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UNIVERSITY OF TWENTE.

U-TODAY

Science & Technology Magazine

Creating the cyberville we want?


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Black Mirror

I find them phenomenal, those smart solutions to keep our environment safe, sustainable and pleasant. The theme of 'smart cities' is therefore a topic that inspires endless talks, discussions and daydreaming. And that is perfect to write about, because this challenge, with the title 'Engineering our digital society', is high on the UT's research agenda.

In our cover story we ask five scientists about this topic. And they offer nice insights. Professor Boudewijn Haverkort from the EEMCS Faculty says: 'Imagine a city as a human body. If you want to know what's going on around you, you have to use your senses.'

I will not reveal any more spoilers (read all about it on pages 6 – 13), but Haverkort believes that it's possible to 'put sensors virtually everywhere'. 'Even sensors in your own body to monitor your vital functions.'

Perhaps it is because I have seen too many dystopian episodes of the series Black Mirror, but that is going too far for me. Sensors in and on my body? For what? To warn me that I'm drinking my third glass of wine? Or that I have been sitting still for two hours in a row? That my heart rate is too high? That I have not laughed for half a day? That I didn't brush my teeth long enough?

All that data then of course goes straight to the general practitioner, company doctor, company psychologist and dentist. And then? Too many questions, in my opinion...

On the other hand, I find it interesting to see whether there is also a smart solution that would allow children to read better (improve their reading comprehension). PhD researcher Mariska Okkinga (interview on page 44) conducted research on this topic and she discovered that we can improve a lot in the classroom when it comes to methodology and reading strategies.

Nevertheless, the doctoral candidate also recognizes that simply picking up a book more often is still the best method for learning to read better. How much simpler - and at the same time how difficult in these times of digital temptation - could it be? Can a UT researcher think of something smart to solve that?

Marieke Platvoet

Editor-in-chief at U-Today

u today

Colophon

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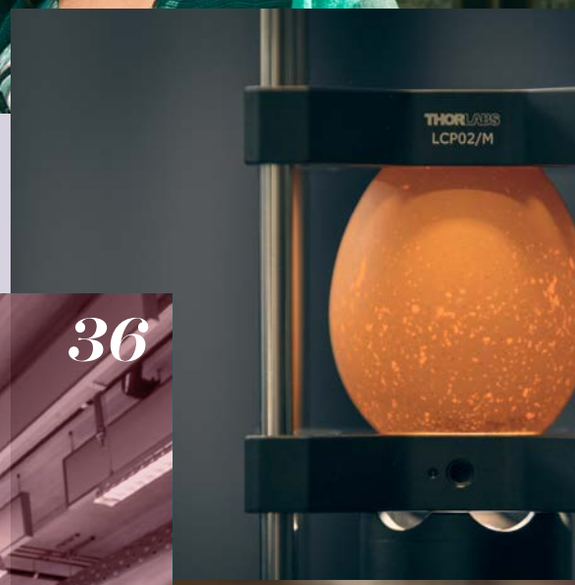


U-TODAY

Science & Technology Magazine

Content

Text: **Michaela Nesvarova & Rense Kuipers**
Photos: **Shutterstock & Rikkert Harink**

Smart Cities: creating the cyberville we want?

More than half of the world's population now lives in urban areas, and by 2030 this number will increase to about 5 billion people. Urbanization is happening on a massive scale, larger than ever before, bringing huge social, economic and environmental challenges. To ensure cities remain livable, we need 'smart' solutions. Hence, we need to transform our current cities into even smarter cities. How can we do that?

Let's forget about the buzzword 'smart cities'. In this article we explore the basic components we need for this urban transformation by highlighting its four main building blocks: the tangible, the invisible, the organized and the human city. And we want to tell you a story about what life in a smart city of the future might look like...

'Take me down to the paradise city...' The morning light and the music wake you up. It's a different song every day, because Alexa has analysed your sleeping pattern and concluded that you wake up faster this way. You open your eyes. The window blinds have been opened, the bedside lamp turned on. Your apartment knows you ought to get up and get ready for work. You vaguely remember a loud ringing of an alarm clock from your childhood and are glad it's far gone.
You take a few short steps into the shower. It turns on automatically, there are sensors in the doors. The water temperature is instantly perfect. Perfect for you, that is. You enjoy the hot water, but soon the beeping starts. A warning, reminding you that 'You've been here for almost five minutes. Responsible water consumption, remember?!' Yes, you know. You agreed to this and set up the measuring device yourself. You stick to your usual shower time. You could decide not to, but you know that the coffee machine has already switched on. You put on the clothes Alexa suggested based on the most recent weather report. Do you really want to be

wearing the grey shirt today? Why not, after all. It's easier this way, efficient.
You follow the smell of coffee into the kitchen. It's much smaller than your parents' kitchen used to be. Much sleeker, too. All appliances are powered by electricity generated here in the building. Bless the new solar panels. The idea of gas and open flame in the middle of your apartment seems rather absurd nowadays. You walk to the fridge and look over the daily recommendations on its screen. You should definitely eat the strawberry yoghurt, it will expire otherwise. The fridge also kindly suggests that you take the last apple, it will add new ones onto the shopping list. Yes, that will do. Like most things inside your fridge, the apple comes from the building's rooftop garden. Think globally, act locally.

Phenomenal

You squeeze by the table to get to the sofa in the seating area. You don't really like calling it a living room, it feels like playing fast and loose with the word "room", but it's still your favourite area of the apartment. The TV is not too large, the little couch is just right, and the view over the city's green rooftops is phenomenal.
Time to leave for work. No need to bring keys. Everything unlocks once it sees your lovely face, even the cars use facial recognition. Speaking of which, it's a bit chilly outside today, so you are hoping one of the self-driving city cars will be available. Shared property has many advantages, no insurance or maintenance costs for you, but it can be hard to predict if you will be able to get your share that day. Unless you pay premium, of course. There are always the bikes, though. But you don't have to paddle this morning. Two of the mini automobiles are standing down the street. People get out of one, you signal, the car spots you and rushes to pick you up.
You hop in and ask the vehicle to take you to the office. You are still a little hungry and consider stopping by the bakery on the way, but the car turns left and you notice it's not taking its usual route due to possible heavy traffic on the main street. You could easily override this decision and change the route, but you know the system would ask you for a reason - just because it aims to adjust to your preferences in the future - and providing an explanation such as 'I have a hankering for a croissant' might confuse the databank. It might even end up on the table of the Chief Information Officer of the city. You smile at that thought and look at the Google Maps on the display again.
The car is taking you through the 'old town'. You leave the green streets of your neighbourhood, lined with trees and water streams, to enter what the city used to be. This part is still being reconstructed. Most of the houses are being demolished, both the overground and underground infrastructure ripped out and replaced. It's supposedly the easiest way, as evidenced by the 'new town', where you live. It used

'You work sitting down or standing up'

to look just like this - family houses, private gardens and garages, no anti-floods systems - until one very unfortunate gas leak gave it a clean slate.

Quinoa salad

Just another day in the office. You work sitting down or standing up, depending on what the sensors in your chair deem best at the moment. Your lunch gets delivered to your desk by Clyde, the autonomous robot the company bought. Today you are having a quinoa salad with steamed broccoli and a smoothie on the side. Fresh and nutritious, as always. At the end of the day, you call for a car via the app and share the ride with a co-worker, seeing that you both need to stop by the City Hall and discuss your opinion on the plans for a new waste recycling system with the local government representatives.

After the meeting you decide to walk home, which also makes your wristwatch happy, because you are finally getting the exercise it has been asking you for all day long. The sun has already set and the streets seem cold and dark, even though the clever lights turn on as you approach them. Once you get home, Alexa senses you look tired and offers to cheer you up with some leftover ice-cream. It's a nice gesture, but you'd rather have a croissant. You spend the rest of the evening in your VR gaming world, playing a friendly battle with your cousin. As the midnight approaches, both your watch and Alexa remind you that you need to get up early in the morning, and so you forget about watching the latest episode of your favourite show. You say 'good night', the blinds close, the lamp is turned off. And not only yours. The city sleeps. How smart.

The main building blocks

The tangible city

The tangible city includes the things we can 'touch'. Think of our buildings, roads, water systems. We often take this hardware for granted and use it daily without giving it a second thought. Yet the infrastructures are unescapably there. They are the silent servants of society. The future is often presented as high-tech dots on the horizon, like fully functional self-driving cars, hyperloops and solar paneled roofs. However, before we can make everything faster, better, stronger and – most of all – smarter, meet the elephant that's blocking the way towards a smarter tangible city: the Global Infrastructure Gap.

According to a 2014 report from the World Economic Forum, the United States alone have an infrastructural gap of 3.7 trillion dollars annually. UT professor André Dorée adds that the gap between supply and demand doesn't apply exclusively to the US. 'It's an issue in the Netherlands also. Not only regarding the above ground infrastructure, but also below. In the Netherlands alone we have a total of more than two million kilometers of cables and pipes below our surface, worth hundreds of billions. And most of the today's Dutch infrastructure was built after the Second World War, thus nearing the end of its lifespan. One of the major challenges we have to overcome to create smarter cities, is finding ways to overhaul networks that move beyond their lifespan in a smart way.'

Dorée knows that if that doesn't happen, things can get disastrous. Be it on a small scale – like gas leaks – or on a larger scale, like a huge water main burst which meant the Amsterdam based VU Medical Centre needed to evacuate all its patients a few years ago. The professor at the faculty of Engineering Technology believes that a 'minimally invasive surgery' approach to civil engineering can help us to improve our below ground infrastructure. Forget green fields and clear sky blue prints. 'The tangible city is already crowded with hardware, copes with a dense population, provides limited space, and systemic shortage of time and money for projects. Focus is required. More often than not, we don't even have a good overview of the subterranean infrastructure. And how can you fix something if you don't even know what's there? To move forward we have to locate potential problems and find weak spots. Which requires extensive mapping of everything we have below ground.'

The professor sees a major role for civil engineers to create smarter, more livable cities. 'It's about finding technology that enables transitions. There are a lot of holes and gaps – not even in a literal sense, but also in the knowledge we have of our infrastructure. Developing smarter technologies can help us in making conscious decisions about uncharted territory. If we want to improve our cities, it starts with taking a step back and rethink the way we look at our assets. We cannot overcome our current challenges if we keep formulating new ones.'

'Drones could replace police helicopters'

The organized city

Who governs the cities of the future? Who makes sure that daily life doesn't come to a complete standstill? Who makes the decisions that should be best for you as a citizen? The organized smart city is an intricate web of all kinds of parties collaborating: the government, businesses, people and – last but not least – academia. The real challenge in the organized city is how those parties can benefit from each other.

Marcel Boogers, professor in Innovation and Regional Governance, believes the government has two key tasks to channel the transition to smarter cities: facilitating and regulating. 'You see all kinds of major and extremely powerful corporations getting more control over our lives. For governments it is hard to pull the brake on that movement. So when it comes to big data that's being collected by companies like Google, Facebook and Microsoft, maybe it's best for governments to not try to beat them, but join them. Nowadays, Google probably knows more about you than your own government. So why not use it to the advantage of you and your inhabitants?'

Boogers agrees with his colleague Haverkort that establishing the position of a Chief Information Officer in each municipality should become a common practice. He continues on Haverkort's example: 'Some data should be protected by the government. But other data from companies could be very well used. Why not use Google Maps data to get a clearer picture of traffic flow? It already works quite well. And smart algorithms can help the police to predict where and when crime will be more likely to happen. Data can help the government in its decision making process.'

There are definitely problems with too much privatization, professor André Dorée adds to Boogers' remarks. 'Transitioning to a smarter city isn't only a technological challenge, but also an organizational one. Coordination of the growing number of private utility companies is plagued by all kinds of hold-ups. The more parties involved, the more they behave strategically, the more processes and more uncertainty it will lead to. Privatiza-

tion in the tangible city created a no man's land, absence of clear problem ownership and the risk of stalemate.'

It's not only about problem ownership, but also ownership in itself, Boogers believes. 'Data will rule everything and everyone's lives? No, I don't buy the idea of us moving towards a technocracy. The internet has created a more level playing field when it comes to information access. Nowadays everyone can be an expert. And I do believe that politicians and local governments can use technology more to engage with people, share information and create policies. Ultimately, it's still people who make the decisions. Not technology.'

The invisible city

Citizens produce data. Probably more often than not without even knowing so. That's where the invisible city comes into play. Who collects your data? How? What happens with the information stream we call big data? And the question that is on everyone's mind: is my privacy at stake? When cities become more digitalized, there's no way you can get around data collection. And no way you won't notice the invisible impact it has on you as a citizen.

'Imagine a city as a human body,' says professor Boudewijn Haverkort of the EEMCS faculty. 'If you want to know what's going on around you, you have to use your senses. Be it by seeing, smelling, hearing, tasting or feeling. The same concept applies to a city: the better you sense what's going on, the better you can respond to changes. Better yet, the better you can change something to improve the living, breathing organism that a smart city is.'

Haverkort thinks that it's possible to put sensors on everything. 'And it's a growing movement. Think of Wi-Fi trackers, advanced face recognition software, even sensors in your own body to monitor your vital functions. Your public transport behavior is measurable, the same goes for your private transport behavior, when you use Google Maps.'

'It's still people who make the decisions'

'Data is just data,' according to the professor of Design and Analysis of Communication Systems. 'It comes down to how we use the collected data. Ideally you use it to improve the quality of life of people and thereby also the livability in a city.' As an example, Haverkort names the goal of reducing emission fuels. 'One of the ways to do that is to get an insight into the way we use different modes of transport. No one really likes public transport, but there is a way to make it less of a hassle. If you have insight into the data of people's behavior, a bus could for instance take shortcuts along the way. Take it a step further and imagine a city in which car ownership isn't necessary. When people share cars, you could rapidly decrease traffic, congestion and thereby emission.'

Now, who would collect and own that data? Haverkort states that two concepts are of paramount importance: security and privacy. 'It's not necessarily a trade-off between the two of them, if you take the right measures. Security is about others not overlooking what you're doing and it comes at a price. Privacy is about what you want to tell about yourself. I think it's really important that before data could be collected, people should have the option to opt-out. That they are in control of what they do or do not share. In the end, data is still just invisible data. But when data gets combined, it can get a lot less harmless.'

The human city

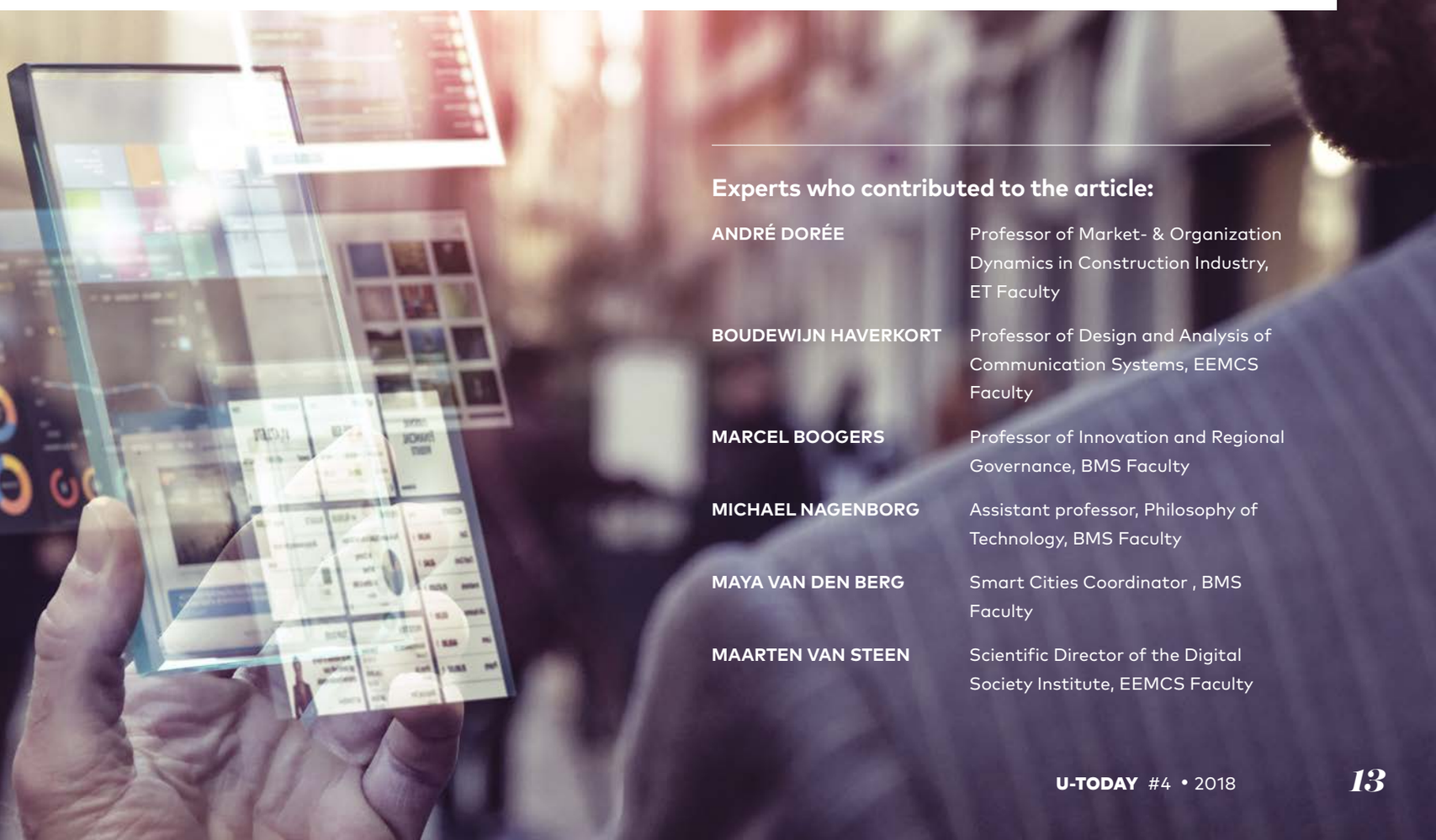
No city can exist without its inhabitants. They are what truly make a society function. Having all kinds of technology affecting our daily lives in a smart city, are we losing touch of the human factor or not? In the end, it's smart citizens who make a city smarter. Let's explore the impact and implications of digitalization on people.

According to philosopher Michael Nagenborg, technology isn't really tailor-made for humans. 'A technical system doesn't really recognize us as an individual. The system works by its own built-in rules and codes. And it sees the world differently than we do.' That's one of the reasons that Nagenborg thinks that a technology push alone doesn't make a city or society smarter. 'But it does require us to think of the desirable qualities a smarter city should have. To keep it livable, enjoyable and meaningful to be part of such a society.'

Nagenborg believes it's an interplay between both worlds. 'It's important to understand what difference a new technology makes. For example, drones could replace police helicopters for surveillance purposes. However, technically it's quite easy to have drones surveilling 24 hours a day in contrast to a police helicopter. The real challenge is to anticipate what difference a technology will make. Before we have it, we don't know how it works and how it will affect us. Hence, we need to experiment with new technologies to understand what they mean to us.'

There are also human factors in which we do need to make a stance, Nagenborg believes. Especially since digitalization generally creates more data. 'Too often, data is mistaken as facts. Data is never neutral and its acquisition and use rely on interpretation. Ownership of data is an issue, too. As an example, the data coming from the Wi-Fi trackers in the city of Enschede is in the hands of the private company that runs them. You see these growing pains all over the place in cities that become smarter. It's the problem of multiple hands, who may not even have bad intentions with the data.'

Nagenborg sees a specific risk in the distributed nature of data collection and handling. 'Ironically, a benevolent big brother might be a easier to control than an infinite number of small parties collecting data for themselves. And then the trust factor comes in. I believe transparency is the start of trust. It starts with people knowing what's going on around them and who's doing it. Knowing is half the battle towards becoming a smarter society.' ●



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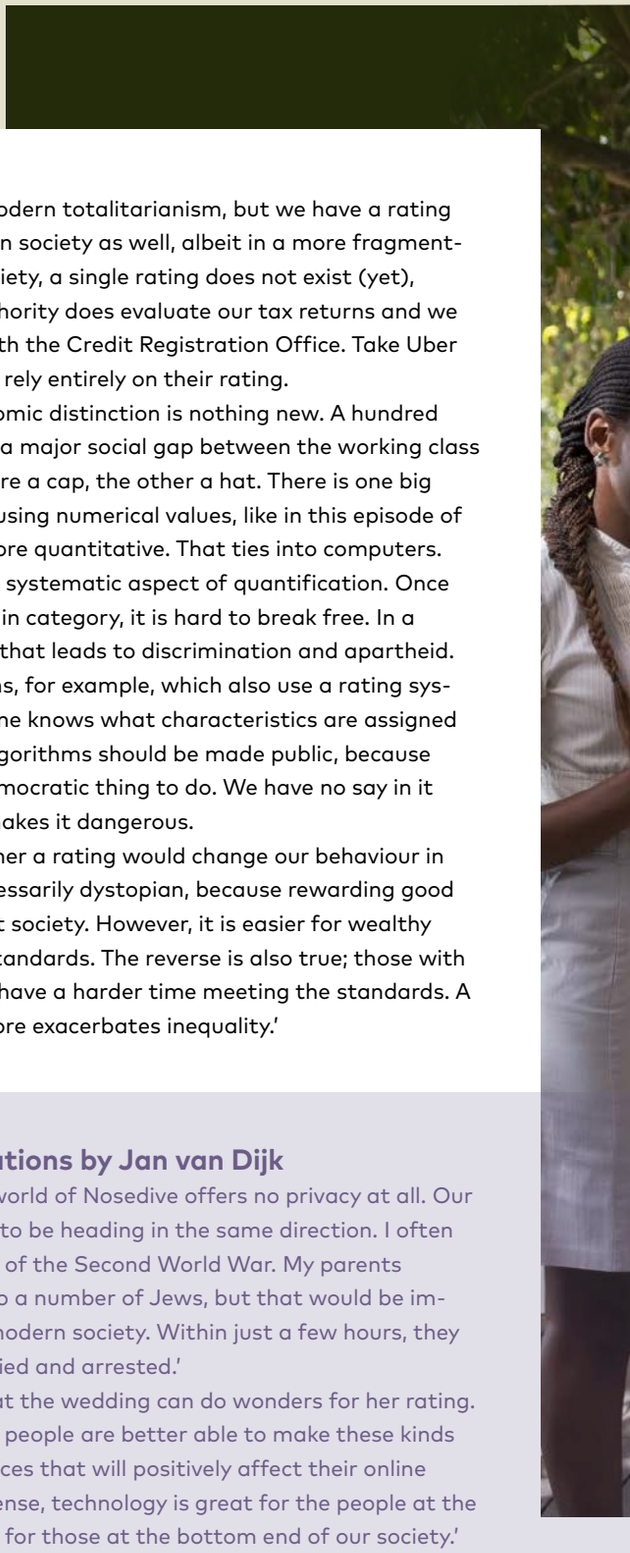
POP CULTURE

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



In this edition, the British television series Black Mirror (2011 – present), specifically the episode Nosedive, is analysed by Jan van Dijk, professor of Communication Science. If you have not watched this episode yet, beware of spoilers!

The plot

In this episode of Black Mirror, we follow Lacie, a young woman in a fictitious world. The people in this futuristic society rate each other on a scale of one to five, using an app. If someone brings their colleague a cup of coffee, they get five stars. If they share a great holiday photo, another five stars. If they scream at a customer service agent, one star. This rating determines the users' socioeconomic status and – as the episode makes clear – virtually everyone uses the app.
Lacie starts out with a rating of 4.2 and she is doing everything she can to raise it to a 4.5. That will give her a sizeable discount on a desirable apartment. It seems impossible, until an old school friend asks her to be her bridesmaid. That presents her with a unique opportunity, because all the guests at the wedding have a rating of 4.5 or higher. A single good score from one of those people would give her own rating a serious boost – not to mention what a whole crowd could do. Unfortunately, Lacie does not make it to the wedding unscathed.

First impression

Van Dijk: 'Nosedive is very dystopian. It presents an awful vision of the future and illustrates the consequences of the digital revolution. The pastel colours also stood out to me. Everything is made to look better than it is – sort of like our Facebook profiles.'

Realism/feasibility

Although the series is dystopian, Van Dijk believes this episode has many similarities with our current society. 'Take the social credit system in China,' Van Dijk says. 'It was introduced in 2016 and is used to rate the online behaviour of Chinese citizens.
If you show good behaviour – by the government's definition, that is – you gain credit. Citizens with high scores have a better chance of, for example, getting a job with the government.
The internet is a mirror of our society. In China, it is part of the country's brand of modern totalitarianism, but we have a rating system in our Western society as well, albeit in a more fragmented manner. In our society, a single rating does not exist (yet), although the Tax Authority does evaluate our tax returns and we have registrations with the Credit Registration Office. Take Uber taxis or Airbnbs; they rely entirely on their rating.
Of course, socioeconomic distinction is nothing new. A hundred years ago, there was a major social gap between the working class and the elite. One wore a cap, the other a hat. There is one big difference, however: using numerical values, like in this episode of Black Mirror, is far more quantitative. That ties into computers. The danger lies in the systematic aspect of quantification. Once you are put in a certain category, it is hard to break free. In a worst-case scenario, that leads to discrimination and apartheid. Facebook's algorithms, for example, which also use a rating system, are secret. No one knows what characteristics are assigned which score. These algorithms should be made public, because that would be the democratic thing to do. We have no say in it right now and that makes it dangerous.
The question is whether a rating would change our behaviour in any way. It is not necessarily dystopian, because rewarding good behaviour can benefit society. However, it is easier for wealthy people to meet the standards. The reverse is also true; those with fewer capital means have a harder time meeting the standards. A rating system therefore exacerbates inequality.'

Stray observations by Jan van Dijk

- 'The dystopian world of Nosedive offers no privacy at all. Our society appears to be heading in the same direction. I often use the example of the Second World War. My parents offered refuge to a number of Jews, but that would be impossible in our modern society. Within just a few hours, they would be identified and arrested.'
- 'Lacie knows that the wedding can do wonders for her rating. Highly educated people are better able to make these kinds of strategic choices that will positively affect their online rating. In that sense, technology is great for the people at the top, but horrible for those at the bottom end of our society.'
- 'I especially liked the final scene of the episode, in which Lacie no longer cares about her app. She stops pretending to be better than she is and starts screaming and cussing at everyone.'

Text: **Jelle Posthuma**

Still from episode 'Nosedive' of the TV series ***Black Mirror***.

Messy

If the city of the future is 'smart', what do we call cities that do not meet that criterion? Nicholas You, director of the Guangzhou Institute for Urban Innovation in China, was unequivocal on the matter during a conference in Singapore: cities that refuse to take the 'smart' course are simply 'stupid'. Such places are simply asking for urban sprawl, where stubborn people move to thinly populated suburban areas and live as they please. It is far more efficient to pack people close together into skyscrapers, as it reduces car usage and harmful emissions. Additionally, people are far easier to manage if they all live in an organised, hypermodern environment full of sensors and cameras that produce valuable data. If this data is combined and analysed in the right way, it can lead to solutions to countless urban problems such as traffic jams, pollution and crime. Who wouldn't want that?

In the cover story, professor Boudewijn Haverkort explains that a city can be compared to a human body. All organs would be able to work together in perfect harmony if every street and every building, every device and every living creature were tailored to people's wishes and the wellbeing of the whole, using the right technology. However, what wishes are still desirable in a smart city? The wish to drive your own gas-guzzling old timer is a tricky one, as is the wish to drink alcohol or go to bed too late. If the smart city is a body, are the people its conscious brain or are they like red blood cells that can only go with the flow?

In the book Calm Chaos by the Italian author Sandro Veronesi, the main character talks about the joy of ignoring a navigation system's directions and stubbornly turning right whenever it tells you to turn left. Of course, turning left might be far more efficient and sensible than turning right or going straight on. More efficiency does not necessarily make us happy, however. The human way of living life is quite messy, as Veronesi demonstrates. We are just going about our business and often get ourselves into trouble. There is surely a better way, but how far are we willing to go when it comes to streamlining our existence to maximise its efficiency?

The typical smart city of the future does not exist yet and the political decisions that it requires will have different outcomes in China than in Europe. I can only hope that my city will leave enough room for the inefficient mess we desperately need sometimes.

Enith Vlooswijk
Science journalist

E

Everyday Science

Finding your way with algorithms

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

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

Algorithms are everywhere. But how do they influence our lives? 'An algorithm is like a recipe,' says UT researcher Bodo Manthey, Associate Professor at the chair Discrete Mathematics and Mathematical Programming. 'With an algorithm you take steps that lead you to a result. In our current society algorithms already have a big influence, but we talk too often only about the negative effects and forget the positive contributions. For example, thanks to algorithms, navigation we use in our cars or on our phones is possible. And this is only one of many examples.'

'Let's imagine the application of algorithms to calculate all the possible routes from Enschede to Schiphol. A naïve approach would be to look at all possible routes, which would take millions of years to do. If the calculation of one route takes a few milliseconds, the total calculation easily takes ten times the age of the universe. That is obviously useless, and exactly not how one wants to use computers.'

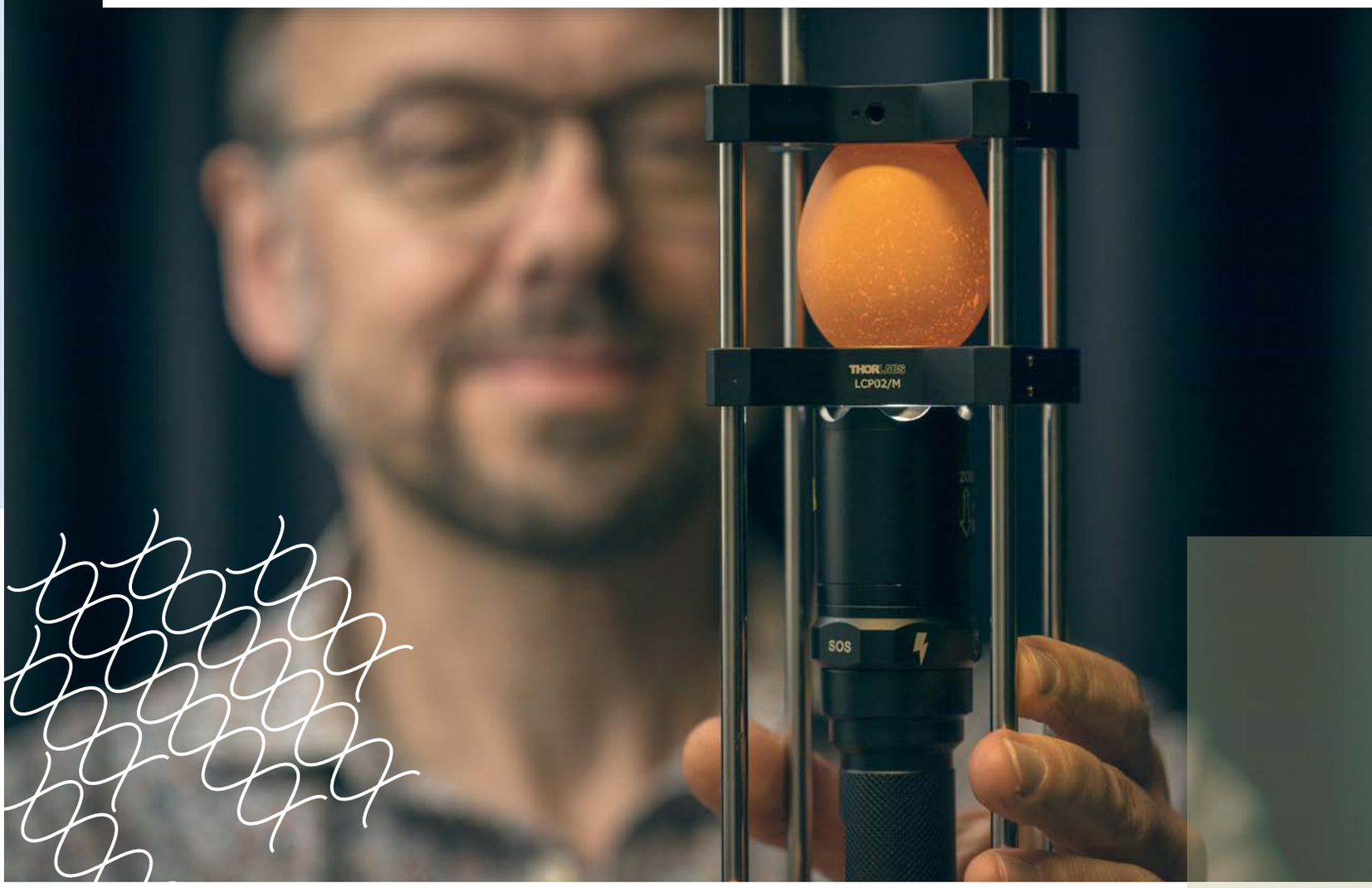
The Dutch mathematician Edsger Dijkstra developed the first efficient shortest path algorithm, which avoids looking at all possible routes, but finds a shortest route efficiently. 'In the 1950s, when Dijkstra published his algorithm, computers did not yet have the computing power to solve the problem. This has changed and nowadays every navigation system contains a variant of Dijkstra's algorithm. His algorithm is very clever and is taught to thousands of students.'

Although algorithms have a major impact on our society, artificial intelligence with the ability to think independently, still does not exist. 'Researchers have been saying since the 1970s: there will be artificial intelligence in ten years from now. If they, the people from the 1970s, would see what we can do now, they would probably call it AI. However, our borders of what we think is artificial intelligence are shifting constantly. For the time being, there are still a lot of things that people can do better than algorithms.'

PROFESSOR WIENDELT STEENBERGEN AND HIS CREATIVE RESEARCH

Saving billions of chicks

The words 'science' and 'creativity' are not often used in the same sentence. However, Wiendelt Steenbergen, professor of Biomedical Photonic Imaging, manages to combine the two. He has been awarded the NWO Open Mind Grant twice already, once with his proposed research into the use of peppers for a possible new cancer treatment and once with a way to save billions of chicks.



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

'The grant challenges you to bring your wild ideas to fruition'

Where do your ideas come from?
'Two years ago, my department started organising an annual PhD Day. On that day, all PhD candidates explain how their research is going and what they want to achieve. We end the day with a Crazy Ideas Contest. Everyone gets to pitch an outlandish yet somewhat feasible idea related to the department's field of expertise. As the department's head, I had to join in, so I came up with these ideas.'

Was the Open Mind Grant a way to pursue these ideas?
'Exactly. The grant challenges you to bring your wild ideas to fruition. NWO does expect you to jump through a few hoops: write a two-page research proposal, shoot a video and – if you make it to the finals – prepare a pitch. On the other hand, you have a chance to receive funding to spend a year working on a societal issue and approach it from a surprising angle.'

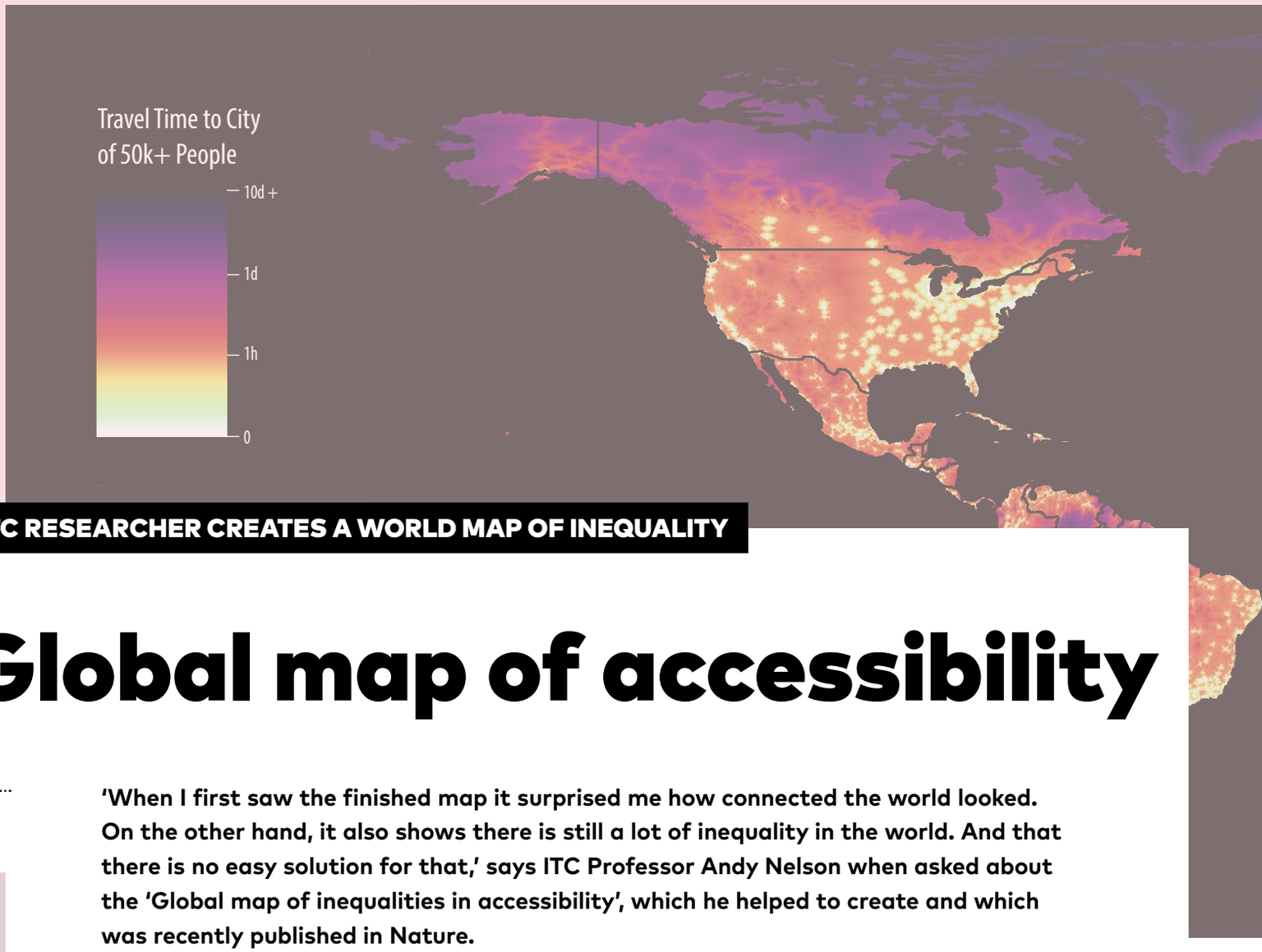
Saving billions of chicks appears to tie into that perfectly.
'It is not really about saving the chicks, but rather about preventing their existence. In the Netherlands alone, 45 million rooster chicks are killed every year. On a global scale, that number is circa 3.2 billion. The agricultural industry is only commercially interested in hens. That is why I believe there is a clear need, from several angles, to resolve this problem.'

How will you go about that?
'For patent reasons, I cannot reveal too much just yet. What I can say is that we are working on a way to use light to determine the sex of the chick within a few days of the egg being laid. At that point, it is little more than a clump of blood vessels and some protein, but it should be possible to tell whether this will grow into a rooster or a hen. This method also keeps the egg intact. No one else has managed that yet. There are other ways to determine the sex of a chick at an early stage, but they all require a hole to be poked into the egg's shell. My method is designed to be totally non-invasive.'

Saving billions of chicks sounds quite heroic. Do you look at it like that?
'That would be a bit too much praise. It is true that chicks are pretty cute and our research can definitely help to treat animal lives with more care. At the same time, this research will be interesting in an economic sense if the technology can be scaled up from the lab to an industry environment. It will allow us to make a positive difference in several ways.'

How is the research that won you the same grant in 2016 doing?
'It's looking promising. The research centred around the use of a certain substance in peppers, capsaicin, which stimulates a patient's blood flow in such a way that circulating tumour cells are pushed towards the surface of the skin. The ointment we currently use does not contain any capsaicin at all, but it has a similar effect. We can use thermography to examine a patient's blood flow. It looks like the blood flow is large enough to treat tumour cells circulating in someone's blood through the skin. We are currently collecting all our research results.'

These appear to be two entirely different types of research.
'That is true. It is also what makes this so much fun: exploring scientific avenues and conducting research in fields that you do not have a track record in yet. We are working from a solid foundation: we are using technologies that we have developed over a period of twenty years. Who knows; perhaps one of these avenues will lead to an entirely new line of research that we can have an impact with.' ●



ITC RESEARCHER CREATES A WORLD MAP OF INEQUALITY

Global map of accessibility

'When I first saw the finished map it surprised me how connected the world looked. On the other hand, it also shows there is still a lot of inequality in the world. And that there is no easy solution for that,' says ITC Professor Andy Nelson when asked about the 'Global map of inequalities in accessibility', which he helped to create and which was recently published in Nature.

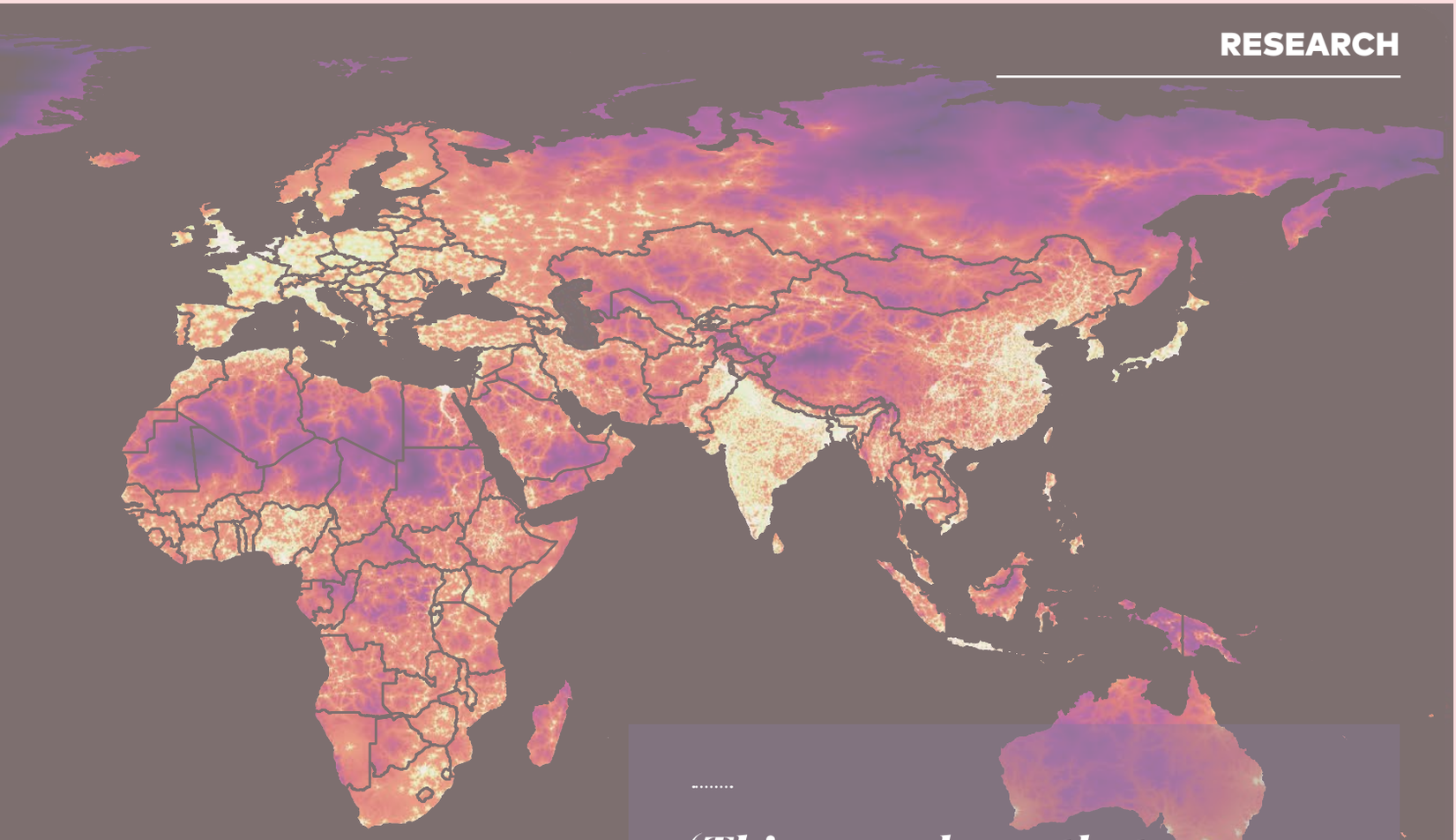
The full name of the map, which stirred up a lot of interest worldwide, is 'A global map of travel time to cities to assess inequalities in accessibility in 2015'. In a nutshell, it shows how long it takes to get to the nearest city from anywhere on Earth. 'Cities are hubs for economic and social activities. They offer a high concentration of markets, jobs and facilities for healthcare or education,' explains Nelson. 'The map reveals how easy it is for people in different areas to access these resources - and that many people, especially in developing countries, often have to spend long hours to meet their basic needs.'

'The solution isn't to build more roads'

Collaboration with Google

The map is a result of a collaboration between various experts from the University of Oxford, the European Commission's Joint Research Centre (JRC), Vizzuality, the University of Washington, the University of Queensland, Imperial College, the University of Twente and, last but not least, Google which provided large data sets and the processing tools that made the map possible.

It all started with the ITC professor, though. In 2008, Andy Nelson was working at JRC and was asked by the World Bank to calculate the number of people who lived within one hour travel time of a city. He accepted the project and ran with it. 'I didn't stop at one hour from a city, I kept going and ended up with a global map, which received a lot of attention. It was a completely new visualization of how connected we are,' says Nelson, whose original method was used to generate the new (and much more detailed) map. 'We used the same method,



'This map shows that people are left behind'

Text: **Michaela Nesvarova**
Photos: **Nature vol 553**

but improved the quality of the map thanks to big advances in the available information and means, which we had at our disposal thanks to the collaboration with Google.'

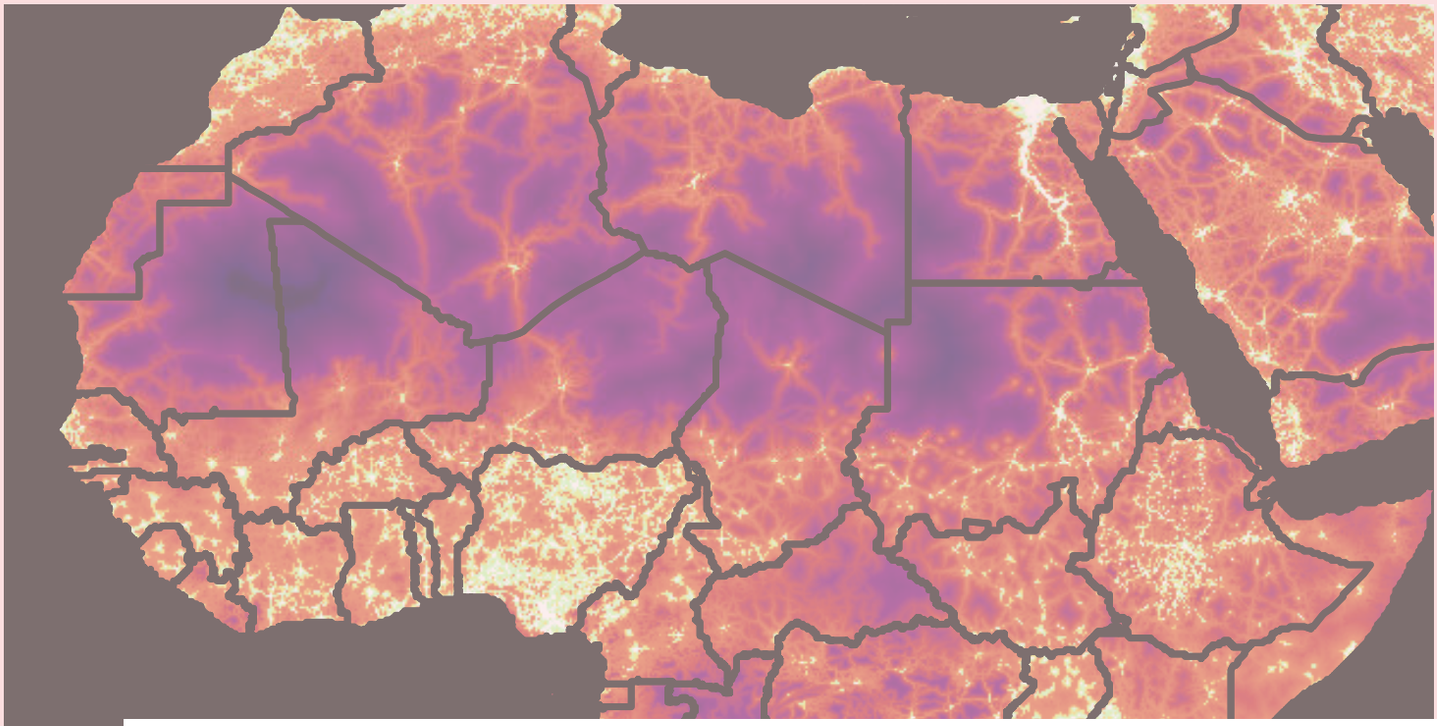
Where do we go and how long does it take?

How does it all work? 'To make the map, you need several layers of spatial information that cover the entire world,' Nelson begins to describe the method. 'Firstly, you need to know where people want to travel to. In this case, that means all cities with more than 50,000 inhabitants, because we can assume that such cities have all necessary facilities that people need access to, including hospitals, schools, food markets etc. Secondly, you need to know how long it takes to get there. For that you need data on transport networks and the typical speeds of travel over those networks, and for foot-based speeds you need to know the slope and type of land - is the area covered by forest, grassland or desert? Once you have that information, you can estimate how long it takes to cross one kilometer of the land.'

A special algorithm was used to calculate the shortest route from anywhere to the nearest city. This approach is very computationally expensive, though, and so this is where Google came into play. The researchers used a newly implemented version of the algorithm on Google Earth Engine (a cloud computing platform for global scale analysis), which allowed them to quickly process very large sets of data. On top of that, Google provided a new road data set, which the researchers combined with the roads from Open Street Map to make the most detailed and up to date representation of the world's land-based transport networks. This made the production of the map much faster and easier than it was ten years ago.

'People are left behind'

The global map is now completed and publicly accessible. The current map is a generic representation of our world in 2015, but Professor Nelson stresses that it can easily be updated or used for creating more detailed maps of smaller areas. 'We chose to generate a map of 2015, because that was the starting year of the UN's Sustainable Development Goals, which carry the theme "leave no one behind". This map shows that people are left behind.'



Knowing how accessible a place is can be very useful for researchers, policy makers or investors. 'Accessibility is an important factor in many domains: healthcare, food security, deforestation and so on. For instance, if you have bad access to health services, child mortality is likely to be higher or vaccination rates lower. Access to market influences the availability, quality and price of food. Not to mention that the time you spend travelling could otherwise be spent on something more productive, like work or education,' says Nelson.

Low access and too much access

Based on the map, which parts of the world seem to have the biggest problems with accessibility? 'Well, on one hand, you could say "Not the Netherlands!" since everything is well connected and even small towns provide good access to many services people need, even accounting for the traffic jams! On the other hand, the concept of "remote" doesn't really apply in this country, and that may make it hard to maintain the isolated and peaceful character of some rural and natural areas which also have a high value,' answers Nelson.

A striking example of the problem of too much access is Indonesia where road building has opened up previously remote areas which have then suffered from higher rates of deforestation. Sub-Saharan Africa provides examples where too little access is the problem. 'We looked at large household survey data in developing countries and saw that poor access to cities was associated with lower wealth, lower rates of education and poorer health outcomes, compared to households with better access,' clarifies the UT researcher.

With these examples, we start to see the two sides of accessibility. So, how can access to basic economic and social needs be improved while maintaining and even improving the natural environment? The map could be used to help answer this question. 'The solution isn't to build more roads,' stresses Nelson. 'The world is already a well-connected place. The map can guide where improvements to the transport network would provide the most benefits with the least impacts and it can show where road construction should be avoided.' ●

Images: Weiss DJ., Nelson A., Gibson HS., Temperley WH., Peedell S., Lieber A., Hancher M., Poyart E., Belchior S., Fullman N., Mappin B., Dalrymple U., Rozier J., Lucas TCD., Howes RE., Tusting LS., Kang SY., Cameron E., Bisanzio D., Battle KE., Bhatt S., Gething PW. (2018) A global map of travel time to cities to assess inequalities in accessibility in 2015. Nature vol 553, p333-336.

‘High risk, high gain’

Alvaro Marin

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

‘My idea is sometimes considered naïve. Some people often tell me I don’t know what I’m doing, but if it works, it would be amazing, and that’s what this is about: high risk, high gain,’ says Alvaro Marin, who’s been awarded the prestigious ERC Starting Grant for his project NanoPacks.

Even though he received a personal grant worth 1,5 million euros, this Assistant Professor from the UT’s Physics of Fluids group doesn’t believe he should be featured in the ‘Rising star’ category. Alvaro Marin doesn’t focus on prizes. He is all about science. And about making his research accessible to the general public - which he demonstrates by intelligibly explaining his project that involves complex topics and terms such as ‘plasmonic hotspots’ and ‘vanishing worlds’.
‘Within the NanoPacks project we are making tiny droplets below one microliter in size. We put elements inside them, let the droplets evaporate and wait for these elements to interact. Through this process we aim to make complex and useful structures,’ begins Marin, while drawing droplets and particles on a piece of paper. ‘I call these droplets “vanishing worlds”, because they shrink and that forces all the elements inside to interact. If we play with how they interact, we can create new structures. Chemists have worked on this self-assembly a lot, but my idea relies on the shrinkage, on physics, which is a new approach.’
Marin and his team use special metallic or metal-coated nanoparticles inside their vanishing worlds. ‘When these particles come together, they form plasmonic hotspots, which can be used for detection of single molecules,’ says the scientist. ‘We hope to make simple systems in which we can create these plasmonic hotspots. By simple I mean cheap and easy to use, because current plasmonic hotspots structures are very expensive and not suitable for commercialization.’
Although Marin stresses that he ‘is not the guy to make it into a product and bring it to the market’, he does keep the real-life applications of his research in mind: ‘Our approach should allow us to detect even very small traces of biogenetical material, including those produced by some pathogens.’ As such, this completely new method of single molecule detection could be used for early detection of diseases, one day maybe even cancer. ●

Our ‘Rising Star’ Alvaro Marin:

2008 PhD in Engineering, Department of Aerospace Engineering and Fluid Mechanics, University of Seville

2008-2011 Postdoctoral Fellow in the Physics of Fluids group at the University of Twente

2012 - 2016 Researcher associate in the Institute of Fluid Mechanics and Aerospace Engineering at the Bundeswehr University Munich

2016 ERC starting grant, Assistant Professor at the University of Twente

THE LAB

The GeoScience Laboratory

Did you know that ITC has its own lab? Mostly located on the ground floor of the faculty building, the GeoScience Laboratory (GSL) is in fact rather large. It includes a total of 12 rooms that house a combination of spectroscopy, geophysics and (geo)chemistry facilities. As all these would naturally not fit into one picture, this photo only shows a glimpse of the sample preparation lab, where you can find, for instance, a muffle furnace, a polishing machine or equipment for sieving and grinding. GSL is run by ITC researcher Caroline Lievens and is open to anyone, but all users must first undergo a training. Once they are properly instructed, they can book time with equipment of their choice. The lab offers a wide range of instruments that allow its users to carry out spectroscopic and/or analytical measurements on sample material. For example, the chemistry laboratory is used to analyze soils, minerals, biomass, oils or (contaminated) water. The geophysical laboratory has equipment for investigating earth subsurface structure; and the spectroscopy lab aims to determine earth material chemistry and physics. There is also a field lab and a drone room filled with – unsurprisingly – various drones that researchers can use for, among other things, determining efficiency of crop production or for post-hazardous damage assessment.

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


ANNEMARTH IDENBURG

Text: **Rik Visschedijk**
Photos: **Christiaan Krouwels**

ALUMNA ANNEMARTH IDENBURG DISCUSSES HER WORK IN THE HAGUE

Where science meets policy

'Searching' is an important word for UT alumna Annemarth Idenburg (1963). In secondary school, she was not sure what she would go on to study. She ended up choosing applied mathematics, and switching to the Public Administration faculty for her doctoral degree. She is still searching today, in her role as project coordinator with the Netherlands Scientific Council for Government Policy (WRR) in The Hague – for information, scientific knowledge and ways to translate policy issues.

Former UT professor of Public Administration Rob Hoppe once described her role as that of a 'boundary worker' and Idenburg can identify with that. 'It's where science meets policy,' she summarises. 'Of course, it's not a scientific role, but you do interpret scientific knowledge. I do not draw up policies myself, either. My colleagues and I offer advice on long-term developments.'

Practical mathematics

With her background – having studied Applied Mathematics at the UT – she stands out at the WRR. Her colleagues are lawyers, public administrators, sociologists and historians. 'It is true that people with a background in the sciences are somewhat underrepresented,' she laughs. 'At the same time, my background is broader than just the sciences. During my studies I was looking for the practical applications of the mathematics I was learning. That is why I went to Indonesia to study the demand for phone connections. I obtained my doctoral degree through research into a subject with environmental and economic ramifications.'

That desire to combine theory and practice started at an early age. In secondary school, Idenburg loved history and considered studying it. 'There were other programmes that also appealed to me. I was looking for something socially relevant. When I realised that I was mainly looking for mathematics in any programme's curriculum, I decided to pursue mathematics directly and enrolled at the UT.'

Comprehensive and complex

She coordinates projects at the WRR. Their contents vary from the close interlinkages of the banking sector with our society, to civic participation and disparities in health along socioeconomic lines. 'I love working on different projects,' Idenburg says. 'I believe I am a valuable addition to these teams with my background in the sciences. The subjects we tackle are

comprehensive and complex. I bring systematic working methods and network thinking to the table. Whenever someone says, "that is how it is", I immediately start looking for the exception.'

She uses her knowledge on a variety of projects. When she started working with the WRR in 2008, she joined the i-government project and became project coordinator of the 'Vertrouwen in burgers' ('Confidence in Citizens') project in 2009. 'We noticed that the collaboration between the government and citizens is not always optimal. Governments complained that citizens were not involved enough, while citizens launched all kinds of initiatives that the government did not support. We wondered what the problem was.'

Next came the 'Financialisation' project. 'How to develop a financial sector that supports economic development and increases the resilience of our society,' Idenburg summarises. 'We were caught in the middle of the economic crisis and it became clear that our society had become extremely vulnerable through overreliance on the financial sector.' Most of these projects result in a publication. Idenburg: 'It is not immediately translated into policy. Our work is (or should be) read by policy makers – both politicians and officials.'

After being seconded to the SER (Social and Economic Council of the Netherlands) this past year, she is now moving her stuff back into her old office, which she shares with a colleague. One of the upcoming projects has to do with infrastructure. 'We are currently exploring what the focus of our research should be, but it will have something to do with the social values concerned. The government invests heavily in infrastructure and it is important to keep such social values as inclusivity and social justice in mind as well.'

'The UT is a recurring element in my life'

Scientific aspects

In Idenburg's work, scientific aspects often play a major role. When working on a project, she explores the latest publications on the topic. 'That is not always easy,' she says. 'Part of science is debate. When we start working on a project, that debate is usually not over yet. Review papers come in handy, though, as does Google Scholar. We also gain a lot of knowledge from talking to people on the ground. Together, the members of the Council have an extensive scientific network that we can use.'

Idenburg works in The Hague, close to the country's political heart. The WRR is located on the Buitenhof. Nearly every day, she travels there from Amersfoort, where she lives with her husband and the last of her three children that still lives at home. 'I also visit the campus from time to time,' she says. 'My oldest son is studying physics there.' She has a special relationship with the UT. 'I moved there when I was a toddler. My brother was the first baby to be born on the campus. When I started my own studies, I moved into a room on the Calslaan 1-2. I could see my old house from my window, that was quite special. The UT is a recurring element in my life.' ●

Netherlands Scientific Council for Government Policy

The WRR was founded in 1972 at the initiative of, among others, the Royal Netherlands Academy of Arts and Sciences (KNAW). Its goal is to incorporate more scientific knowledge into policies. The WRR advises on long-term government policy. The Council itself, which consists of renowned experts from the sciences and society, is appointed by the Crown and sets its own agenda.

Text: **Jelle Posthuma** Photo: **Gijs van Ouwerkerk**

M

Master Research

Saving lives with augmented reality goggles

'With virtual assistance, you are not alone'

Reanimation with the help of VR goggles. Sander Giesselink (24), master's student of Human Media Interaction, is writing his thesis about it. He even built a 3D visualisation which provides remote assistance during reanimation.

Suppose you are out in the middle of nowhere. Suddenly, the only other person with you has a heart attack and falls to the ground. You dial 112 and speak to a paramedic. 'Activate your goggles,' they say. You do as they say and see two hands appear in your field of view. A large, green arrow points to the victim's head. From the goggles' small speakers, you hear a voice telling you to 'tilt back their head and lift up their chin.' Two virtual arms demonstrate what you have to do. The paramedic talks you through the reanimation step by step.

Virtually on site

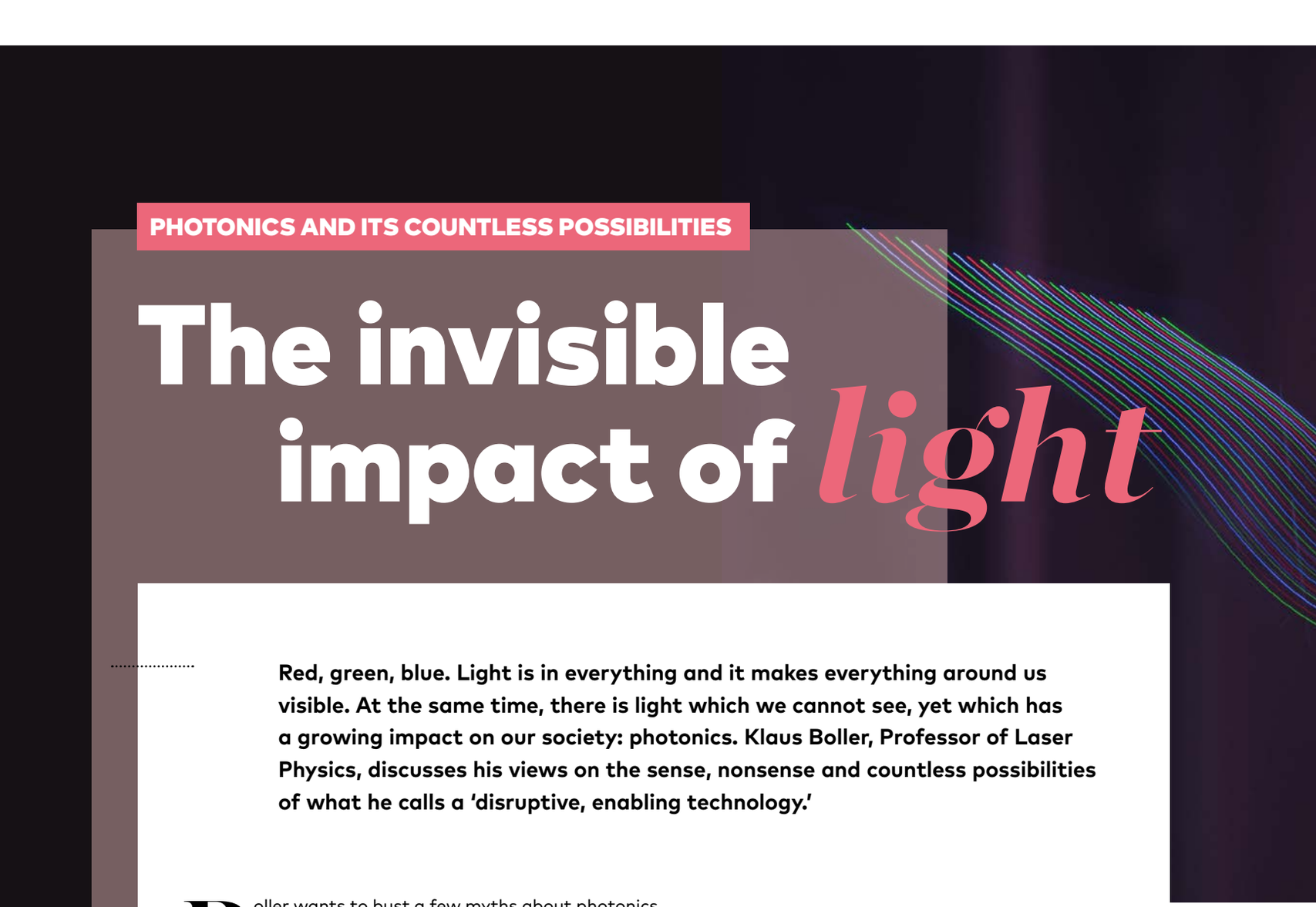
The goggles that can save a victim's life are augmented reality (AR) goggles. The AR goggles add 3D visualisations to the wearer's real vision. Once contact has been established with the emergency call centre, the paramedic's hands appear in the wearer's field of view. They can demonstrate the reanimation process remotely. From the call centre, they can also start instructional videos or show the right rhythm. With the help of virtual reality (VR) goggles, the paramedic can see exactly what the bystander sees. That makes it possible to provide better feedback and more (visual) instruction than on the telephone. The paramedic can be right there besides the victim, albeit virtually.

Professional aid

The idea for this remote reanimation assistance comes from master's student Sander Giesselink, a student of Human Media Interaction at the UT. 'During a heart attack, the first few minutes are crucial,' Giesselink explains. 'It always takes a while for professional aid workers to arrive on the scene. With virtual assistance, you are not alone. That is very important in a situation as stressful as reanimating someone.'
Giesselink discovered how useful virtual and augmented reality can be for instructional purposes during one of his master's subjects. 'We visited KLM, where they are developing fire drills in VR for stewards and stewardesses,' the student explains. 'For my master's project, I developed an instructional programme that helps people during reanimation.' Giesselink built upon the Open Immersive Telepresence System developed by fellow student Emiel Harmsen. This technology allows someone to be present in a different location virtually. The goggles are state of the art at the moment, which means the technology is not yet widely available. 'That will happen once people start wearing smart glasses,' Giesselink expects. 'Augmented reality is the future, especially for instructional purposes. I would love to explore this field further and perhaps go for a PhD.'

PHOTONICS AND ITS COUNTLESS POSSIBILITIES

The invisible impact of *light*



Red, green, blue. Light is in everything and it makes everything around us visible. At the same time, there is light which we cannot see, yet which has a growing impact on our society: photonics. Klaus Boller, Professor of Laser Physics, discusses his views on the sense, nonsense and countless possibilities of what he calls a 'disruptive, enabling technology.'

Boller wants to bust a few myths about photonics, especially now that the technology, which focuses on the interaction between photons and electrons, is starting to gain traction in mainstream media. 'No, photonic chips will never replace the electronic chips in your laptop or smartphone. They are simply too big for that. You cannot use optical chips in electronic equipment on a nanoscale.'

Drilling holes

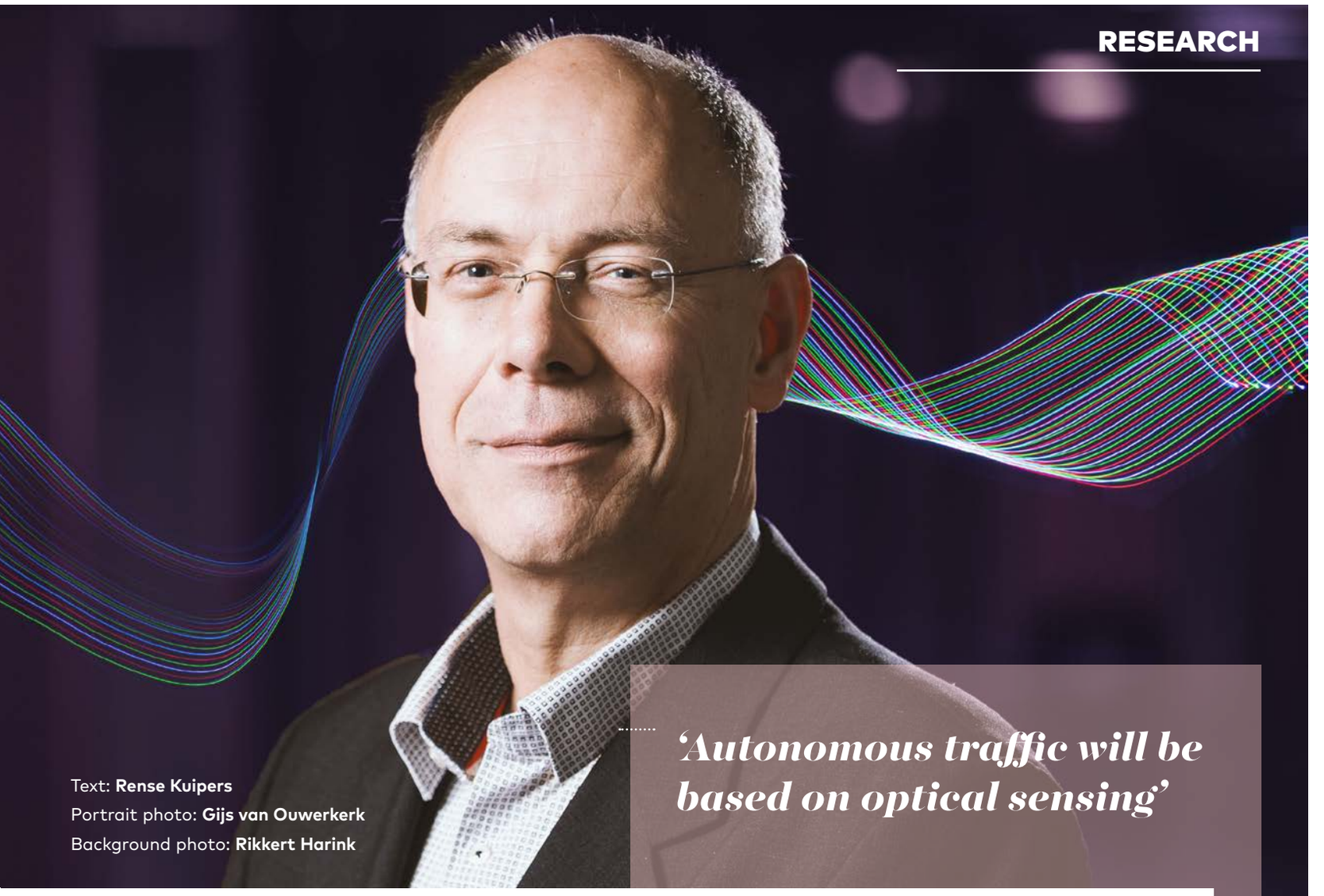
Photonics is not the answer to everything, and that includes Moore's Law. The professor is adamant about that. However, as his story goes on, it becomes increasingly clear that the technology has the potential to turn much of our world upside down. Boller is quick to put that impact into the right perspective, because it is an enabling technology: 'The technology in itself is completely worthless. Compare it to drilling holes. That has no use, except making cavities. Its strength lies in what it facilitates. That is what makes it such a wonderful enabling technology.'

Where is photonics having such a major impact then, if not in our household equipment? 'The key property of light is its speed,' Boller answers. 'It is the carrier of all information that can be described with a large quantity of more detailed information. To give an example: the large data stream from computers must ultimately be collected and transmitted via, for example, a fibreglass network. In that sense, electronics is practically a relic of the past. The people at my phone network back home in Germany must be beating themselves up because the cable network they put in the ground twenty years ago consists of copper cables. It is simply too slow to meet our future data needs.'

'Twente is a global leader in clean-frequency laser chips'

Blank page

Boller predicts that photonics will play a major role in meeting our growing data needs. If we want to transition to a 5G mobile network, the use of this photonic technology is essential. 'It will play a role in the timing and rhythms between mobile



'Autonomous traffic will be based on optical sensing'

Text: **Rense Kuipers**
Portrait photo: **Gijs van Ouwerkerk**
Background photo: **Rikkert Harink**

phones and cell towers. The microwaves are translated using optical tricks on chips,' Boller says. 'At the moment, the signal is sent out in a wide radius and only a small part is picked up by cell phones. The goal is to facilitate direct communication between a phone and the antenna on a cell tower. That is where the optics are found: the antenna will consist of a photonics-controlled arrangement of antennas, a so-called antenna array. If everything works well, the data stream can be sped up by a factor of a thousand.'

Photonics can not only improve our mobile networks. Boller believes the biggest challenge associated with the underground fibreglass network is pushing as much data as possible through the optical cables. 'That is certainly possible, up to a factor of a hundred or more, as long as you use the right modulation techniques and extremely phase stabile lasers,' Boller says. 'Look at it as a piece of paper that you want to write as much information as possible on. If it is already covered in writing, there is less available space and the final result will be hard to understand. However, if you use a blank page, you can write down more information in a clearer and more efficient manner. The same principle applies to data streams that you write on laser light,' the professor explains.

Leader

He has more examples. 'Take Google's data centres. They are so large that the distance between two microchips can easily be two kilometres. It is important to cover that distance as quickly and with as much data as possible.' However, Boller knows that optics is about accuracy as much as speed. 'Think of optical sensors. After all, glass fibres are nothing more than sensor heads. Autonomous traffic will be based on optical sensing to carefully measure the vehicles' relative positions.' Boller also mentions sensors in buildings, airplane wings, oil sources, endoscopes... Without doubt, every one of these applications can benefit from the enabling technology that is photonics.

Boller rightfully concludes that Twente – like Eindhoven – is one of the world's hubs when it comes to this innovative technology. Whereas the people in Eindhoven mainly excel at manufacturing semiconductors, Twente is a global leader in clean-frequency laser chips. 'It is the result of forty years of relatively unrestricted work,' Boller says. 'A lead like that is hard to overcome, especially in a world where the saying that 'the winner takes it all' is increasingly true. This first move we made has given us a major advantage.' ●

Text: **Michaela Nesvarova**
Photo: **Jamy Li**

DE-ENIGMA PROJECT HOPES TO REVOLUTIONIZE AUTISM THERAPY

Robots for autistic children

Can interaction with robots help autistic children improve their interaction with humans? Quite possibly. Together with European partners, UT researchers from the HMI group are developing a robot for autistic children, a robot that could help these children improve their interpersonal communication.

There are over five million people with autism in Europe. As is characteristic for this neurodevelopmental condition, children (and adults) on the autism spectrum experience difficulties with social communication and interaction, which influences not only their lives but also lives of people around them. So wouldn't it be great if they could 'train' their social skills on a robot, and not even know they are doing it? The DE-ENIGMA project is a Horizon2020 project coordinated by the University of Twente. It hopes to revolutionize autism therapy by using a robot called Robokind's Zeno, which resembles a young child – and is meant for young children. 'Other therapies are more test oriented. They include tasks with correct answers. Our approach aims to use the robot as a playmate rather than a teacher of the child,' says Jamy Li. Li is a researcher from the UT's HMI (Human Media Interaction) group who is working on the DE-ENIGMA project and whose own work focuses on human-robot interaction.

'The robot first mirrors face movements of the child'

Make a face

How would it work? The children would simply play with Zeno. 'The robot first mirrors face movements of the child, so the child becomes interested in different parts of the robot's face,' explains Li. 'As the next steps, the robot indicates which part of the face to move or asks the child to identify the right part of the face.' Why the focus on face? 'Faces are really important in order to see how people feel and react to your actions. However, autistic children don't process facial expressions the same as typically developing children.' The robot could therefore help the

Touch a robot

In one of his research projects, Li studied how people experience touching a robot. Based on experiments, during which participants had to either point to or touch a humanoid robot, Li found out that people show signs of physiological arousal when touching a robot in so called 'low accessibility parts', such as legs, buttocks and other body parts that we usually associate with a more intimate interaction. 'Although we didn't explicitly compare it in this research, these findings indicate that the reaction to touching a robotic body is very similar to touching an actual human being,' points out the scientist. 'Because also with people we are more comfortable touching high accessibility areas, such as the hands, arms and head, and more uncomfortable touching low accessibility areas.'

children recognize and express emotions, easing their everyday interactions.

The DE-ENIGMA project is still in the development phase. Robokind's Zeno will be properly tested by autistic children later this year. Yet, it is not difficult to imagine that children with autism perceive a robot as more comfortable to communicate with than humans. How is it with the rest of the population, though? How do we react when we interact with a humanoid robot? Surprisingly similar as when we talk to a person, says Jamy Li: 'It seems that, to some degree, we see such robots as tiny people.' ●

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.

Albert van den Berg

PROFESSOR IN THE BIOS LAB-ON-A-CHIP GROUP

I was on a train from Basel to Arnhem. It must have been in the late nineties. The train followed the course of the Rhine. I had spread scientific articles all over my compartment and I was reading through them at my leisure. I was relaxed and let my thoughts wander. It was a creative period in my career. I had just begun to form my own research group. I had my eureka moment near the Lorelei, a tall rock formation where the Rhine makes a sharp turn. My predecessor, Piet Bergveld, invented the ISFET sensor. This chip measures the acidity of fluids. A transistor detects the ion concentration in a fluid and turns it into an electrical signal. The pH of the fluid that runs through the chip determines the charge on the transistor surface.

On the train, I was thinking about how to control the fluid

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

flow electrically. The eureka moment came when I thought about reversing our method: what if we use a chip to influence the charge in the fluid and control the fluid flow? Using a thin isolator layer, it should be possible to create a strong electrical field in the fluid. With the nanotechnology of MESA+ in Twente it was possible to create an extremely thin insulator of silicon nitride.

The idea proved to work well with clean fluids. It was harder to develop a practical application, however. When working with fluids such as urine and blood, proteins also attach to the insulator layer. That prevented us from building a real robust system. Nevertheless, the article we wrote for Science based on the idea I had on the train has been cited over six hundred times and a patent was granted in 2003.

REVOLUTIONARY SOLAR CELL DESIGN FOR SOLAR FUEL PRODUCTION

A new solar fuel on the rise

Scientists of UT department Molecular Nanofabrication made a huge step in improving the efficiency of solar fuel production. Their new solar cell design boosts the efficiency of the conversion of solar energy into hydrogen by a factor four. As a bonus, the solar cell does not contain rare earth materials, such as platinum, but is constructed mainly from earth abundant materials like silicon, nickel and molybdenum.

Text & photos: **Hans Wolkers**

Carefully, scientist Wouter Vijselaar attaches two electrical wires to a plastic holder containing a newly designed solar fuel cell. Then he directs a beam of artificial solar light to the cell. Immediately small gas bubbles appear. 'Hydrogen gas,' he explains. 'The solar cell transforms light into hydrogen gas, a well-known energy carrier. Due to our new solar cell, the efficiency for this reaction increased from 2.5 tot 10.8 percent.' In February, 2018, Vijselaar successfully defended his thesis on his solar-to-fuel cell research. According to the committee, Vijselaar's research demonstrated excellent scientific quality, and rewarded his dissertation with a cum laude qualification.

Necessary technology

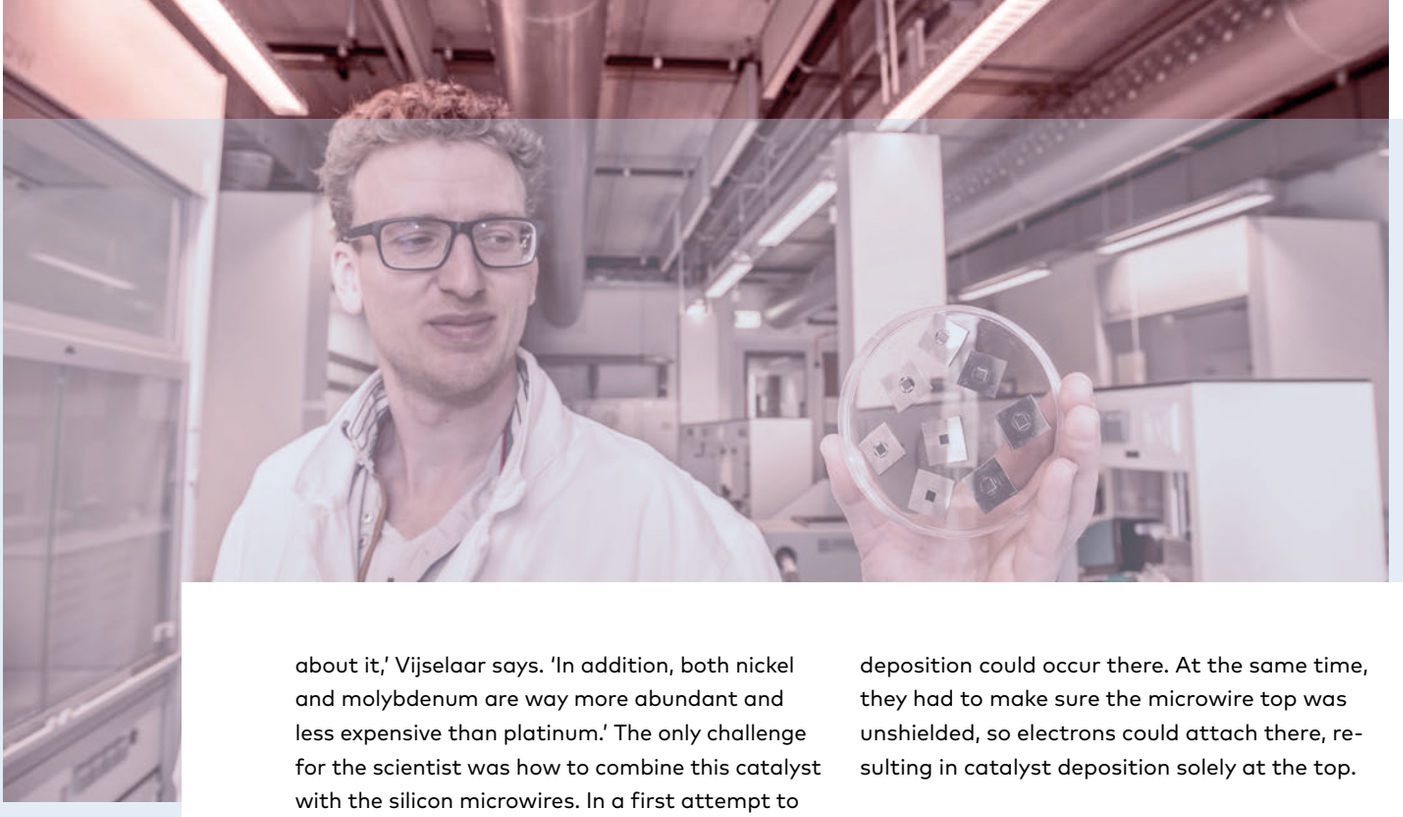
The conversion of solar energy into solar fuels is an indispensable technology in the energy transition from fossil fuels to more sustainable energy sources like wind or sun. If sunlight can efficiently be converted into a transportable energy carrier, such as hydrogen, the application of solar energy will drastically increase. 'Hydrogen has the great advantage that it is easy to produce and easy to collect,' Vijselaar explains. 'In addition, there's just formation of hydrogen, so no further purification steps are required.' However, current solar fuel cells are not very efficient, partly due to their flat, 2-dimensional, design. 'The highest efficiency to convert sunlight into hydrogen was just about 2.5 percent,' Vijselaar says. 'So, we decided to make a more efficient design of a solar-to-fuel cell.'
In the scientific literature, the scientist found a concept idea, that incorporated silicon 'microwires', making it 3D. The extremely small wires

'We decided to make a more efficient design'

only measure 4 micrometers in diameter: roughly the thickness of 1/20th of a human hair. The scientists optimized the efficiency of the new solar cell by experimenting with length and density of the wires. They finally reached an optimum efficiency with wires about 40 micrometers long. Optimal microwire density was around two million per square centimeter. In this forest of densely packed, hair-like silicon structures solar energy is captured and converted into electricity. Due to the 3D construction, reflection is reduced, while surface area is increased. This results in capturing twice the amount of sunlight as compared to a planar solar cell.

Reliable catalyst

But increasing the surface area of a solar cell was only the first step in designing a more efficient solar fuel device. The silicon microwires proved to be great to produce electricity from sunlight, but terrible to convert this electricity into hydrogen: silicon has tremendous losses to produce hydrogen and therefore greatly lowers the overall efficiency. To improve efficiency, a catalyst is needed to boost the conversion. Platinum would be the most effective, but this is an expensive and rare earth metal. Therefore, Vijselaar turned to a good old, and reliable catalyst: nickel molybdenum (NiMo). 'This catalyst has been used since the early seventies and there's a lot of knowledge



about it,' Vijselaar says. 'In addition, both nickel and molybdenum are way more abundant and less expensive than platinum.' The only challenge for the scientist was how to combine this catalyst with the silicon microwires. In a first attempt to include NiMo to the solar cell, small particles of the catalyst were deposited over the complete microwires. Because the particles were smaller than the wavelength of light, there were no reflections. As a result, a lot of sunlight was captured, despite the catalyst's presence. However, the conversion to hydrogen didn't work out, because the individual NiMo particles were too small to function as an effective catalyst. 'We had to figure out a way to increase the density of the NiMo catalyst, without reducing the amount of light captured', Vijselaar explains. 'We decided to place the catalyst solely on top of the microwires.'

Promising technique

But again, the scientists were faced with a problem. How to attach the catalyst specifically on top of the microwires? It was obviously impossible to do this for each microwire individually; they needed a technique to do it for millions at once. A promising technique to achieve this is called electrodeposition, or electroplating. This is a process that uses electrons to deposit dissolved metal ions (for example nickel and molybdenum salts) so that they form a thin metal alloy coating on an electrode, for example on silicon. In order to only coat the top of the microwire with the catalyst, the scientists had to manipulate it in such a way that they shield the sides of the microwires for electrons, so no catalyst deposition could occur there. At the same time, they had to make sure the microwire top was unshielded, so electrons could attach there, resulting in catalyst deposition solely at the top.

'To our big surprise it worked already the first time'

To achieve this, the scientists took a kind of detour. First, they coated the whole microwire with silica. This material is an insulator and therefore, no electroplating can take place. In the next step, they used a high-energy argon canon. When aimed at the right angle, argon atoms would effectively shatter and remove the silica from the top part of the microwires. 'We briefly experimented with this technique on a late Friday afternoon,' Vijselaar says. 'To our big surprise it worked already the first time! I had the best weekend ever!' The final step to a working solar fuel device was relatively easy: after applying an electrical current to the device, electroplating would only take place on the exposed silicon microwire tops, while the sides of the microwires are protected by the insulating silica.

Clever design

The resulting solar cell generates electricity within the microwires, where the light is captured and transformed into electricity. At the top, the catalyst effectively converts the electricity into hydrogen gas. 'This design works very well at lab scale,' Vijselaar says. 'Before commercializing this new solar fuel unit we need to scale it up for further testing. In addition, we need to design efficient and cost-effective manufacturing procedures.' But before the team will set steps towards marketing their product they want to make further improvements to the design. Vijselaar: 'According to the laws of physics, we can increase the efficiency even more when we apply a second light absorber material to our silicon solar cell. We are currently figuring out how to do this. We need to find a clever design to make this work.' ●

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 explore the connection between fuel cells and electric cars and why they seem to be taking turns in popularity.

The ups and downs of fuel cells and electric cars

Text: **Michaela Nesvarova**

Both technologies emerged around the same time, in the 1830's. Both have experienced periods of great interest and prospects, as well as periods when they were considered outdated. Interestingly, these periods never happened to coincide for fuel cells and electric cars - if one of them was the centre of attention, the other one seemed to be forgotten at the moment. 'They are like communicating pipelines. If one hype finishes, the other one begins,' says Kornelia Konrad, UT researcher of Anticipation and Assessment of Emerging Technologies.

'A fuel cell is like a cat with nine lives,' continues Konrad. 'When the technical principles were studied in the 19th century, some, as the later Nobel Prize winner Wilhelm Ostwald, already envisaged a revolutionary potential for energy production and major impacts for industrial cities, but at the time realizing the fuel cell principle posed various chemical and material puzzles. The technology resurfaced in 1960's, and triggered expectations and intensified development work with first applications in space. Then the interest declined again only to come back in the 1980's and late 90's, when the real hype began. This was triggered by car companies that claimed they would have fuel cell cars ready by 2004. That didn't happen, the hype died out and everyone's attention shifted to electric cars.'

Such a shift has happened more than once. 'Electric cars were rather popular around the 1900's, even more popular than gasoline cars, which eventually won - there are several explanations for that, including the limited range of electric cars or Ford's ability to produce gasoline cars for the masses.' Either way, the era of electric cars seemed over. At least until the 1990's, when a lot of work was dedicated to them once more. Yet, when the results of this work proved disappointing (again), their time in the spotlight ended and the hype focused on fuel cells began (again). 'At year 2000, nobody talked about electric cars. Fuel cells were the future. Now electric vehicles are "it",' says Konrad. 'This nicely shows that technologies don't always either succeed or die. They often hibernate and resurface.' ●

'Many young people struggle to understand what a text means'

Text: **Kitty van Gerven**
Photo: **Shutterstock & Rikkert Harink**

RESEARCH OF DOCTORAL CANDIDATE MARISKA OKKINGA

Improving reading of children is not easy

Reading comprehension skills are essential to functioning in our knowledge-based society. Nevertheless, the number of students who struggle to master this skill appears to be growing. It is high time to stimulate the development of reading comprehension. However, as PhD candidate Mariska Okkinga concludes, that is easier said than done.

If you want to make soup, you have to read the recipe. If you want to use your new smartphone, you have to read – and be able to understand – the manual. Almost everything we do comes with written instructions nowadays. 'Reading comprehension is a basic skill that you need throughout your entire life in everything you do,' Mariska Okkinga notes. Nevertheless, many young people, particularly those with a pre-vocational secondary education, struggle to understand what a text means, even though the education sector has been focusing on the development of this skill for decades.

'In the early 80s, studies in America revealed that there was insufficient focus on reading comprehension skills. From that moment on, reading strategies were developed based on what skilled readers did. Examples of such strategies include constantly asking yourself whether you still understand what a text means as you are reading it, summarising what you just read and looking up the meaning of words you do not know.'

'Nieuwsbegrip' method

These reading strategies were translated into teaching methods and introduced in schools. One method, which has been growing in popularity in our country over the past decade, is 'Nieuwsbegrip' ('news understanding'). It was developed by the CED-Group (Centre for Educational Services). Circa 80% of all elementary and high school students are taught this method. Every week, they explore a current news topic and learn to master one of the five reading strategies (predicting, summarising, asking questions, clearing up confusion and making connections) with the help of assignments. These strategies are first demonstrated out loud by the teacher. The students then practise by deploying the strategies – out loud – in small groups.

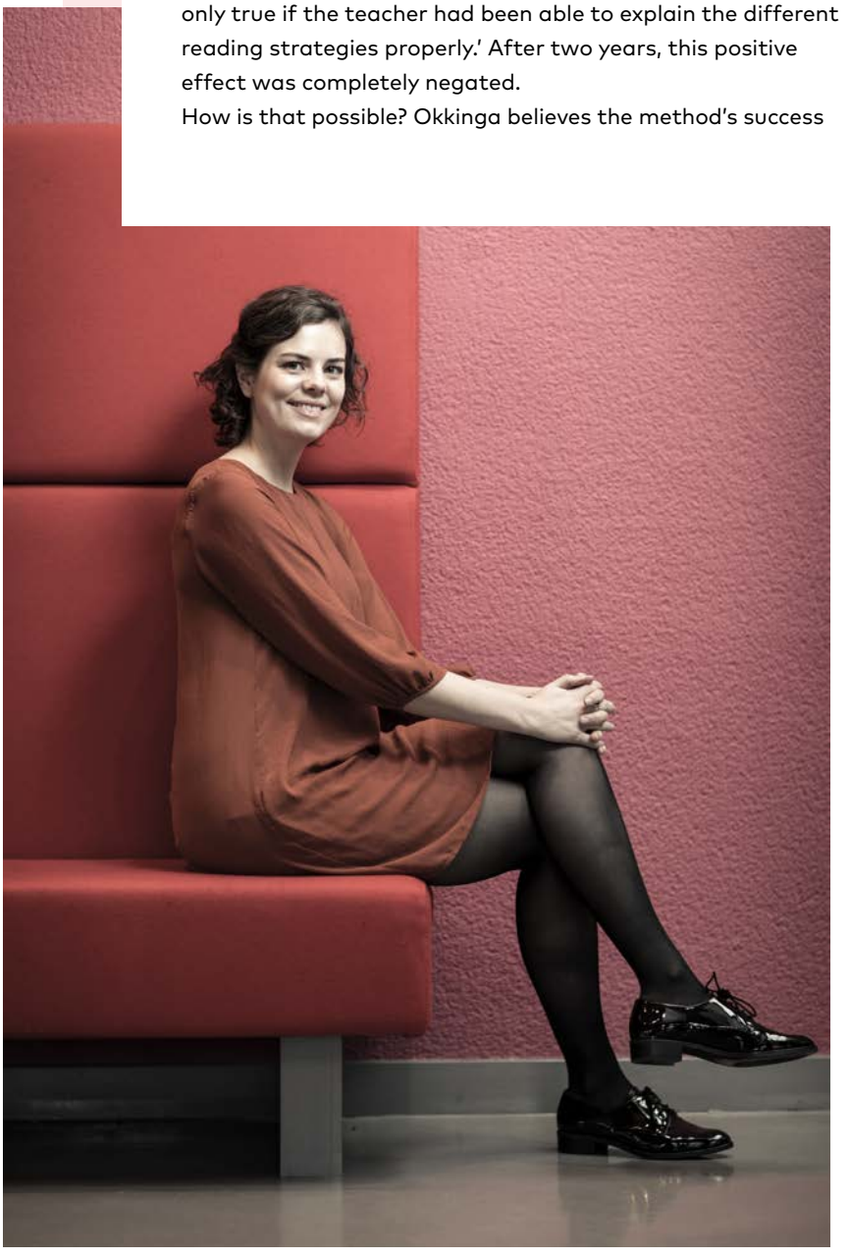
The question remains whether this actually helps to improve the students' reading comprehension. Earlier studies revealed that this method can be successful if a researcher or teacher works directly with one small group of students. To determine whether classroom instruction leads to the same results, Okkinga began her doctoral research into the effects of the Nieuwsbegrip method in 2011, shortly after graduating as a psychologist in Leiden. She conducted her research at the University of Twente's Behavioural Management and Social Sciences faculty with

financial support from the Ministry of Education, Culture and Science. For a period of two years, she tracked the results of circa 350 – mostly low-achieving – students in twenty classes at ten different pre-vocational secondary education schools in the Netherlands. 'At each school, two comparable first-year classes participated. One used the Nieuwsbegrip method, while the other did not.'

Effects tested

Okkinga visited the classes twice per year to observe the students and each class took four reading comprehension tests. The result: 'After a year, the method appeared to have some effect. The students who were instructed in the Nieuwsbegrip method had a slightly higher level of reading comprehension than the students in the control groups. However, that was only true if the teacher had been able to explain the different reading strategies properly.' After two years, this positive effect was completely negated.

How is that possible? Okkinga believes the method's success depends entirely on the teacher's ability to properly demonstrate the strategies. 'If the teacher was able to demonstrate in an above-average manner how to use reading comprehension strategies during the Nieuwsbegrip lessons, the results were similar to those of the control group after two years. If this instruction was below average, the results were ultimately worse than those of the students in the control group. In that case, the instruction method of the teacher in the control group was actually more effective,' concluded Okkinga, who recently obtained her doctoral degree in psychology from the UT.



'Coaching teachers is crucial'

Putting on a performance

Okkinga says that quite a few teachers clearly struggled with demonstrating the strategies, despite the instructions they received beforehand. 'They felt like they were putting on a performance.' That was not all. 'Offering differentiated instruction in classes where the students work in groups also proved difficult for some.'

Nevertheless, it would be wrong to conclude that Nieuwsbegrip is ineffective in a classroom context. 'In the end, all students, both those in the intervention classes and those in the control classes, improved their reading comprehension.' The effectiveness of the teaching method could be increased, she says. For example, the rigid method used to teach students the different reading strategies – 'Sometimes, it is like teaching them tricks' – could be replaced by a method that teaches them to employ the strategies in a more flexible manner. 'I would also like to see different genres of texts being used; not just news reports, but also texts that tie into the students' interests.'

Coaching teachers

Okkinga, who recently began her research into 'study reading' among students enrolled in teachers training programmes at the Knowledge Centre for Talent Development in Rotterdam, believes it is perhaps far more important that prospective teachers learn to instruct others in the use of reading strategies during their training. 'Coaching teachers is crucial.' Furthermore, Okkinga believes schools can gain a lot by stimulating collaboration between departments. 'Why not cover a difficult text from a biology textbook during a Dutch class?'

In the end, the most important thing of all is... 'We all know the answer to that one,' the psychologist sighs. 'The most important thing of all is that children read more. The more you read, the better you will get at it. You will benefit from that for the rest of your life.' ●

Condoms

Condoms, toasters, clothespins, shoelaces, bras, deodorant, garden hoses. Where am I going with this? Bicycle pumps, coffee filter holders, corkscrews, socks, straws, doorbells, egg boilers, earplugs, clotheslines, needles, bicycle bells, doormats... I can keep going. Each of these objects has a 'smart' version available online. Bicycle tyres, flowerpots, sunscreens, shoe soles, umbrellas... People have been calling things 'smart' for decades. It can also refer to processes and systems: materials, coaching, lighting systems, airports and even entire cities. The exact definition of 'smart' varies, but it always boils down to this: built-in software and sensors result in interaction with the environment and the user, proactivity and a form of self-organisation. The objects listed above make it clear that the use of the term 'smart' has gotten completely out of hand. Developers were apparently so enamoured with their own smarts that they proceeded to call their creations the same. The word 'smart' is a simple, positive and admirable way to describe a complex concept. The question remains if this was a wise choice. It is not smart to call yourself smart. It makes you sound arrogant and it creates the wrong kind of expectation. Sometimes, it seems like technology becomes clumsier and less reliable as it becomes more advanced. Of course, its interior complexity has increased by orders of magnitude, which means there is a lot more that can go wrong. However, the user's experience is also important.

The city of Enschede has also called itself 'smart.' If I find any waste dumped in the woods on my way to the University, I can tweet a picture and the location to the city. Enschede is quick to reply and the waste will be gone two days later. This is a great example of technology facilitating collaboration between a citizen and the city.

However, last time the city asked me to submit my report via the 'smart report' feature. I answered that they already had all the information they needed. Although the 'smart report' website is quite convenient, it is easier to send a tweet if you are already active on Twitter. The message is clear: you can make technology smarter and smarter, but it can hurt the user-technology combination.

If you want to be taken seriously, it would be wise to steer clear of the term 'smart.' Good, intelligent technology should become the new standard. Developers should focus on that and stop their idle boasting.

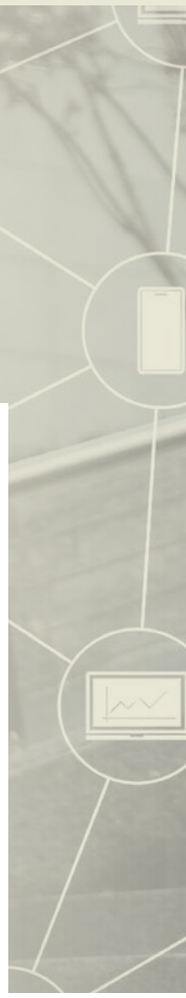
Let me conclude with another list: bird houses, lawnmowers, lighters, manhole covers, contact lenses, windshield wipers, backpacks, street tiles, suitcases, ashtrays, rain barrels, coat racks, golf balls. Where will it end?

Wiendelt Steenbergen
Professor of Biomedical Photonic Imaging

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

THE GREY AREA OF CRYPTOCURRENCY AND BLOCKCHAIN TECHNOLOGY

Blockchain: the threat of a bubble looms



Bitcoin, cryptocurrency and especially the underlying blockchain technology have become ingrained in our society. Where some simply enjoy trading virtual currencies, others see opportunities to break through the central administration of big data with banks and pension funds. Two UT researchers share their views on blockchains.

Assistant professor Maarten Everts (Services, Cybersecurity and Safety department) mainly sees opportunities. 'The technology can contribute to the increasing digitisation and autonomy of systems,' he says. Shawn Donnelly, assistant professor of International Relations and European Studies, sees social opportunities. Yet he also warns that 'cryptocurrency is a grey area in the banking world. It is a bubble that will burst one day.'

Ledger

Everts believes that blockchains are unique because of their technological nature. 'They are a wonderful combination of cryptography, decentralised computer networks, game theory and economic theory. Simply put, they form a ledger that is not stored on a single computer, but on different participating computers all over the world. That is the power of blockchain.'

'The challenge is to find the right balance'

A major advantage of the technology is that third parties, such as banks or notaries, are no longer needed for e.g. large money transactions. 'That is the background of the blockchain application Bitcoin,' Everts explains. 'Bitcoin appeared on the scene in 2009, during the height of the financial crisis. This was a countermovement that expressed a lack of trust in major institutions such as banks.'

The technology's main asset is its self-regulating ability, based on a majority of votes. During the financial crisis, some bankers turned out to be driven by questionable morals. 'That is economically disadvantageous in a blockchain. A participant cannot simply manipulate a transaction. Connected computers must agree to any changes. Clever checks are built in, such as economic rewards that stimulate participants to follow the rules of the system.'

The technology is not without its problems. 'If the community wants something, yet a computer's software says no, that creates a real problem in blockchains. The programming code is sacred. Intervention by a third party goes against the core philosophy of the blockchain. The challenge is to find the right balance in this regard.'

Maintaining control

Shawn Donnelly also sees possibilities. 'In Estonia, people are achieving great results through experiments with the technology,' he says. 'One example is an ID card that, because of this technology, cannot be copied. In the healthcare sector, they are developing digital, encrypted medical files and letters of referral from physicians.' Donnelly sees plenty of opportunities at the local government level. 'I would stick to that,' he says. 'It is important to maintain some degree of control over other databases, such as that of the police.'

Donnelly views the rise and applications of bitcoin from a background in international relations and an interest in the financial system. 'Bitcoin lacks some core aspects necessary to serve as a proper currency. Its value fluctuates, which makes it unsuitable for saving. It has a limited shelf life as a trade commodity, because how many places actually accept cryptocurrency?' It is all speculation for now.

'The value of the bitcoin fluctuates so strongly that it is classified as a high-risk investment. You might multiply your money tenfold, or lose everything. That is fine as long as private individuals use some of their savings. It is a different story when banks get involved.'

That is where the problem lies. Donnelly believes banks are becoming increasingly interested in cryptocurrency. 'Banks follow in their clients' footsteps, they always have,' he says. 'What is a bank's core business, however? You can store valuable objects there and it serves as a financial intermediary by keeping and lending money. High-risk cryptocurrencies do not fit into this model. Central banks recognise this problem.'

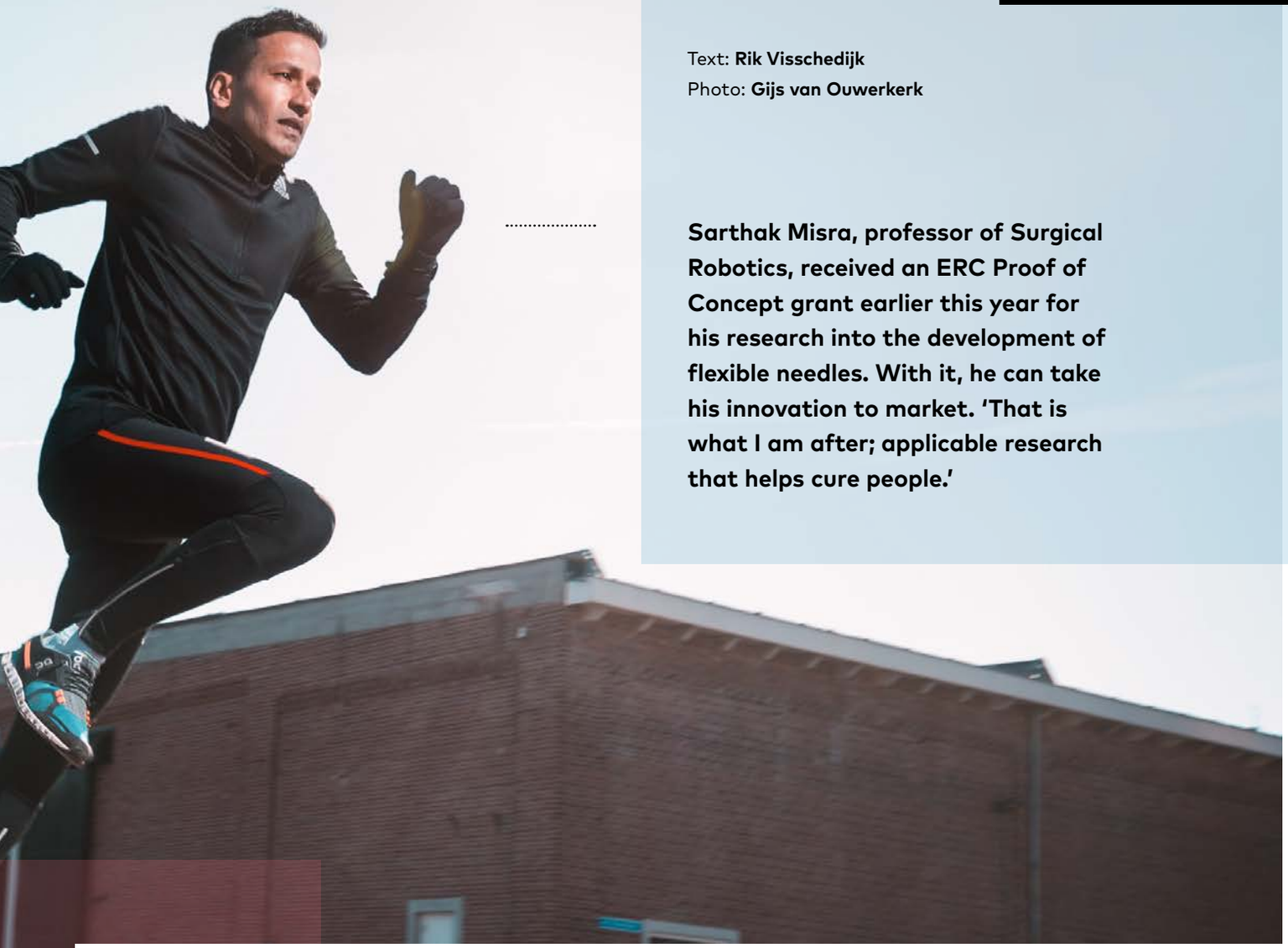
Grey area

That does not mean that regular banks stay away from cryptocurrency. 'The rise of cryptocurrency has created a grey area,' Donnelly says. 'Hedge funds are getting involved in bitcoin and, through these funds, so are banks. That has created a phenomenon of unregulated financial intermediaries that we call shadow banking.'

That is a serious problem, Donnelly believes. During the financial crisis, when there was little supervision on banks' reckless lending, the bubble eventually burst. 'That might happen again,' he says. 'Banks are still too big to fail. If it goes wrong, the consequences will be severe, because governments end up providing guarantees. The problem with cryptocurrency is that banks are getting involved and there is little supervision. In that grey area, we assign value to the trade in virtual currency. That value is ultimately based on nothing. That makes it a bubble like all others.' ●

PROFESSOR OF SURGICAL ROBOTICS SARTHAK MISRA

‘I want to conduct research that *matters*’



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

Sarthak Misra, professor of Surgical Robotics, received an ERC Proof of Concept grant earlier this year for his research into the development of flexible needles. With it, he can take his innovation to market. 'That is what I am after; applicable research that helps cure people.'

INSPIRE: that is the name of the project Misra is currently working on. It is short for Instrument Shape Sensing for Minimally Invasive Interventions. 'We are developing a flexible needle,' Misra explains. 'The needle contains sensors that recognise the optimal path through the human body. It lets us reach the target location with minimal damage to the body. We call that needle steering.' This is just one example of the novel techniques to reach challenging locations in the body that Misra develops as principal investigator of the Surgical Robotics Laboratory. Another example is a medical microrobot that is controlled by an electromagnetic system. 'These applications limit the damage we cause on the way to hard-to-reach places in a patient's body.'

Fantastic Voyage

Misra shows a presentation. One slide contains the trailer of the 1966 science-fiction movie Fantastic Voyage. 'When I first saw that movie, in which scientists are shrunk down to enter the human body aboard a microscopic ship, I knew I wanted to develop such kind of cool systems. It might have been on a sub-conscious level, but that movie definitely shaped my future.'

'It is better to come up with an idea that can conquer the world than choose the safe path'

That is not to say that Misra immediately choose a scientific career. The walls of his office in the Horst display his diplomas: a master's in Engineering from McGill University (Canada) and a doctorate from the world-class university of Johns

Hopkins (USA). There is also a miniature model of a space shuttle, and for a good reason. After acquiring his master's degree, he spent three years working on the International Space Program at the Canadian tech company MacDonald Dettwiler and Associates.

'After my studies, I did not know exactly what I wanted to do next,' Misra, originally from India, says. 'When I was given the opportunity to work on the International Space Program, I did not hesitate for a second. At the time, NASA was working on a major programme and the organisation I worked for carried out important assignments for the space agency. All robotic components for the space station programme were developed in Canada.'

Space station

Misra worked on the development of the International Space Station. 'Two years before the actual NASA mission, countless people got to work as part of different groups,' Misra says. 'I was part of the mission operations and analysis group. We ran through all possible scenarios for the mission, such as assembling truss segments to the space station, installing the station's entry and exit point (airlock). We had to calculate everything that could possibly go wrong and find ways to anticipate those scenarios. I mainly worked on the Canadarm 2, a seventeen-metre-long robotic arm that weighs 1,600 kilos. NASA uses that arm to connect other parts to the space station in orbit.'

It was a wonderful time, Misra says. Nevertheless, he wanted to return to the world of academics after three years of working for NASA. 'I felt that I had to educate myself further if I wanted to continue my development,' he explains. 'Still, it was good for me to gain experience outside a university setting for three years. At MacDonald Dettwiler, I learned things that I never would have learned if I had immediately moved on to obtain a doctorate, for example working on large interdisciplinary projects with big teams, and under strict and at times strenuous deadlines. You know, I was not ready to go for a doctoral degree just yet. Other people might flourish by staying in the academic world, but this was the right course for me.'

Armed with his aerospace experience, he was admitted into the prestigious Johns Hopkins University in Baltimore with a scholarship and he obtained his doctoral degree.

Great offer

After getting his PhD, he moved on to the UT in 2009. That was a logical step for Misra. 'The offer was simply too good to

Sarthak Misra in a nutshell:

2017:	Appointed as full professor of Surgical Robotics
2011:	Associate Professor
2009:	Assistant Professor at the UT (tenure track)
2007 -2008:	Graduate student at Johns Hopkins University
2001 - 2005:	International Space Program (MacDonald Dettwiler and Associates)

resist.' He was one of the first researchers to enter a tenure track. 'The path to a professorship was clear and I was given the freedom to set up my own laboratory.' He reached the position of full professor last year. 'More importantly, we have built a state-of-the-art lab where a highly diverse group of people work on applications that truly matter.'

Doing work that matters is what gets the professor out of bed every morning and keeps him motivated. He lives in Groningen and spends around three to four days per week in Enschede. One day a week, he works at the University Medical Centre in Groningen, where his group has a lab too.

Misra travelled the world to reach his goal and finally found his place in Twente. 'Science is international by definition,' he says. 'My parents come from India and I did some of my schooling there. I come from a family of academics. I was never apprehensive to go to a new place and to start afresh, and pursue new goals. That is how I ended up in Canada. At the moment, I feel right at home in the Netherlands. This is a great place for my seven-year-old son to grow up.'

'It was good for me to gain experience outside the university'

'Conquer the world'

What are his views on the Dutch culture and scientific climate after having worked in so many different places? 'When I was growing up, we lived in different countries,' Misra says. 'We moved between Canada and India and I spent my toddler years in Germany. Adjusting has become second nature to me.'

At Johns Hopkins, Misra worked in an ambitious world-class environment with renowned experts. 'I try to pass that experience on to my students. I motivate them to think big and push the boundaries. I tell them it is better to come up with ideas and technologies that can truly make an impact.'

For Misra, pushing boundaries is not limited to his work. He runs ten to fifteen kilometres nearly every day. He ran the Rotterdam marathon twice and strives to finish under three hours. 'Running is good for me,' he says. 'It makes me feel alive. I take my running shoes with me wherever I go. There is no better way to get over a jetlag than going for a run. It is also the perfect way to clear your head, or carefully examine or focus on a problem.'

Over the next year and a half, Misra has €150 grand to spend on translating his research into a commercial or social proposal. 'I am very happy with this grant,' he says. 'I always strive to translate fundamental science into practical applications. That is exactly what we have been given a chance to do.' ●

C

Captured on Camera

Text & photo:
Gijs van Ouwerkerk

Soft fluidic actuator

Professor Herman van der Kooij received a Vici grant for the development of a flexible robotic suit that helps paralyzed people walk again. This suit aims to support the movements of the body using soft actuators and doesn't need a cumbersome and heavy exoskeleton. In this laboratory model of a knee joint by postdoc researcher Allan Veale, the actuator in question is a flexible white tube that is folded within a honeycomb-like structure. The knee joint can move to the desired position simply by regulating the air pressure within this tube. Where other existing soft actuators typically generate torques between 1 and 10 Newton-meters, this UT innovation is capable of approximately 90 Newton-meters, enough to make a person rise from a sitting position.

Text: **Egbert van Hattem**
Photo: **Tecnotion**

‘COACHING, MENTORING AND SPARRING TOGETHER’

Dave Vogel, a Master’s student Systems and Control, got a two-year scholarship from Tecnotion, the linear motor company based in Almelo. He and his supervisor, senior designer Thorwald van Vuure, talk about their collaboration.

To find and bind talent, the UT and partners FME (the entrepreneur organization for the tech industry) and Holland High Tech, founded the ‘MKB technology scholarship’. Technology companies from the Eastern Netherlands can participate by offering students a scholarship for their two-year Master’s. The UT provides for contact matching of students and companies. For regional companies, the scholarship program is a good way of getting in touch with highly educated, technical students.
Interested? You can find more information on www.utwente.nl/careerservice or contact Strategic Business Development: 053-4894484.

How did your collaboration come to be?
Thorwald: ‘In the beginning, I was quite skeptical. Every student wants a scholarship like this, but the question is: what will you get in return? This scholarship is not an employment, neither is it a down payment in which a student will come back for an employment. What it is, is coaching, mentoring and sparring together. That’ll result in a fresh look on recruitment and thereby UT contacts. Large companies have a big budget to acquire talented students. We don’t have that kind of budget, but this is our way of putting in the effort. And it’s worth it to attract talent.’
Dave: ‘The funny thing is, I’m from Almelo but I hadn’t heard of Tecnotion before. I’m happy that the scholarship gave me the opportunity to get an unrestricted look behind the scenes. I noticed that the organizational structure was very horizontal and that everyone was very open and approachable. You’ll immediately get viewed and appreciated as a person, which really spoke to me.’

Does supervision take a lot of time?
Thorwald: ‘Once a month, we get together for about an hour or so. Formally that is. In reality, our meetings always take more time than initially planned. Till at least three hours. I spar a lot with Dave, for instance about the model learning methods he studied during his education. He looks at dynamic processes in a different way. For me on a new abstract level, which is refreshing. I learn a lot from him when he’s working on his modeling.’
Dave: ‘I often say: if we scrutinize our own processes, to what new insights will that lead? It resulted in an internship assignment in which the performance of a robotic control system is central. Besides Thorwald, I collaborated with Peter Wennink, who manages the measurement and test setup of this system. He took a lot of time to help me out. It’s fantastic to see a company like Tecnotion dealing with R&D. Very different from the university.’

What’s the difference?
Thorwald: ‘In small and medium sized enterprises, every project is multidisciplinary. An improved measurement setup should directly deliver useful information that I can use for my customers. Besides that, product and production improvements should fit in with the regular workflow and, of course, be affordable.’
Dave: ‘Those are all aspects that you don’t usually get confronted with during your education at the university. I learn a lot on the practical side of things: if I have a test setup ready, a cable break could happen at any time. It’s all common practice here.’

The contract states that Dave will behave as an ambassador for the company…
Dave: ‘That doesn’t take a lot of effort at all. Technologically speaking, what happens here is very interesting. I do talk about that to fellow students and others.’
Thorwald: ‘That’s exactly the right and believable way to do this.’

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