meaningless, even without mobile phones, while an emoji can be perceived as something entirely meaningful. Technology does play a role in shaping how you relate to yourself and others.'

To further explain his point, Liberati mentions the concept of online friends. 'The moment you have a friend on Facebook or Instagram, what happens to your concept of 'a friend'? You can have a lot of friends on social media, but how does this affect your definition of a friend? Does it strengthen your ties with the people you see often or are these relationships being diluted offline?' On the other end of the intimate technology spectrum, emerging technologies like sex robots, in which the technology itself also develops, also alter the meaning we give to relationships. 'There are robots nowadays that can say no to having sex, which goes directly against the classical idea of digital technology of helping us get what we want. While a sex robot is still an inanimate object, a robot saying no does affect the concept of a relationship and it reshuffles our values.'

Even though something seems weird like a Japanese man recently marrying a hologram like, or rude like playing a video game when the person next to you wants to talk, to Liberati intimate technology is never a game of right or wrong. 'It all boils down to the value you put into 100 percent of your time and attention. The value you put into meaningful interaction, so to speak. Which is constantly shifting, every day.'

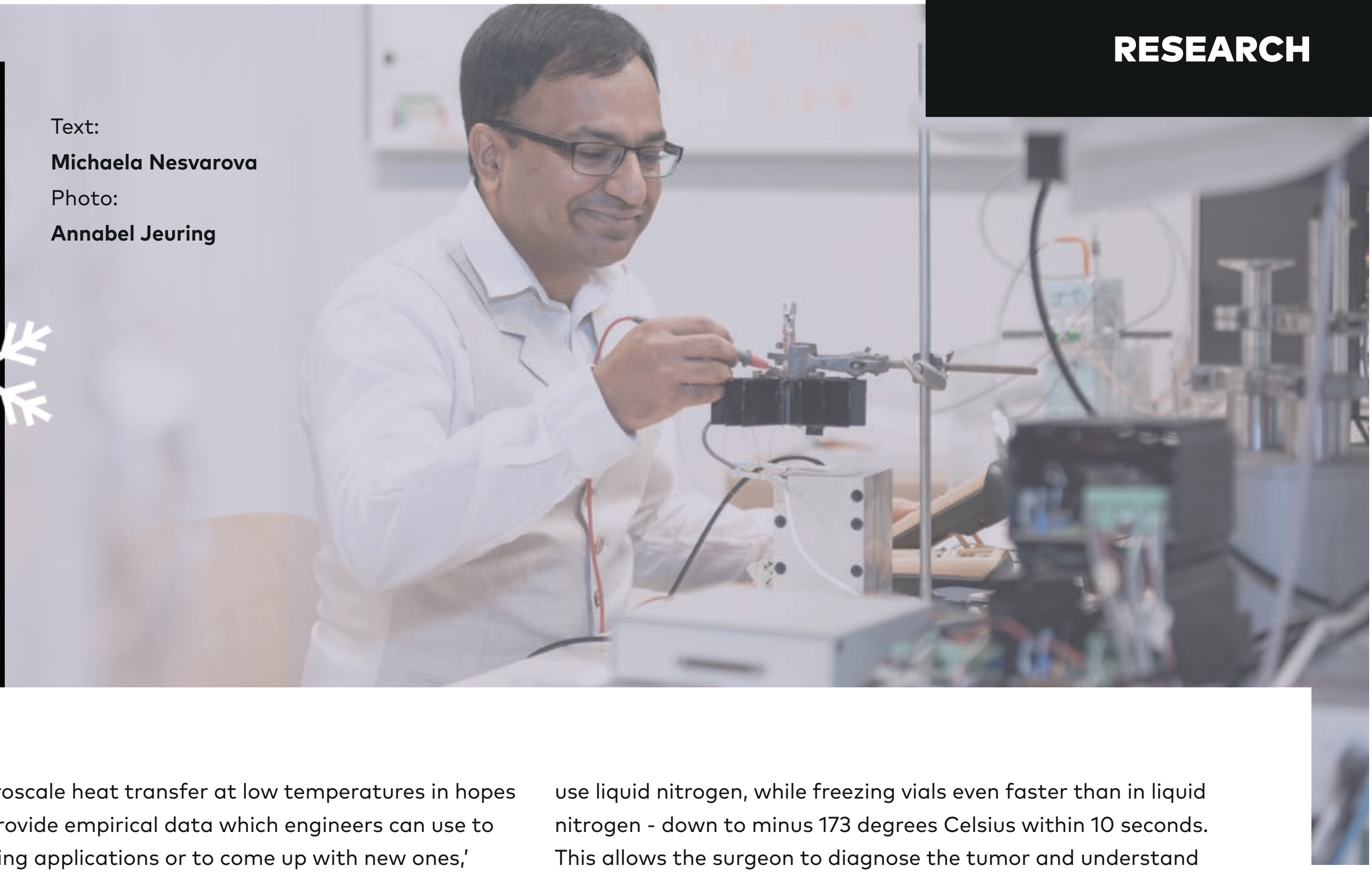
SRINIVAS VANAPALLI AND HIS RESEARCH INTO CRYOGENICS

Freeze!

For many people, the word 'cryogenics' prompts sci-fi movie flashbacks and images of human bodies being frozen just to be brought back to life hundreds of years later. While that might not be possible, cryogenic engineering relates to many useful and often groundbreaking applications. UT scientist Srinivas Vanapalli, who leads the only cryogenics research group in the Netherlands, is working on some of them. Including a method to 'freeze and destroy' tumor cells.

'If you cool the cells fast enough, you can destroy them'

Cryogenics refers to production and behaviour of materials at very low temperatures. In his lab at the UT's Faculty of Science and Technology (TNW), Srinivas Vanapalli works at temperatures of −150 °C and below. If he wanted to work on superconducting electronics, he'd need to crank up the cooling even more and work at temperatures close to absolute zero. What is it all for, though? 'If you look at Nobel Prizes for physics, quite a lot of them would not be possible without cryogenic expertise. In that sense, cryogenics is often underrated,' says Vanapalli. 'Yet, if you want to go to space, you need it. If you have a frozen pizza in your fridge, it has undergone cryogenic treatment. Oxygen tanks in hospitals wouldn't exist without it.'
Properties of materials are very different at such low temperatures. 'That is why we do academic research.



Text:
Michaela Nesvarova
Photo:
Annabel Jeuring

We study microscale heat transfer at low temperatures in hopes that we can provide empirical data which engineers can use to optimize existing applications or to come up with new ones,' summarizes the UT scientist. 'We could contribute, for example, to food processing, pharmaceuticals and medical applications.'

Destroying tumor cells

One of the challenges Vanapalli is tackling together with the University of Nijmegen is a treatment of tumor cells. 'Cryogenics is already used for sample preservation of tumor cells. However, if you cool the cells fast enough, you can destroy them.' Which could open up doors to a new cancer treatment. 'The method is being tested, but it needs to be improved. Right now, a needle is applied to the tumor. It produces high pressure gas, which expands and produces cold, until eventually an "ice ball" is formed. Once the temperature reaches -40°C, the cells are destroyed. We need to understand the cryogenic processes that happen during this procedure, so that we know exactly where and when it is -40°C and not kill any healthy cells. Furthermore, we'd like to increase the cooling capacity of the needle, so that we can progress through the tumor much faster. We have an idea on how to achieve this. We will be developing a needle that has the same volume but a bigger cooling capacity.'
Vanapalli has already contributed to the healthcare industry with another medical application. He has developed a so called 'snap freezer', an achievement for which he also received the George T. Mulholland Memorial Award for Excellence in Cryogenic Engineering in 2019. As the name suggests, the snap freezer is able to quickly cool human tissue, which can therefore be immediately preserved and diagnosed. 'Right now, if a surgeon takes a tumor sample during an operation, the sample needs to be transported and cooled in a different room, because liquid nitrogen is used – and that cannot be in the operating room. The snap freezer can be in the room, however. It is compact and doesn't use liquid nitrogen, while freezing vials even faster than in liquid nitrogen - down to minus 173 degrees Celsius within 10 seconds. This allows the surgeon to diagnose the tumor and understand what causes the cancer. This is a necessary step toward personalized molecular medicine. The medical center of the Free University in Amsterdam is currently testing the device.'

Freezing tissue in time

Freezing and preserving human tissue is therefore possible. Could all the futuristic films be true then? Could we, one day soon, freeze human beings and bring them back to life later on? This idea has some (but not a lot of) merit, explains Vanapalli. 'As temperature decreases, your bodily processes slow down. The metabolism slows down, you need to consume less calories and so on. Some scientists are exploring if this process could be used for astronauts who'd travel to Mars, for instance.' However, when it comes to actual freezing of a human body, the story becomes more complicated. 'If you go to -40°C, you can create an amorphous form and freeze the tissue in time – and theoretically bring it back to life. Biologists have shown that this is possible with single cells, on a very small scale. The challenge is to scale it up and I doubt it's possible for an entire human being.'
'Anyway, freezing humans is certainly not what we do here at the University of Twente,' adds Vanapalli. The researcher's goals are a bit more realistic. 'I'm trying to set up a Center of Excellence in Cryogenic Applications right here at the UT. After all, we are the only group in the Netherlands dedicated to cryogenic engineering. We have a lot of expertise here and there are many challenges we could tackle.' Besides having the motivation to improve the world, the scientist finds his work simply enjoyable. 'I've always been fascinated by cold. Heating something is easy, but cooling is very difficult. The excitement I felt when I first managed to reach really low temperatures was amazing. Making cold is fun. It's like a little playground.' ●

Text: **Jelle Posthuma** Photos: **Ivar Pel**

VR GOGGLES ALLOW SICK CHILDREN TO PLAY OUTSIDE

‘I see a slide, *I want to go there!’*

Two UT alumni and a student of Creative Technology developed a virtual playground for sick children. The virtual-reality goggles are used for the first time at the Wilhelmina Children’s Hospital in Utrecht. ‘The children believe they are in a completely different world.’

It is a busy day at the Intensive Care department of the Wilhelmina Children’s Hospital. Nurses are rushing to and fro, families sit with the young patients. In one of the big hospital beds lies a young boy of around four years old. He looks up when the VR goggles are brought into the room. ‘Would you like to try them out?’ The boy nods his head excitedly. The large goggles are strapped onto his head. While his nurse busies herself with injections and tubes, the young patient leaves for a virtual world. ‘What do you see?’ A brief silence. ‘I see a ball, a bridge and a river. And I see a slide. I want to go there!’

Playground

Jason van Eunen watches with a satisfied look on his face. Together with Freek Teunen, Koen Vogel and Emiel Peperkamp, he came up with and developed PlaygroundVR, a virtual playground for sick children. Since November, it is being tested in the Wilhelmina Children’s Hospital in Utrecht. ‘What we offer is a playground for children who cannot go outside themselves. It is a virtual world in which they can play together and forget about their illness and their treatment for a while.’
Van Eunen explains they had their idea some four years ago. ‘Three of the four people behind PlaygroundVR study or studied Creative Technology at the UT. We all love virtual reality. We asked ourselves where VR can have the biggest impact. Anywhere you don’t really want to be, right? Imagine what a child stuck in a hospital bed feels like. They want to play outside, and PlaygroundVR allows them to experience this without even having to get up.’
‘We developed this virtual world ourselves from scratch,

both the design and the code. We try to make everything as accessible as possible in our world. The game is easy to control. There is no starting point or game-over screen. After all, a real playground doesn't have that either.'

Playing together

The Wilhelmina Children's Hospital is the first place where PlaygroundVR is being used and tested. Pedagogical staff member Martin Beuzel is excited about the VR goggles. 'It can distract children while they are getting an injection. As two doctors work on them, the child has lost itself in the virtual playground. The children truly believe they are in a completely different world. They can also play with other children or their families as equals. A child that does not have the strength to throw a ball in real life experiences no such limitations in virtual reality, which is essential to a child's development.'

> *'Imagine what a child stuck in a hospital bed feels like'*

Bringing children together is one of the main goals of PlaygroundVR, Van Eunen explains. 'The multiplayer functionality allows children to play together in the virtual world. That means a child in ward A can meet a child from ward B in the virtual playground. This leads to new friendships. They can come up with games together, like sword fighting or hide and seek. Once they get better, they can play those same games in the real world. How awesome is that?'

Future

Van Eunen emphasises that the project is still in its pilot phase. 'At first, we visited hospitals at our own initiative. It is tough to get involved in the hospital market. A lengthy decision-making process has to be completed before anything can be implemented. Patient care always comes first – and so it should, of course.'
Crowdfunding allows the creators of PlaygroundVR to 'donate' the virtual playground to a number of hospitals, Van Eunen explains. 'The hospitals do not have to pay a penny. To achieve that, we have set up a crowdfunding promotion. Our goal is to raise €18,000 with it. That will allow us to offer the technology to a hospital for free. Our ultimate goal would be to have a little room near the entrance of every hospital where children can pick up their goggles.'

'It can distract children while they are getting an injection'

Hide and seek

Back to the Intensive Care – or rather, back to the virtual playground. The young boy has walked over to the slide. Once at the top, he unfortunately discovers it is closed off by some virtual tape. Unlike in a real playground, you cannot simply crawl underneath it in VR. Van Eunen: 'We have not finished developing the slide yet. Perhaps it will be ready in the next version.'
The young patient's mother has been given a pair of VR goggles of her own. 'I can't see you! Where are you?' Chuckling. 'I'm not telling, come find me.' They are playing a virtual game of hide and seek, which works just as well in the virtual world as it does in the real world. Then again. The boy takes his goggles off. 'You can see me now, right?' ●

Monika Kuffer

Looking for the overlooked

Text: **Michaela Nesvarova**
Photo: **Annabel Jeuring**

In her own words, Monika Kuffer is driven by a sense of 'social justice'. 'I want to make the urban divides visible. Then you have a chance to improve things,' says the Assistant Professor at the Department of Urban and Regional Planning and Geo-Information Management of Faculty ITC. She recently acquired a VENI grant and aims to map the world's population living in slums.

As a child growing up in Munich, Monika Kuffer dreamt of becoming an astronaut. Later she considered a career in medicine or physics. 'I have a problem with making choices. By nature, I find everything interesting.' She ended up studying human geography and took remote sensing as a side subject. 'That was a very odd choice at the time, because there was almost no urban remote sensing done back then. But I was always interested in cities and urban planning. I find it fascinating to observe cities' development from space. Compared to Europe, cities in the Global South are less planned and organized. They often just develop. For a researcher it is very interesting to analyze and model the dynamics of this development.'

It is the Global South that Kuffer's VENI project concentrates on. She wants to identify deprived areas in developing countries and to provide realistic estimates of the number of people living in these disadvantaged communities. 'Local governments have slum statistics and report them to the UN. Based on this data we believe there is currently one billion people living in deprived areas.' However, Kuffer is afraid the number could be much higher. 'There is a question of how accurate the government statistics are. For example, we worked on a project in Bangalore, India. While the local government reported there were 600 slums in Bangalore, we found there were actually about 1500 slums. More than double.'

The ITC scientist wants to understand why there is such a difference in these numbers. She is developing a machine-learning based framework to estimate the amount of poor inhabitants. She will compare the government statistics with local estimates, which are based on remote sensing and ground verification.

'I probably won't arrive to the global total number, but I can contribute to a better understanding of the situation in deprived communities. There is currently a lot of people being overlooked. We need the true numbers and realistic predictions – to provide necessary facilities but also to know how many people actually live on this planet.' ●

Our 'Rising star' Monika Kuffer:

2019	VENI grant
2019 – now	Lead scientist in Climate Resilience of the Urban Poor, initiative coordinated by UN-Habitat
2017 – now	Assistant Professor at ITC Faculty, University of Twente
2017	PhD cum laude, University of Twente
2003–2017	Lecturer at ITC
2010	MSc in Geographic Information Science, University of London
2001-2003	Researcher, Austrian Academy of Science, Vienna
2001	MSc in Human Geography, TU Munich

THE LAB

eHealth House

The newly opened eHealth House at the TechMed Centre is not just your every-day laboratory. At the same time, things couldn't be more everyday here: the lab is literally an apartment, complete with kitchen, living room, bedroom and bathroom, where people can 'live' in.

As a flagship living lab of the Personalised eHealth Technology Programme, there is a little bit more to it than that. Researchers can monitor the residents'

Text: **Rense Kuipers**
Photo: **Annabel Jeuring**

every move from an adjacent control room, except at the bathroom – for obvious reasons. They can also intervene without being in the room, for example by changing the colour of the lights, changing the channels on the tv or suddenly blasting rock 'n' roll through the speakers instead of Chopin. 'This is where all the eHealth research and education of the UT can find a place to experiment,' says lab coordinator Mathilde Hermans. 'The lab focuses on innovations for monitoring and coaching in healthcare. By using wearable technology, mobile apps or domotics, it's for example possible to monitor the recovery of patients after surgery, see how people with mental disorders respond to disturbances, coach daily activities to promote a healthy lifestyle, or gain insight into eating and social behaviour patterns.' Since eHealth is an emerging field of research, time will tell how the lab will be used, says Hermans. 'But we've made this place flexible enough for all interested researchers to make it their second home.'

Text: **Michaela Nesvarova** Photos: **Cristina Tudor**

UT ALUMNA CONNIE NSHEMEREIRWE

‘As scientists, we are too divorced from our societies’

‘I hope this will be interesting enough for you, because I have a rather unusual story.’ She does indeed. Connie Nshemereirwe (45) is a scientist through and through, but this UT alumna is not following the traditional path of a researcher. She has stepped out of academia in order to have more impact on society. Now, self-employed and independent, the Ugandan actively creates a bridge between science and policy - as a trainer, writer, speaker and as the co-chair of the Global Young Academy.

Connie Nshemereirwe obtained both her Master and her PhD degree at the University of Twente, where she studied Design of Educational and Training systems and later Educational Measurement. The journey to these diplomas was anything but straight-forward, though. Growing up in Uganda, she was ‘lucky enough to receive stable education’, says the alumna. ‘You could say that I come from a middle-class family, but that didn’t mean much back then. There were wars, many people went into exile, the country was not very stable. However, I went to a normal school. I did witness a couple of coups, which meant school was suspended for a week or two while the coup was going on. But since I was twelve years old, there have been no coups and my education became stable.’

Young, female and the boss

The education was certainly good enough to allow Nshemereirwe to study civil engineering at the Makerere University, the only university in the country at the time. ‘I’d say that engineering chose me, I didn’t really choose engineering,’ she remarks. ‘It was considered unusual for girls to be good in math or physics, but I was good in those subjects, partly thanks to my dad who was an engineer. I wanted to study more humanities, but my school wouldn’t allow it.’ Once, young Connie even joined a different class, but the headmistress came in and asked her to leave. So she studied physics, math and chemistry and went on to become a civil engineer. ‘It was okay. I didn’t have a strong preference at the time. After I graduated I worked in a remote area of the country. I liked it. It was the first time I was on my own and I was working in construction, telling people what to do. It was quite challenging. I was young, female and I was the boss. It was not easy for people to accept my authority, but I was competent and so they had to accept me eventually.’

'Scientists are held in high esteem, but people don't know what we do'

Connie Nshemereirwe:

1998	BSc. in Civil Engineering, Makerere University (Uganda)
2004	MSc. in the Design of Educational and Training systems, University of Twente
2014	PhD in Educational Measurement, University of Twente
2001 – 2016	Senior Lecturer, Uganda Martyrs University
2016 – now	Independent Science and Policy Facilitator
2018 – now	Co-chair of the Global Young Academy

From a construction site to a university

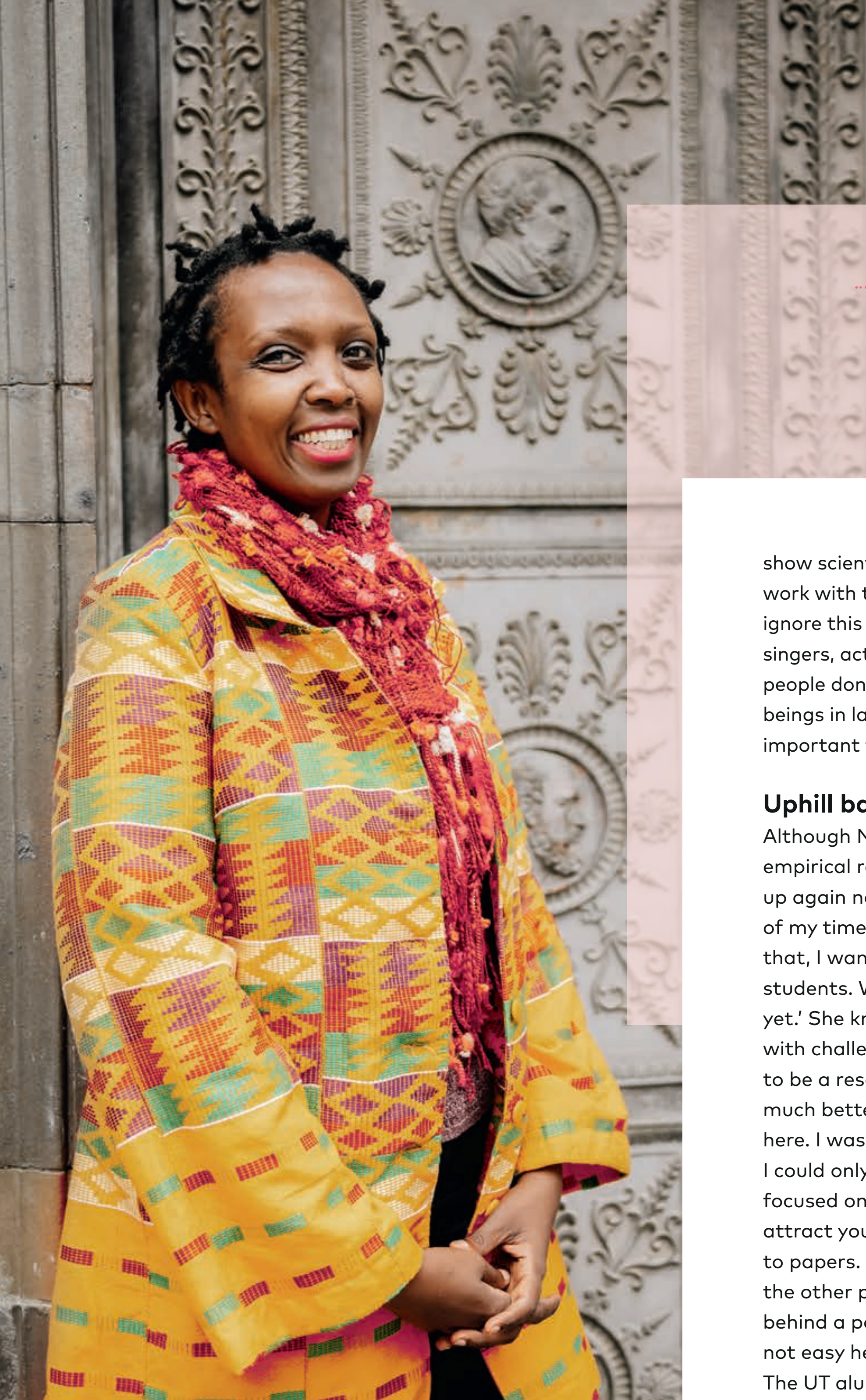
How does a competent engineer from Uganda decide to go study education in the Netherlands? The answer involves a baby and a New Year's resolution. 'My friend was teaching at a university, but she unexpectedly had to go on a maternity leave and asked me to take over her classes. I did and I enjoyed teaching so much! When I was on campus, I felt like I was walking on air. But I was only teaching part-time and the rest of the time I had to be in construction, which was getting quite monotonous. University was such a breath of fresh air.' It didn't take her long to realize that teaching was her true calling. On New Year's Eve 2003 she made the decision to quit engineering and become a teacher. 'I was up all night thinking about what I wanted. When my father saw me in the morning, he was concerned because my eyes were all red. I wasn't crying, I was just thinking hard. I began looking for a programme where I could learn more about education. Universities in Uganda wouldn't accept me without a bachelor degree in education and I didn't want to do another bachelor, so I started looking abroad. I came across Twente. It was perfect. I still remember how excited I was when I found it because it combined education as well as post-education training systems. So on the 1st of January I made up my mind and in August I was already in Enschede. My trip to the Netherlands was actually the first time I was on a plane.' Her time at the UT came with many 'firsts'. 'I remember when I saw my first snow. My roommate was from Zambia and neither of us had ever seen snow before. When it started snowing, we thought something was burning and this was the ash falling down.'

There and back again

After she graduated, Nshemereirwe went back to her home country for six years before returning to the UT. 'There was quite a big gap between my Master and my PhD. I felt that the Master was quite intense: a lot of learning, a lot of growing as a person, a lot of travelling. When I came back to Uganda I felt so skilled and knowledgeable, I didn't feel like I needed a PhD. Later on, however, I began to observe these strange patterns in students who I was teaching. It was puzzling. We were receiving students who had really good grades at high school, but they didn't perform well at the university. They showed shocking gaps in literacy, they were lacking basic skills and background knowledge. So I wanted to research if high school grades in fact predict performance at a university.' By coincidence, she ran into a UT professor who was involved in her desired line of research and it was time to pack for another trip to Enschede. 'That was nice. Living in the Netherlands was generally quite easy for me. It felt like a good fit. I come from a tribe in Uganda which is very direct, Dutch people are also very direct. Everyone always knows where the other stands. I was glad to be back.'

'Being an academic was not enough to make a real change in society'

With a PhD diploma in her pocket, the scientist 'was looking forward to going home and bringing her findings to the university'. She started measuring literacy levels of students, aiming to pinpoint their missing skills and to create programmes to fill the gaps. 'I found out that each student had problems with something else. The skills were so scattered I would basically have to teach them the entire primary school all over again. That made me realize that university was too late for me to intervene and that to make a real difference, I needed to engage policy makers and contribute to a more systemic change. Just being an academic was not enough to make a real change in society. I resigned from the university to work more on the intersection of policy and research. That was the reason I became self-employed.'



'We are these mysterious beings in lab coats'

Connie Nshemereirwe is now an independent science and policy facilitator, passionate about promoting science leadership. She currently serves on the steering committee of the Africa Science Leadership Programme, as well as the executive committees of both the Uganda National Young Academy and the Global Young Academy (GYA), an international society of young scientists. This allows her to share her message all over the world. 'I applied to the GYA because I became very interested in merging the two worlds: of society and science. My personal mission is to show scientists that it's important to communicate their work with the public, that it gives them influence. If you ignore this possibility, you give the influence to politicians, singers, actors... Scientists are held in high esteem, but people don't know what we do. We are these mysterious beings in lab coats. I want to show scientists that it's important to take up their leadership role.'

Uphill battle

Although Nshemereirwe doesn't have time for her own empirical research at the moment, she plans to pick it up again next year. 'Co-chairing the GYA takes up most of my time, but my role there ends in June 2020. After that, I want to continue studying the educational gaps in students. We see what is missing but we don't see why yet.' She knows that continuing her research will come with challenges. 'In Uganda, you need to persevere a lot to be a researcher,' she says. 'In the Netherlands there is much better access to experienced researchers, but not here. I was looking for people specializing in my field and I could only find two women in the entire Uganda who focused on what I do. It's an uphill battle. You need to attract your own money and there is not a good access to papers. When I was writing a paper, I couldn't see all the other papers written on the topic because they were behind a paywall, so I missed a lot. Life of a researcher is not easy here.'

The UT alumna has every intention to persevere. Her plan is simple: she wants to serve her community the best she can. 'I hope to contribute to our consciousness as Africans in general and as African scientists in particular. I want to stress the importance of engaging with society. As scientists, we are too divorced from our societies. We fail to harness the intelligence and skills of the people. That makes our science poorer. I want to increase our awareness and engagement with the world. But if it comes to a real plan for the future, I have given up on having a plan. I take life as it comes.' ●

PROFESSOR DANNIS BROUWER WORKS ON FLEXURE JOINTS

Better movements for life and industry

Hinges based on leaf springs, so called flexure joints, are widely used in the precision industry. They can operate very accurately, but have a small range of motion. Professor Dannis Brouwer, Chair of the Precision Engineering Group of The University of Twente, is developing a new generation of flexure joints, that combine high precision with a much larger range of motion. These future joints have multiple uses: from applications in space and robotics to light-weight prosthesis.

Text & photos:
Hans Wolkers

'There is a need to extend our horizon and optimize our current designs'

'This is our brand-new hexapod that we use to test a next generation of flexure joints,' Professor Dannis Brouwer says. The hexapod, a futuristic looking device called the T-Flex, resembles a giant, six-legged robotic insect turned upside down. Black plastic legs contrast with shining, stainless steel screws and bright orange joints. These allow the legs to move in all directions. When power is switched on, all legs start moving in a surprisingly silent, smooth and flexible motion. The orange flexure joints Brouwer and his team are testing, function just like ball joints in the human body. They have a completely different design though and combine high precision of movement with the possibility to make large strokes. These features make this hexapod unique.

'Traditional ball joints that are used in industrial applications are able to make a similar large stroke, but lack the precision of flexure joints,' Brouwer explains. 'In contrast, current flexure joints are very precise, but only have a small range of motion.' The T-Flex combines the best of both worlds: a large range of motion with precision movements as small as 50 nanometers. That is more than 1000 times smaller than the thickness of a hair and at least twenty times more precise than traditional ball hinges. Brouwer focuses his research on further improving the joint to make it suitable for a wide variety of applications. 'The current joint design, as we use in the T-Flex, is suitable for micro-assembly due to its incredible accuracy,' Brouwer says. 'For example, when you need to pick up something and place it with great precision on a specific spot, like in the manufacturing of computer chips.' The scientist aims for medical applications too, for example as more effective joints in light-weight prosthesis.

Fine balance

A reason for the limited precision in common ball joints is the presence of friction and play. When looking at the roller bearings in the wheel of a bike, for example, there is a fine balance to reduce these opposing quantities. 'It is crucial to tighten the bearings enough to minimize play,' Brouwer explains. 'But if you tighten the bearings too much, there is more friction, resulting in a hampered function.' The same principle applies to other hinges and joints in, for example, the human body as well as the industry. The big advantage of flexure joints is that they operate without resistance or play at all. This is due to their design, using leaf springs. The movement of these joints is based on simply bending the leaf springs, resulting in a smooth operation. This idea is not new: the use of common leaf springs in flexure joints was already described in the early 20th century. The design allowed for precision measurements, for example to assess the power of an earthquake from a large distance: by placing a small weight on a plate that was resting on several leaf springs, the extreme subtle vibrations of a far-away earth quake could reliably be picked up by the springs and transferred to the small weight. Today, the precision industry widely applies flexure joints, among others in machines used for the assembly of tiny elements, such as used in electronics.

Precision work

However, the relatively small range of motion of these traditional flexure joints allows only small movements, making them perfect for precision work only. Brouwer demonstrates how the joints in the T-Flex combine precision and big range of motion in a large metal joint prototype. It has a similar design as the bright orange joints in the T-Flex and moves just like a ball joint. Three blue and red metal rings of about 12 centimeters in diameter are attached on top of each other, using a construction made out of folded leaf springs. Between the rings there is about three centimeters of space left. Brouwer places the three-ringed joint on a table and with minimal effort, he moves the top ring in all directions, as if it was the ball joint of a shoulder.

'The movability together with the high precision creates

applications outside the precision world and opens the possibilities to apply these joints in other fields, such as robotics or even in prosthetic joints.' Besides a higher precision, the new design also beats industrially used ball joints in maintenance. For example, the flexure joint doesn't need any lubrication and is easy to clean. This makes it a potential candidate for use in the food industry machinery. And even in space flexure joints may prove more than useful. Brouwer: 'A ball joint doesn't work in a vacuum, as we have in space: both metal parts will be pushed tightly on each other, impeding its function. Therefore, these joints can't be used in space. But the friction-free flexure joints with a long stroke function perfectly in these conditions.'

Hand prosthesis

Also other types of flexure joints, such as hinge joints based on leaf springs, have large benefits over traditional hinge joints where different moving parts cause resistance. Besides their smooth, friction free movements, these flexure joints can be made from light-weight materials using a 3D printer, keeping both weight and costs at a relatively low level. Brouwer shows a large, white hand, completely made from 3D printed plastic. Every finger moves just like in a real hand, thanks to many flexure hinge joints, also made out of plastic. This prosthesis functions just like a real hand and it weighs just 180 grams. That is a big difference compared to the roughly two kilograms in traditional hand prosthesis. Also the industry is interested in the new hand design. Brouwer: 'We are currently running a project, together with Wageningen University, where we are developing an industrial hand, a so-called gripper. Such a device can be used to automate for example picking fruit.'

Withstand the forces

The newest flexure joint designs still have their limitations though: they are not strong enough to withstand the forces required. This especially applies to models that move like a ball joint. According to Brouwer, the red and blue ringed prototype can sustain around 10 kilograms of pressure, while a hip prosthesis needs to be able to sustain as much as 500 kilograms. In addition, a design suitable for a hip prosthesis should be a whole lot smaller. 'So, there is a need to extend our horizon and optimize our current designs,' Brouwer states. 'For example, by including more supporting leaf springs in the joint. But a problem could be that more springs increase the internal tension in the different springs, affecting smooth movements.' Another possibility is to attach the folded leaf springs to the metal rings using a more flexible, viscous material. This adds to the movement and reduces tension. For the flexure hinge joints in hand prosthesis things may go faster. Brouwer: 'I expect we have a fully functional hand prosthesis within two years from now.' ●

'I expect we have a fully functional hand prosthesis within two years'

Science is all about making choices. Some lines of research achieve great success, while others die unlamented deaths. Back to history delves deep into the archives looking for developments with historical relevance. This time, we look into the industrial revolutions and what we should learn from our past.

Learn from the past

Text:
Rik Visschedijk

Internet of Things, robotics, virtual reality and artificial intelligence: these are all examples of disruptive technologies that have changed the world in which we live and work. Back in 2015, Klaus Schwab, chairman of the World Economic Forum, called it the fourth industrial revolution, because technology has ushered in a new chapter of human history. For the first time ever, technology is changing people in a very literal sense. As Klaus said, 'it is blurring the lines between the physical, digital and biological.'

This revolution – although the term 'evolution' is perhaps more fitting – harkens back to the period from 1760 to 1840 in Great Britain. James Watt's invention of the steam engine and the improvements that were made in agriculture and industry facilitated the mass production of goods, food, machines, equipment and means of transport. At the same time, industrialisation uprooted life as people knew it. Factories, urbanisation, poverty and pollution became facts of life. The production of coal, for example, grew from circa three million tons around 1700 to ten million tons by the end of the century.

The fourth industrial revolution, as Klaus Schwab calls it, is rife with uncertainties. People are afraid that automation will take away their jobs. Economists like Erik Brynjolfsson and Andrew McAfee warn that the revolution may lead to vast inequality: the gap between the haves and the have-nots is at risk of widening even further. Schwab is positive, however: if policy makers, the public, the private sector, the scientific community and citizens all work together, it is possible to come up with an 'integral' solution to the challenges of our new age.

It is not surprising that people are uncertain about all these new technologies. Developments are happening at such a dizzying pace that it is virtually impossible to predict what the world will look like in ten years' time. Humanity has to come up with answers to questions that have not even been asked yet. Politicians and decision-makers play a key role in this, Schwab argues. They must abandon their 'linear thinking' and get more in touch with daily events.

Schwab certainly has a point there. During the first industrial revolution, there was an enormous gap between the rich and the poor. It marked the beginning of an impoverished urban working class: people with hardly any rights, toiling away under abominable conditions. Child labour was commonplace. It would not be until the early twentieth century that the excesses of industrialisation were largely made right. Compulsory education for children and women's suffrage became matters of law.

There are other lessons to be learned from the past. The industrialisation of our society also changed the way we fought our wars. World War I became a war of attrition between France and Germany, where the battles raged on until either side ran out of bodies to use as cannon fodder. Instead of soldiers engaging in man-to-man combat, 'anonymous' machine guns and poison gas were deployed.

History clearly illustrates the importance of carefully considering the opportunities and threats associated with new technologies. As Schwab puts it, that requires a broad coalition. Whenever scientists and businesses develop a new technology, policy makers and politicians are partly responsible for how that technology is utilised – whether it be for production or warfare. ●

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.

‘I have had a few eureka moments over the course of my scientific career. Looking back, they always happened while I was working together with close colleagues, never while I was by myself. In the eighties, for example, I worked as a postgraduate at Bell Labs, a renowned laboratory in the United States.

At that time, it was believed that oxydic materials, such as connections between oxygen and other elements, were always isolators. However, some oxides can have metallic properties. In those metallic oxides, superconductivity – better known as high-temperature superconductivity – was discovered in 1986. This discovery won the researchers a Nobel Prize and would revolutionise our technology, because being able to transport electricity without resistance means you can develop extremely efficient engines and generators and transport energy without any losses along the way.

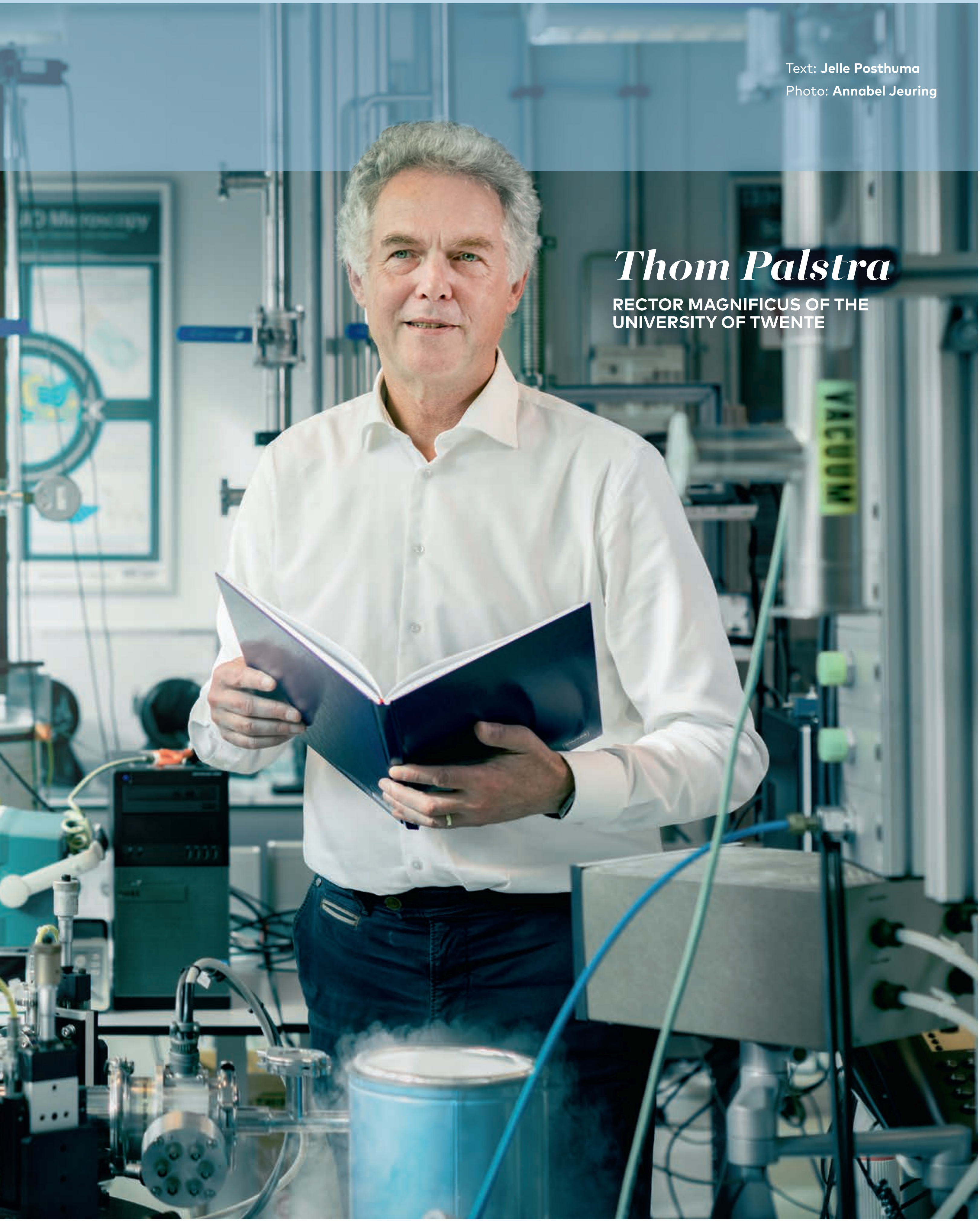
While I was researching those materials at Bell Labs, I noticed that the resistance of the metallic oxides in magnetic fields is actually not zero at all. I looked for an explanation for months, until we got a visit from Bertrand Halperin, a theoretical physicist from Harvard University, who casually told me to look at my theoretical models from a different perspective. I remember exactly where I was at that moment. Room MH-1E-318. He gave me an insight, based on theory, that allowed me to look at and analyse my own measurements in an entirely new way.

Suddenly, everything came together. We finally understood why these superconductors have a finite resistance in a magnetic field. As a result, I was able to explain the limitations of high-temperature superconductivity. I demonstrated that the superconductors, despite their amazing potential, would only have a technological impact in specific circumstances and that the realisation of this impact would take much longer than we had previously imagined.

This was big news in the scientific community. A lot of people struggled to digest it. I gave a lecture in Japan, which had recently invested heavily in this field. After the lecture, I was not invited back to Japan for a few years.

Another example is a conference with about a thousand people in the room where I would present my insights. I was told in advance by a colleague: if you reveal your model here, your career will not end well. I had to swallow for a moment. But I also thought: it is now or never.

Nevertheless, it worked out well for me. “If you are not afraid of stepping on that colleague’s toes, you are made of the right stuff,” my group leader at Bell Labs told me. As a postgraduate with only a year left at the laboratory, I was looking hard to find a new job. My eureka moment had a happy end after all: I was able to stay on at Bell Labs as a researcher for several years.’



Text: **Jelle Posthuma**
Photo: **Annabel Jeuring**

Thom Palstra

RECTOR MAGNIFICUS OF THE UNIVERSITY OF TWENTE

Back to the ivory tower of mathematics

Stories about breakthroughs in the field of self-learning algorithms are fostering dangerously high expectations, professor Johannes Schmidt-Hieber recently warned in his appointment speech. They overshadow the hazards to which the field is exposed due to a lack of theoretical foundations. According to the professor, it is high time for mathematical reflection in the ivory tower.

Johannes Schmidt-Hieber is waiting with bated breath. Almost every week, the media write about the extraordinary capabilities of self-learning algorithms: computer programmes that can learn from the vast quantities of data they are being fed. They can recognise faces, distinguish tumours, speak new languages, decipher handwriting, engage in trade and so on. The possibilities are seemingly endless and the expectations are high – too high, if you ask Schmidt-Hieber. In early October, the government announced its plan to work together with businesses to invest two billion euros in artificial intelligence over the next seven years. Good news, you might think, yet the professor is worried. 'No one is asking what the result of these investments should be. It is primarily being done because other countries are doing it too. That is not a very good reason.'

Schmidt-Hieber fears that the government has allowed itself to be swept away by lofty expectations that will eventually go unrealised. 'These past five years, quite a few problems have been solved. People believe you can extrapolate that rising trend into the future, but it will probably level out instead. If the expectations are too high and go unrealised, no one will want to invest in the field anymore. The result will be an "AI winter", just like we saw in the '70s and '90s.'

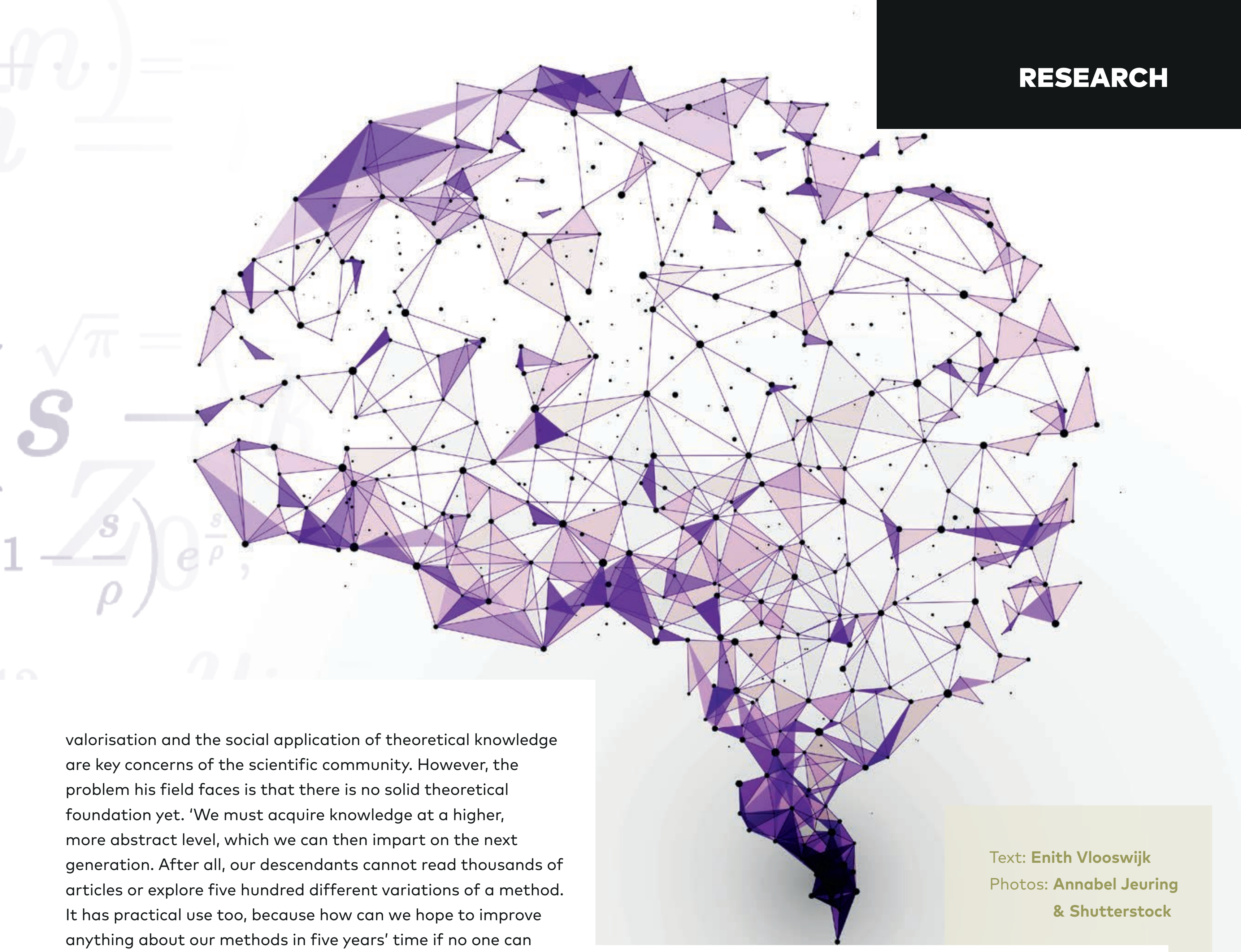
'We must acquire knowledge at a higher, more abstract level'

Deep learning

The breakthroughs in the field of deep learning are clouding our view of the problems that continue to plague the field. While computer scientists and tech companies from all over the world are working on myriad applications, no one can oversee the field as a whole. 'Even experts cannot see the big picture. Too many articles are being published and it is impossible to keep up,' he says in his office. 'You'll probably end up repeating someone else's work. Doctoral candidates need time to conduct their research, but others may publish two or three articles about the same topic in the meantime.'

Developments occur so rapidly that peer review is often skipped over. This may compromise the quality of the publications. Schmidt-Hieber: 'During a summer school on self-learning algorithms at Berkeley, a panel discussion between people at the very top of the field was held exclusively about this topic: how can we reduce the output and increase the quality of publications?'

The professor's solution: statisticians must return to their ivory towers. That might come as a shock in a time when



valorisation and the social application of theoretical knowledge are key concerns of the scientific community. However, the problem his field faces is that there is no solid theoretical foundation yet. 'We must acquire knowledge at a higher, more abstract level, which we can then impart on the next generation. After all, our descendants cannot read thousands of articles or explore five hundred different variations of a method. It has practical use too, because how can we hope to improve anything about our methods in five years' time if no one can read even one percent of everything that is being published?'

Text: **Enith Vlooswijk**
Photos: **Annabel Jeuring & Shutterstock**

Neural networks

Self-learning algorithms, also known as neural networks, are loosely based on the human brain. They contain several layers of 'neurons', countless units that solve sub-problems and share the results with each other. Although the result is visible, as are the data you put in, the computational process that occurs in between remains clouded in obscurity. Schmidt-Hieber does not, as is commonly done, compare the algorithms to black boxes. Instead, he likens them to croquettes: we can examine what is inside, but that mass of numbers does not tell us a whole lot. Nevertheless, the professor believes there are ways to assess the value of these algorithms. 'At the moment, this is commonly done by feeding them new data and empirically assessing the method's performance. We are doing just that, but then at the theoretical level. We do not have any real data, but we can predict in a theoretical manner how the data will be processed and how well a method will perform. That allows us to calculate the margin for error.' To go back to the croquette: it is possible to predict how it will taste based on the recipe, even without actually trying one.

Another matter that the professor would like to examine is why self-learning algorithms appear to circumvent a key principle of statistics. According to this principle, a mathematical method used to describe a phenomenon works better, the more variables are incorporated in it. Here's the croquette again: if you try to make one with just some information about the frying fat and the cooking time, you won't get very far. At the same time, using too many variables increases the number of errors. In other words, using a ten-page recipe needlessly complicates the process of making a croquette. Mathematicians are therefore always looking for the perfect balance. However, this principle does not seem to apply to self-learning algorithms. Once we get up to thousands or even millions of variables, more appears to be better. Mathematicians have no clue why that is, which makes this question all the more appealing to inquisitive minds. 'Scientists love new phenomena that cannot be explained with standard theories,' the professor says enthusiastically. 'This is a very exciting topic, especially for young people.'
Looks like things are about to get interesting in that ivory tower. ●

Unrealistic

In hindsight, my expectations were a bit too high. The promise of not having to spend hours listening to and transcribing my interview fragments probably clouded my judgement. On top of that, my colleague was very enthusiastic. AmberScript, he tweeted, is self-learning software that can turn audio fragments into written text extremely quickly. Fantastic! I rushed over to the website, paid fifteen euros and excitedly uploaded a fifty-minutes-and-forty-four-second conversation to the cloud.

The result was astonishing. Until then, I thought I had talked to a professor about artificial intelligence, but it now became clear that they had said something else entirely: ‘You have to analyse the number of words by how well a method works. That is mainly the après ski. Places. And it. Can warn the condom.’

Many fragments reminded me of the secret messages some people claim to hear when they play the Beatles’ final record in reverse or of Dadaist poetry at its most recalcitrant: ‘That will toothache. Instead of something cat. But that does not mean it is difficult. And.’

I find that ‘and’ at the end of the sentence to be especially touching. I had been tasked with writing an article about the ideas of professor Johannes Schmidt-Hieber, which you can find elsewhere in this publication. Our conversation had been about the importance of mathematically assessing self-learning algorithms using comprehensive theories. Furthermore, the professor warned against allowing expectations to become too high: sooner or later, that will only lead to bitter disappointment, after which no one in their right mind will want to invest in the AI technologies that are so popular at the moment.

Something similar happened in the 1950s and 1980s, when the field experienced a cold ‘AI winter’. While Elon Musk predicts that computers will soon surpass human intelligence, people like Schmidt-Hieber are trying their best to keep everyone’s expectations in check – while getting their thermal socks ready just in case.

That is what we talked about. I had hoped that AmberScript’s self-learning algorithm would make the transcription process a little easier. Perhaps it is for the best that it did no such thing. We scientific journalists play an important role in creating unrealistic expectations for the future. I am here to tell you that it will be a long time before a self-learning algorithm can make complete sense of spoken words. What it is good at, however, is spitting out a catchy phrase to end an article with. ‘This too a great opportunity together a next generation,’ the algorithm preached. ‘But also stood a Cactus Club.’

Enith Vlooswijk

Science journalist

Text: **Rense Kuipers** Photo: **Annabel Jeuring**

M

Master Research

Using machine learning to predict Parkinson's disease

'I love becoming an expert'

During her Technical Medicine Master's research, Maaike Dotinga dug deep into the world of machine learning to predict whether someone has Parkinson's disease. She was graded a 10 for her thesis and her work is being implemented at the Isala hospital in Zwolle.

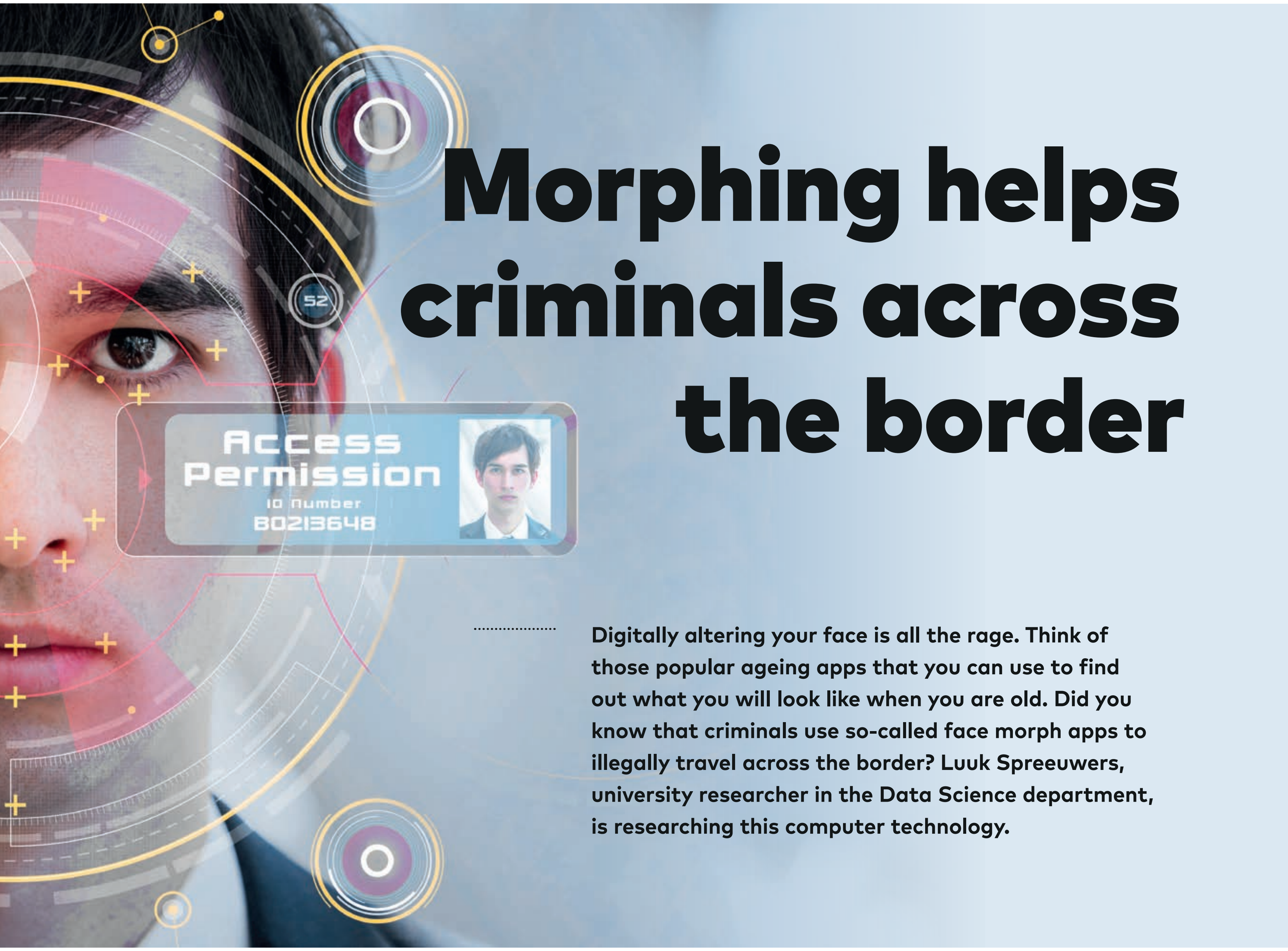
During her study internships, Maaike Dotinga hopped from hospital to hospital: Nijmegen, Zwolle, Groningen and back again to the Isala hospital in Zwolle. In her third and final year as an MSc student, she worked on her master thesis project in Zwolle. 'The goal was to investigate the application of machine learning in nuclear medicine, an entirely new field of research for the Isala hospital,' explains Dotinga. 'One of the specific projects I focused on, was to use machine learning technology to predict if a patient has Parkinson's disease or not.'

Since there wasn't much groundwork to begin with, a lot of Dotinga's work came down to pioneering. 'Which was a lot of fun! The original plan was to use deep learning instead of machine learning. But that proved to be too complex, since deep learning neural networks are basically a black box. Both the hospital and I lacked the technical know-how. So we took a step back and looked at more simple machine learning algorithms instead.'

This proved to be a very fruitful approach. Dotinga managed to develop a Parkinson's model based on nuclear scan parameters, thereby eventually deriving one single formula. This formula proved to be as good as a nuclear medicine physician when diagnosing someone with Parkinson's disease based on a nuclear scan. 'Of course you still need a nuclear medicine physician, but the physician can use this model either as a basis to interpret the nuclear scan or as a second opinion. It works so well that Isala is currently investigating how to implement this method in clinical routine.' Also, Dotinga recently won the Young Talent Philips Graduation Award for Biomedical Technology 2019 for her work.

Even before defending her Master's thesis in August, Dotinga knew she wanted to continue as a researcher. 'In May I already secured a job as a PhD student at the Leiden University Medical Center, where I've been working since September. I love researching, going in-depth and becoming an expert in a specific field of research.' At the LUMC, Dotinga continues working multidisciplinary in both nuclear medicine and medical oncology.

Dotinga doesn't have any concrete career plans. 'I can now fully focus on interesting and complex cases. But since I grew up in the relatively rural Friesland, I always said I wanted to see technical medicine applied in the smaller, more local hospitals. Unfortunately, Technical Medicine isn't that present in these hospitals yet. The cases are less complex, but you can help more people. Who knows, maybe this will be my next step.'



Morphing helps criminals across the border

Digitally altering your face is all the rage. Think of those popular ageing apps that you can use to find out what you will look like when you are old. Did you know that criminals use so-called face morph apps to illegally travel across the border? Luuk Spreeuwers, university researcher in the Data Science department, is researching this computer technology.

'Let me show you something first,' Spreeuwers says as he takes out his phone. 'This is a face morph application.' On the screen of Spreeuwers' iPhone are two passport photos of random people. At the press of a button, one image is superimposed over the other, creating an entirely new, completely unique face. 'That's how easy the morphing process is. Myriad apps like this one are available for free.'

Criminals

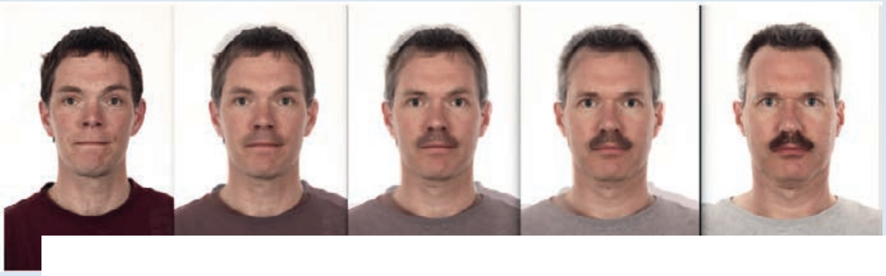
The application seems harmless enough at first glance. It looks like something you would try out with your friends for a laugh. However, the app has proven very useful to criminals. Here's why: suppose a criminal knows the law is closing in on them and they want to leave the country. However, they have no chance of making it through customs without getting caught. Using someone else's passport to be able to travel out of the country would be the perfect solution.

'The problem might be much bigger than we think'

That is where the face morphing process comes in, Spreeuwers explains. 'First of all, the criminal has to find someone who looks like them. It can be a random person or a family member, as long as there is some physical resemblance. The criminal approaches them and asks them if they would like to make some extra cash on the side. If they say no, there is always the threat of violence to persuade them. The criminal then asks the person in question for a passport photo. The culprit's picture and the criminal's own are fed into one of these easy-to-use apps to create a morph.'

It is now time for step two. 'The culprit is given a print-out of the manipulated picture and goes down to town hall to

Real face morph using photos of Florens de Wit and Luuk Spreeuwers.



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

apply for a new passport. The official behind the desk is tasked with making sure the passport photo matches the person standing in front of them. They are used to imperfect matches, because people tend to change over time. Someone might decide to grow a beard or get a new pair of glasses. The clerk cannot tell the difference between the fake image and the person at their desk. The culprit therefore has no trouble getting a new, valid and government-issued passport. They hand it over to the criminal, who looks enough like the morphed picture to make it through customs without getting caught. Thanks to their new identity, they have managed to leave the country after all.'

Facial characteristics

How is it possible that the fake passport arouses no suspicion at town hall or during the manual and automated customs inspections? 'Human observers are hardly able to recognise a good morph,' Spreeuwers explains. 'The same goes for the automated passport check at airports. Various studies have shown that morphs can pass any standard automated passport check. That is a scary thought, of course.'

'As I mentioned, people are easily fooled by morphs. In general, only the centre portion of a face is used. Everything around it, such as a person's hair and the background, are not usable. If you combine a thick head of hair and a bald pate, the effect looks very weird. We call that "ghosting". Here's what people do instead: they only use the centre portion of the face and paste that onto the face of someone else. If you do it well, it becomes almost impossible for humans to recognise that they are being deceived.'

Automated facial recognition technology also has trouble identifying morphs, Spreeuwers explains. 'During an inspection, this technology tries to detect facial characteristics. The technology is trained by being fed a vast quantity of data consisting of millions of passport photos. When you show a ton of faces to a self-learning system, it will extract the main characteristics of a face on its own.'

'A good morph contains characteristics that match two different faces: there is a degree of overlap. That is exactly the problem. As a result of this overlap, the facial recognition technology cannot tell the fake image from a 'real' face, because it looks a bit like both of the original faces that were used to create the morph. All it takes is a moderate degree of resemblance between the two individuals. Even an automated facial recognition system will let the criminal with their false passport through.'

'Human observers are hardly able to recognise a good morph'

Natural or unnatural

The Netherlands and Germany have already called the attention of the European Commission (EC) to the topic of morphing. A research proposal entitled 'State of the Art of Morphing Detection' (SOTAMD) has been submitted and approved, Spreeuwers says. 'We want to generate a database filled with highly challenging morphs. In a way, we are putting ourselves in the criminals' shoes. That is how the research team wants to develop a benchmark that poses a challenge to the morphing detection algorithms and can train them.'

'We want to find out if morphs produce any unnatural distortions in faces. Are morphs fundamentally different from real pictures, or are they realistic images of non-existent individuals? In other words, does combining two pictures create a new person or is the result something unnatural? If any unnatural distortion occurs, that can be detected.'

'The scope of this problem is not entirely clear yet. There is one documented case of a criminal who made it across the border with a morphed passport photo. In some other cases, journalists have tried to do the same. This tells us it is not impossible. Since detection is such a challenge, the magnitude of the situation is hard to guess at. The problem might be much bigger than we think. In any case, it is a serious threat.' ●

KEES VENNER, PROFESSOR OF FLUID DYNAMICS

'It's not all about achievements'

'Sometimes I think I'd like to step out of my busy schedule, but I really enjoy what I do. I do plenty of challenging things,' says Kees Venner and one can only agree. The UT professor rode his motorcycle to Israel right after the First Gulf War, he jumped out of an airplane and, as a daily challenge, he trains and walks five big dogs. He leads a research group. And he seems to handle it all with the precision and mindfulness of a karate 'master' – which he also happens to be.

'It's quite ironic. I didn't want to work in fluid dynamics. I thought it was too difficult. Now I'm a full professor in this field,' says the UT scientist. But let's put a pin in that for now. Because as Kees Venner wisely remarks later on in the conversation: 'You should not only look at where people are, but how they got there.'

Has academic career always been the dream?
'I wanted to be a fighter pilot, a surgeon... I considered many professions. But I met a girl and she lived in Enschede, so I ended up at the University of Twente, studying mechanical engineering.'

So you came here for love?
'Yes, you could say that. Love changed, though. And I stayed.'

Right after graduation, you spent five years doing research at the Weizmann Institute of Science in Israel. What was it like to live there?
'It was a very intensive way of living. I came there right after the first Gulf War, so it was still a bit stressful, but people there take care of each other. I felt very much at home. I loved living and travelling there. In the Netherlands no company wanted to insure my motorcycle for me, though.'

You actually drove your motorcycle from the Netherlands to Israel?
'Yes. I drove there. My dog came there by plane.'

You are a dog person, I think.
'I'm an animal person.'

Let's back up a bit. What inspired you to pursue a career in fluids engineering?
'During my studies I was inspired by one professor. I was really intrigued by the way he gave lectures. I met a PhD student who worked with him. He told me about the topic he studied and how difficult it was, so I thought I should give it a try. For my PhD research, I worked on developing a numerical method in lubrication. It was a very challenging problem and I wanted to solve it. I did it and I'm actually still using the method in research now, 28 years later.'

Was this the plan?
'Of course I considered doing something completely different, but this was the path that opened. I came back to the UT and became a professor in 2014. I was honored to get the opportunity to lead and inspire a group.'

What do you enjoy about working in this field?
'I enjoy solving problems that have practical applications.

Text: **Michaela Nesvarova**
Photos: **Annabel Jeuring**

KEES VENNER

'I do everything I do with my heart'

Fluids dynamics is everywhere. In your cup of coffee, in our fight against the sea and living under sea level, in insects flying around. I try to understand physical phenomena related to a problem and translate it to a practical solution. For example, in my group we work on reducing the problem of aircraft noise and we contribute to medical applications. I might not be doing a lot of science myself in this job, but I do create openings and possibilities for people. I initiate research and I am the bridge between physics and practical problems. That is why the title of my inaugural speech was "Crossing scales and bridging disciplines". I think it's important to do that. Talking to people from different backgrounds makes you realize how much you use the language of your own field. And we need to learn how to talk to each other.'

Since you returned from Israel, have you only lived in Enschede?
'Yes, I've lived on different spots in Enschede. For now I'm settled near the campus. We have four kids - ages 16, 18, 21 and 23 – and three of them still live at home. We have five dogs and three cats. And there is of course my partner. She is the most important one.'

How did you meet?
'We met eleven years ago. She was my neighbor. It all started because she knocked on my door and asked me if I wanted to jump out of an airplane with her. With a parachute. I said yes. We jumped and it developed from there. It was funny. When I told my colleagues that I jumped out of an airplane, their first response was "why? Was the plane broken?" Aeronautical engineers, you see? I just thought it was fun.'

You also do karate.
'Yes, I learnt it in Israel. Now I have a third degree black belt. Karate is not only about technical development, but also about personal development. It's like a playground for real life. It teaches you to be calm in face of difficulties. It teaches you to be kind. It helps you develop many qualities. I still teach karate on Sundays.'

That sounds like you have quite a busy schedule.
'Yes, I have a busy schedule and sometimes I think the workload is really high. I must admit that there was a lot of time I could have spent with my family that I spent for the university instead. However, I do everything I do with my heart. Moreover, I'm lucky to be in a position where I can help others with their workload. As a professor, you can create an environment where people can grow.'

Kees Venner in a nutshell:

1963	Born in Eindhoven
1987	MSc Mechanical Engineering, University of Twente
1991	PhD Mechanical Engineering, University of Twente
1991 – 1994	Postdoc, Applied Mathematics and Computer Science, Weizmann Institute of Science in Israel
2002 – 2014	Assistant and Associate Professor, Engineering Fluid Dynamics, University of Twente
2014 – now	Full Professor of Engineering Fluid Dynamics, University of Twente

You enjoy teaching, right? You even received the Brinksma Innovation Grant in 2019 for your innovative teaching method.
'I enjoy creating an environment in which we all learn. It is not about one direction teaching. I like to share my enthusiasm for the subject and I believe that education is an important part of development. It opens doors. The prize was awarded for the idea to introduce "twin teaching" method. It uses the presence of not one, but two teachers in the classroom – one is giving a lecture, as usual, and one is sitting in the audience together with the students. Having a teacher in the audience lowers the threshold for students. It creates a more inspiring environment in which students are less afraid to ask questions – they see that an expert, sometimes a full professor, is there but still doesn't understand the topic and is asking questions. In science we are so focused on a small area of expertise. We are specialists that hardly talk to the specialists next door. However, in that sense, the UT is a good environment. This is not an academic snake pit. We have a good collegial atmosphere here.'

Is there anything you'd really like to accomplish or try in your lifetime?
'Whatever you do, you should do it with full dedication. You should express yourself with full ability and with enthusiasm. The most important thing for me is to have a healthy and inspiring group of people doing good science and contributing to the world. I want to open doors to people who have difficulties. When hiring people, we always look at their CV and their distinctions. What we should focus on is their potential, though. We should make our university inclusive also for people who have had setbacks in life. We should create ways for people to develop themselves, also among supporting staff. And we actually need to do it, not just agree to it. We need to create opportunities for people with difficulties.'

You seem very passionate about this topic. Where does this motivation come from?
'You see that you grow yourself if you create opportunities for others. You learn from every other human being. It is very rewarding. And it makes you aware of how lucky you are if you have had no setbacks in life. It's not all about achievements. You get a lot from your parents, from your environment and so on. You should not only look at where people are, but how they got there. I cannot change the entire world, but if I hire one person with difficulties, then I already change the world for one person. We should not wait for big decisions from above. We should develop ourselves and inspire others. If you are aware of your role as a human being, you can change someone's life without even realizing it.'

One last thing. I just have to ask: why do you actually have five dogs?
'Kind of by accident. Sometimes we regret having so many, but it is so nice to see them all together as a pack. And it's a good management exercise. In a way, it's like managing a team. If you allow them space, they grow and you end up with a good team. Which doesn't mean I'm comparing people to dogs!' ●

'You learn from every other human being'

C

Captured on Camera

Detail of a wavefront shaping setup

One of the beauties of optics is its versatility. A huge range of experiments and applications that can be realized with standard building blocks: lenses, mirrors, lasers, beam splitters. In the last couple of years, a new standard building block has revolutionized optics: the spatial light modulator (SLM). An SLM is a computer programmable optical element that adds a whole extra dimension of versatility, truly leading optics into the digital age. The setup in the picture is used for focusing light through non-transparent tissue, a technique called 'wavefront shaping' that was pioneered in Twente in 2007 by Ivo Vellekoop and Allard Mosk. Thanks to the versatility of SLMs, the exact same setup is also used for measuring optical aberrations in brain tissue, identifying wave correlations in scattered light, creating 3-D reconstructions of cells, and – by flipping one mirror – as a regular microscope.

Text :
Ivo Vellekoop
Photo :
Annabel Jeuring

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