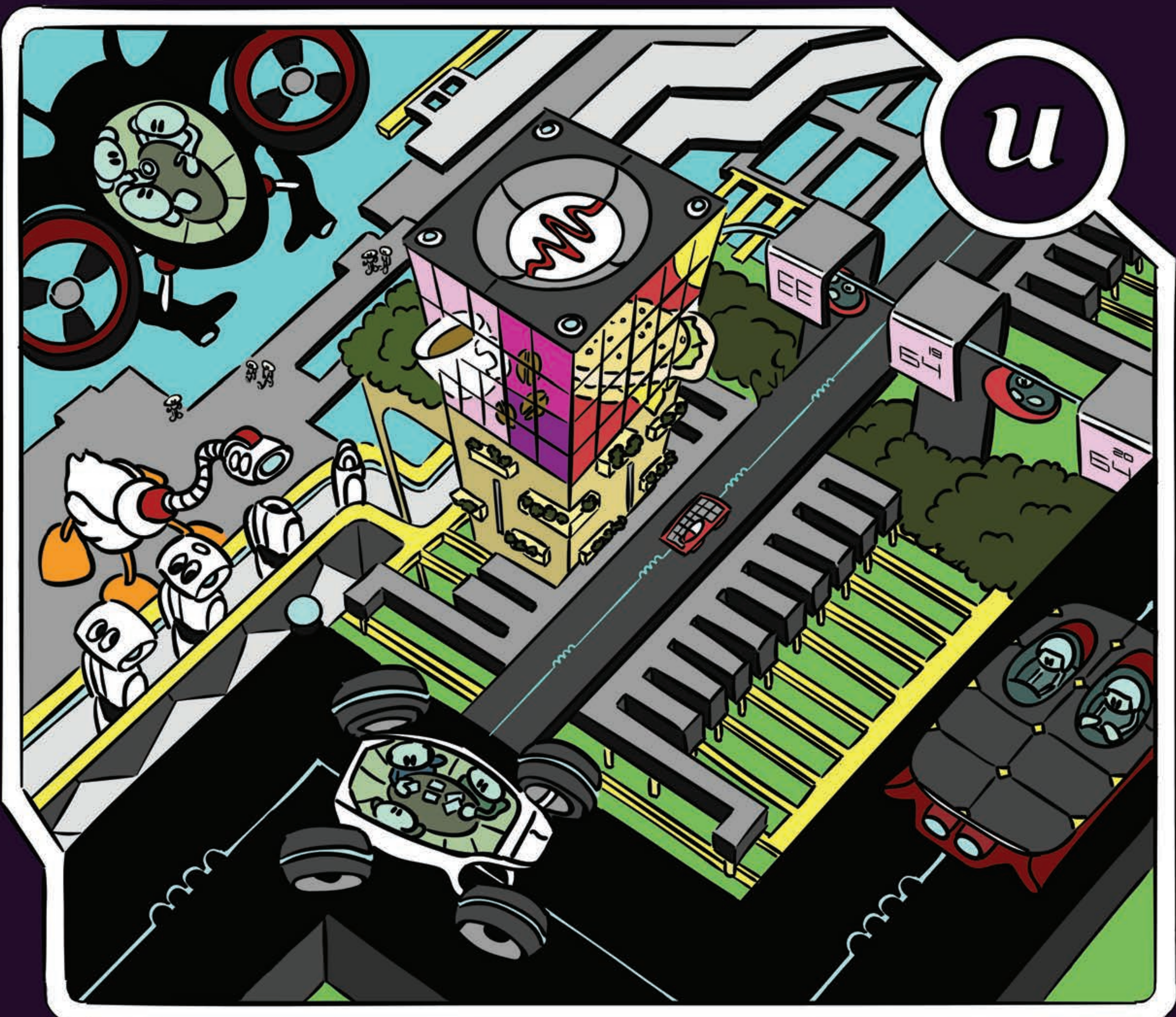
UNIVERSITY OF TWENTE. | Special edition U-Today

ELECTRICAL ENGINEERING



FROM SCIENCE FICTION TO SCIENCE FACTION

CONTENT

Cover: Luuk van Ewijk

Colophon
This journalistic special edition of U-Today, the independent journalistic medium at the University of Twente, was drawn up together with the study department Electrical Engineering.

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u today

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FOREWORD

SHAPING THE WORLD

Electrical Engineering has been shaping the world we live in, enabling most of the technology that we use every day. What looked like pure science fiction just some time ago, is now electrical engineering enabled science faction. This includes mobile phones, wireless data access, augmented and networked gaming, computers, computerized control for mechanical systems, internet-of-things devices, medical systems, robotics, self-driving cars and much more. All these devices and systems have two things in common: The functionality enabled by the electrical engineering core is very visible whereas the actual electrical engineering core itself is not visible.

The invisible workhorses in electrical engineering are the chips. They contain signal processors, provide digital computational power and include circuits to receive data from and send data to the physical real world. Many of these chips are small, spanning a few square millimeters. On that small area a complete system can be built, nowadays containing easily multiple kilometers of metal interconnect lines between millions, and billions of transistors. These transistors are truly invisible, smaller than a tenth of the wavelength of visible light.

At the University of Twente cutting edge research is done on these fields including novel nano-devices, micro-mechanical sensors and actuators, advanced integrated electronic systems, wirelessly communicating networked systems, biomedical applications, robotics, artificial intelligence and power electronics.

All this research aims at enabling the next step in technology, continuing to shape the world we live in, morphing today's science fiction into tomorrow's science faction. Consequently, also our education is such that our students learn many skills, acquire a lot of in-depth knowledge, get involved in state-of-the-art research projects, are motivated, challenged... enabling them to continue to shape the world.

In this special we give a glimpse of interesting aspects of a selection of Electrical Engineering topics at the University of Twente. Please enjoy reading this magazine and be mesmerized by the ever more omnipresent electrical engineering aspects all around you.

Anne-Johan Annema
Programme Director Electrical Engineering

FUTURISTIC IDEAS

TECHNOLOGY OF THE FUTURE

Put student Tara van Abkoude and professor Bram Nauta together, ask them what the world will look like in a decade or so and they come up with the wildest and most futuristic ideas. Best of all, both of them know that their field of expertise, electrical engineering, will decide what our future will look like. 'We are working today on the magic of tomorrow.'

Tara van Abkoude, currently enrolled in the first year of her Master's in Electrical Engineering with a specialisation in telecommunication, is originally from Eindhoven. She was inspired during a job fair at her high school. 'There were two electrical engineers standing in front of a plasma screen, telling that we could be the next designers. What interested me most was that you work on the front end of new technological developments. Electrical engineering is a broad field that involves much more than just chips and bits. How do people communicate? How do you set up a Wi-Fi connection? The science subjects that I found average in high school were suddenly and vividly brought to life.'

For Bram Nauta, professor of Integrated Circuits Design, contributing to a new future is exactly what keeps this field so interesting to him after all those years. 'Most students have a real drive to contribute to society. For example, in the past we discovered how to get rid of the electronic noise in wireless receivers, i.e. the noise that your smartphone itself produces. When that is gone, your reception improves markedly. This technology was initially invented for televisions, but it was never used for that purpose. Now, it has a new application in smartphones. Even though your invention might not be used immediately, it always finds its way into society eventually. I love that.'
It is interesting that Tara, being from Eindhoven, chose to study in Enschede, even though Eindhoven University of Technology was located practically in her own backyard. 'I immediately loved the atmosphere in Twente and the campus is beautiful. But most of all I am interested in small sensor networks which makes the Nanolab another major point in Enschede's favour. Bram Nauta knows, students feel free to walk in to their lecturer's office with questions. 'They might stick around after a lecture. It is great for us to work with such motivated students,' he says. 'An enthusiastic lecturer has a much easier time getting students properly motivated,' Van Abkoude adds.

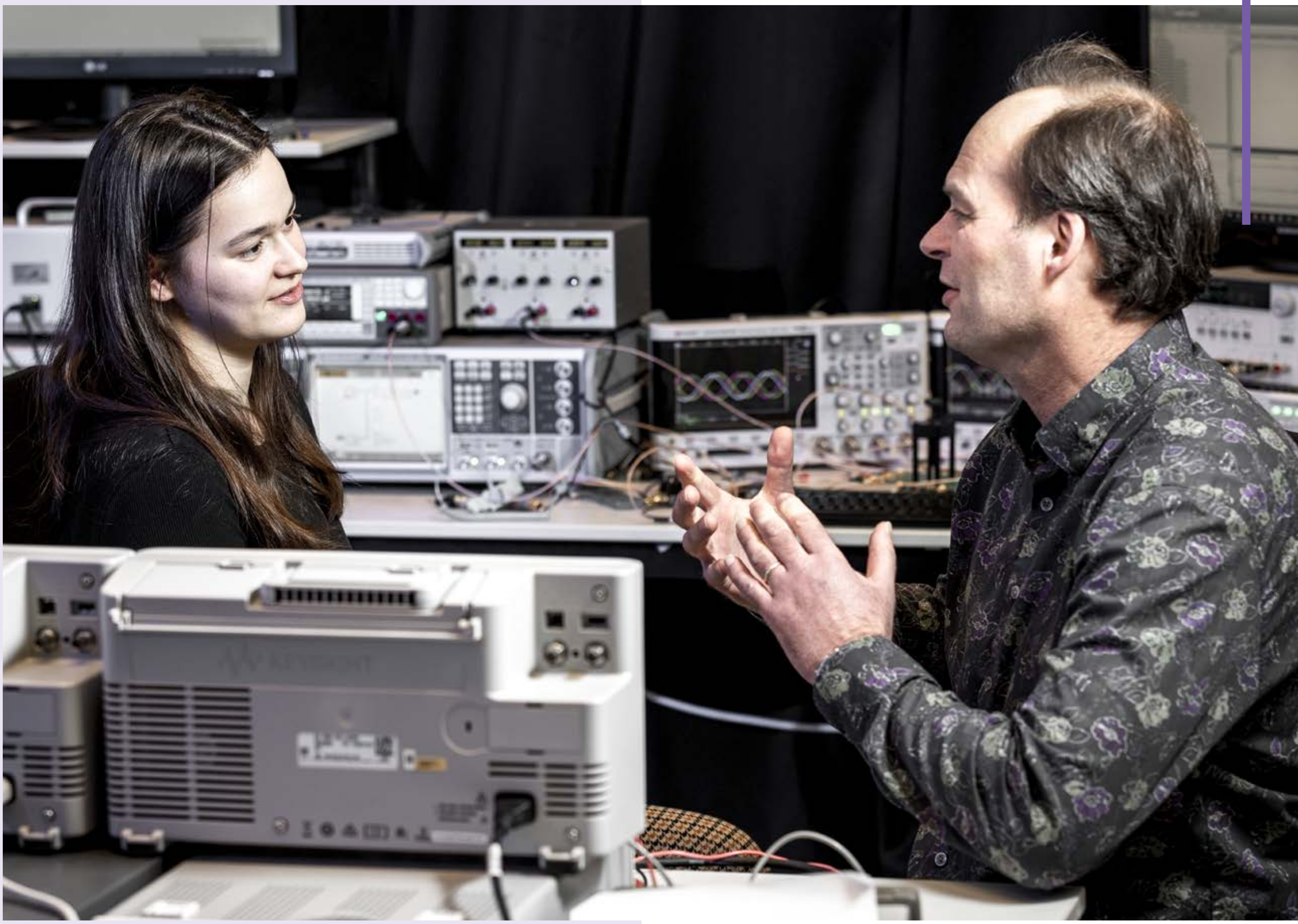
Progress

Is our society even waiting for all those inventions? That is a weird question for the two passionate engineers. 'Were you waiting for a smartphone ten years ago, or a camera in your phone? If you only give people what they want right now, you will never make any progress. No one asked for inventions such as satellite navigation, Wi-Fi and Bluetooth, yet we cannot imagine our lives without them. If we did not create the necessary technology, those new inventions would not exist,' Nauta says.

They have an idea or two about those new inventions. Communicating via a pair of glasses, for example, which sees the article you are reading and relays your thumbs up to the paper that published it, or which helps you ignore the pie in the fridge and choose something healthier instead. Sensors in your shoes that know when your feet are cold and you are almost home, so they turn up the thermostat and draw you a nice hot bath. If you are feeling down, the system knows that too and will welcome you home with relaxing music. 'Of course, none of this is carved in stone. It will not happen if there is no demand for it. Humans will always be in control,' Van Abkoude believes.

It is up to the world of electrical engineering to make all those innovations possible. A pair of glasses designed to help you choose vegetables over snack food must be able to tell the two apart. Inventions such as autonomous vehicles will only work if the internet can handle all that data. '5G is just the beginning,' Van Abkoude suspects. 'Most modern technology can only function properly when we do our jobs right. Chips have already made all kinds of equipment obsolete. A music player, a camera, a compass: because of inventions made by electrical engineers, they all fit into your smartphone. We are not coming up with new applications, but electrical engineering does ensure that the world can look completely different in a decade or so. Lending a helping hand at the forefront of these developments is much more fun than playing catch-up in the rear,' Nauta says excitedly.
Tara certainly needs no convincing. She has the brains, the skills and the motivation to make it very far indeed. 'Of course, it is hard work, but if you are curious about how things work and want to help develop the technology of the future, this is definitely the right place for you.' ●

Text: **Frederike Krommendijk**
Photo: **Rikkert Harink**



‘IF YOU ONLY GIVE PEOPLE WHAT THEY WANT RIGHT NOW, YOU WILL NEVER MAKE ANY PROGRESS’

No robot without electronics

Text: **Frederike Krommendijk**
Photo: **UT archives**

MEET THE STUDENTS

Anand Nateshan (19)
second-year bachelor's student

'I already knew I wanted to study Electrical Engineering; I just had to figure out where. Before this, I attended Cairo American College in Cairo, Egypt. I then took a brief summer course in Utrecht. I immediately liked the Dutch lecturers for their accessible and personal approach. I ended up choosing the UT because this is the only Dutch university that offers this programme in English. The classes are smaller than at other universities and lecturers actually know your name.'

A robot cannot exist without electronics and control technology. These areas of expertise will become increasingly important in the decades to come, says Stefano Stramigioli, professor of Advanced Robotics. 'A robot's entire nervous system and brain consist of electronics and control loops.'

According to the professor, electronics and control technology are essential to the proper functioning of any robot. 'How can I make that robot do what I want? Whether it involves sensory or motoric solutions, whether you want your robot to process images or operate and control things, it all revolves around electronics and control technology. Instead of working on a single component, you need a bird's-eye perspective, a true systems approach that allows you to oversee the entire complex. You must understand how the whole system works together and therefore operate on a multidisciplinary level.'
Unlike their early predecessors, modern robots are not limited to performing only one task. Instead, they must be able to do a whole lot at once in real time. Take a robot vacuum cleaner, for example: it must not only discern where it is using visual technology, but it must also do its job immediately and effectively in that new space. 'In addition to extremely rapid image processing, you also need aspects of control technology and possibly some form of artificial intelligence to perform the correct actions in an unfamiliar environment.'
A robot vacuum cleaner is child's play for the experts in the Robotics and Mechatronics (RaM) department. They are working on inventions that will have a much larger impact on society. One example is a robot that not only combines the images of MRI and CT scans to determine the exact location of a tumour, but also inserts a needle in the perfect position to take a sample or – in the future – eliminate the tumour entirely. 'You can fight cancer without making a single incision. We are already researching the applications of this technology on patients with breast cancer. It makes the treatment a lot more accurate, because the robot uses the scans to find the right spot much faster. Human doctors have less to do: the robot does its job immediately and in real time.'
The future lies in the hands of systems thinkers, Stramigioli knows. They can go wild in the state-of-the-art RaM lab. 'We design systems for the robots of the future. People from all over the world have visited us here and every one of them was absolutely amazed by what they saw. It is the greatest playground imaginable for anyone interested in cutting-edge technology.'
The possible applications are endless.
The University of Twente already has a reputation to uphold. Stramigioli himself is the vice-president of euRobotics and coordinator of two major innovation hubs in the fields of healthcare and inspection and maintenance. The UT is involved in projects where robots assist with police tasks. Researchers are also working on drones that not only visually inspect the rotor blades of a windmill, but can also instantly detect and transmit data about possible malfunctions. 'That requires a robot that not only has image-processing capabilities, but can also process the data into useful information in real time and transmit it. On top of that, it must be able to maintain a steady flight path in the vicinity of enormous windmills. This is just one example of how electronics, photonics, physics and other fields come together.'
The professor believes it will be another fifty years or so before robots and artificial intelligence can create such complex and autonomous systems that humans barely have to lift a finger anymore. Horror or hallelujah? Stramigioli thinks it will be the latter: 'You cannot stop the march of technological progress. These inventions will generate more wealth and give us all a lot more free time. It is up to our politicians to develop an economic system that will allow everyone to reap the rewards.' ●

Practical experience

'What I like most is the level of challenge that the programme offers. I believe it is perfectly doable, as long as you devote a healthy amount of time and effort to your studies. I am also amazed by how much time we spend on the practical side of things. During a project for which we had to make a Segway remotely controllable, I learned that you cannot rely solely on your theoretical knowledge. Practical skills are just as important, since you never know what problems you might encounter. In the future, I would love to work on electric cars. I am fascinated by their sensor networks and the way in which different components communicate with each other. I would love to be involved in the development of autonomous vehicles.'

Text: **Rense Kuipers**

ARTIFICIAL INTELLIGENCE

Towards a new generation of electronics

To professors Wilfred van der Wiel and Raymond Veldhuis, artificial intelligence (A.I.) is not about killer robots or handy humanoid butlers. It's about making sure the intelligence is energy efficient and barely noticeable, yet improving our daily lives.

I'm sitting in front of a Professor of Nano Electronics and a Professor of Biometric Pattern Recognition leading a Data Science group. Where do your research areas meet?

Veldhuis (pictured right): 'It's funny that we've found each other, since we're both on the extremes of the electrical engineering spectrum. In this case, it boils down to Wilfred making something that my research group needs. The last five years, machine learning has developed tremendously. The problem is that in reality, this technology is mostly realized in standard (digital) computers, which are not really optimal for the task. We want to take an important and fundamental step: realizing A.I. in dedicated hardware, that can be used everywhere and anytime with low power consumption.'

Van der Wiel: 'That's where our newly established Center for Brain-Inspired Nano Systems (BRAINS) comes into play. We want to make a new generation of hardware for machine learning and A.I. Not by using conventional methods, but using nanomaterials for the underlying information structures. Nowadays, if you look at processors, it's always step by step, or sequential. That is nothing compared to the processing power of the human brain, which in essence is a parallel processor.'

Veldhuis: 'The question is how we can use A.I. and machine learning in a better way. With the computers we have, there is a huge mismatch between task and form. We use advanced machines to perform even the simplest of tasks. That's a job for the systems we already have, that are able to perform additions and multiplications. If we want to take it further, we're going to need alternative, more wearable systems.'

So what will our future A.I. require from an electrical engineer?

Van der Wiel: 'We're making the step towards a new generation of electronics. So you don't want an engineer thinking about filling the trunk of a self-driving car with a bunch of servers. No, an electrical engineer should think of new ways of having the same computational power as a true embedded system within a car.'

Veldhuis: 'To add another example, you don't want to have huge computers for face or fingerprint recognition. They have to be more omnipresent and invisible. Over the years, I've slowly seen very different disciplines within electrical engineering merge with each other. Which is a good development, looking at the future. Undoubtedly, some things will stay the same, like the underlying math and physics...'

Van der Wiel: '...But change is coming, undeniably. A.I. developments will excessively intervene with our daily lives, to the point that we have to decide as a society what we want and what we don't want.'

With great power comes great responsibility?

Van der Wiel: 'Well, as an engineer you are also a citizen. It's not far-fetched that we can think of integrating tiny systems in the human brain. In prospective theory, if you want to become an instant expert in math – or electrical engineering for that sake – you may be able to get a suitable implant at some stage! But where does the human stop and the machine begin? Our self-consciousness is sacred to us, so simply talking about the idea of this is touching some sore points in society.'

Veldhuis: 'Another aspect is that legislation is always running behind on technological innovations nowadays. Look at the internet, drones, privacy... So yes, I think designing responsibly is very important.'

Van der Wiel: 'Think about the big picture as an electrical engineer. Keep an open mind when you're tinkering with circuits.'

The UT is the place to put this into practice?

Van der Wiel: 'Of course!' (laughs). 'Sincerely yes, I believe so. It's because of how a certain mindset has been cultivated over the years, to work together and bring completely different disciplines together. Of course, this took time, effort and mutual trust. But the culture stands as it is nowadays and it is something for anyone to become part of.'

Veldhuis: 'We're both living examples of that. So wherever your interests lie, there is always something to find here in Twente.' ●

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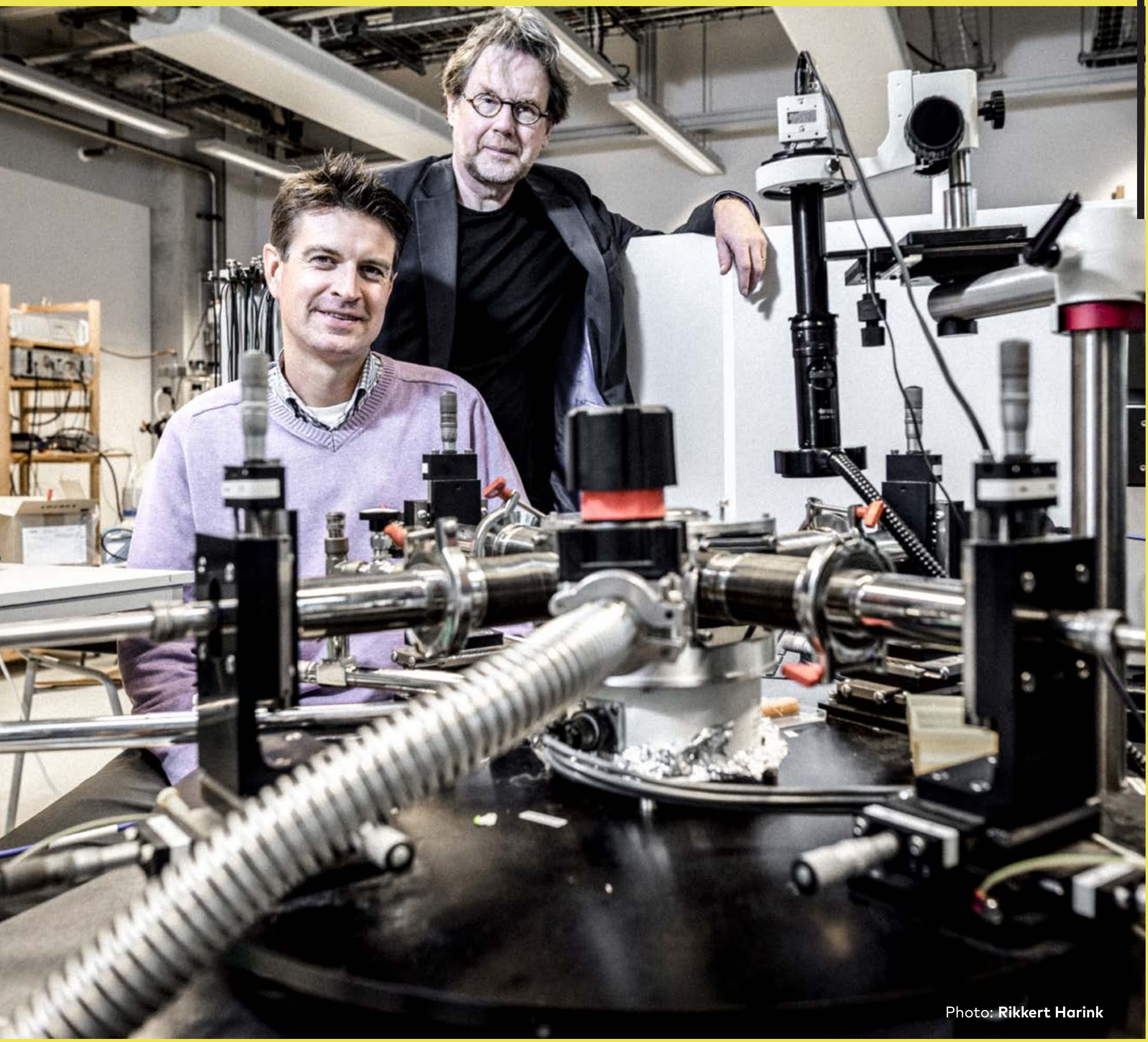

Photo: **Rikkert Harink**

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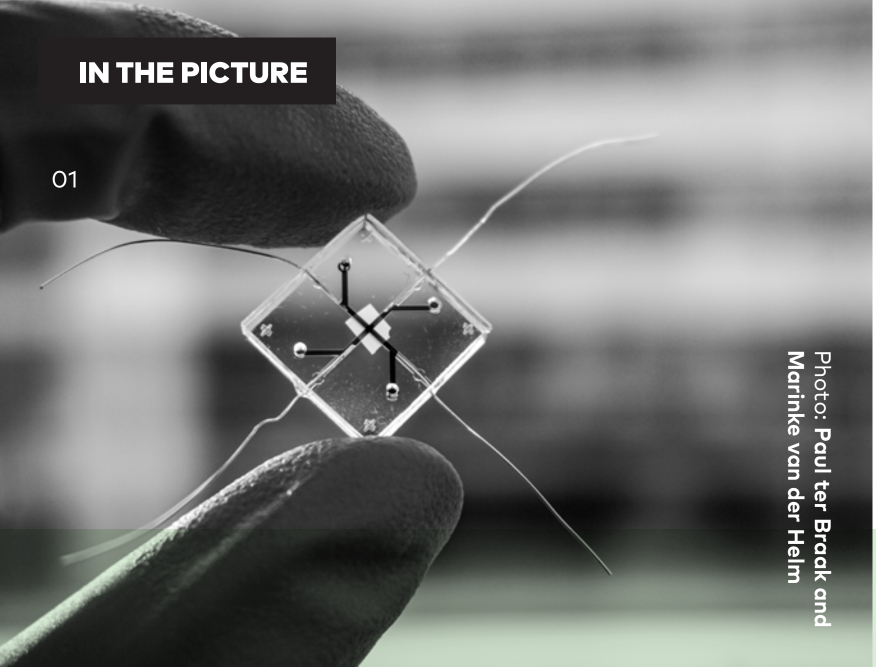


Photo: **Paul ter Braak and Marinke van der Helm**

Photos: **Rikkert Harink**

02

04

05

In Electrical Engineering at the UT we have multiple labs including BIOS lab, NanoElectronics Lab, RaM lab and the ICD lab.

01 + 02 Lab-on-a-Chip Lab
The Lab-on-a-Chip aims at the research and development of lab-on-a-chip systems. It's mission is to advance the knowledge and understanding of nanofluidics and nanosensing, bridge the gap between users from physical, chemical, biomedical and life-science fields, develop new micro- and nano-technologies for Lab-on-a-Chip systems and demonstrate the potential of LOC applications.

03 NanoElectronics Lab
Researchers in action in the cryogenic measurement laboratory of the NanoElectronics Group, member of the Center for Brain-Inspired Nano Systems (BRAINS).

04 Robotics and Mechatronics Lab
In the Robotics and Mechatronics (RaM) lab systems are designed for the robots of the future. This lab is top of the bill and attracts global attention.

05 Integrated Circuit Design Lab
In the Integrated Circuit Design (ICD) Lab, the main subject of the research program is the design of state-of-the-art analog and mixed-signal integrated circuits, with a focus on CMOS Transceivers.

MEET THE STUDENTS

Renée Meijer (22)
second-year bachelor's student

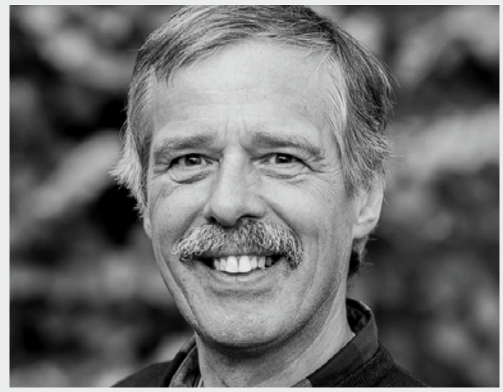
'My choice for electrical engineering (EE) began in Australia. I spent some time there working as an au pair for a General Practioner. I jokingly told him that I would set up his practice for him. They held me to my word and before I knew it, I was already working on it. I discovered how much I love setting up servers, linking computers together and, above all, neatly connecting all those hundreds of cables. That's when I knew that I wanted to do something in this field. Once I got back to the Netherlands, I chose the UT because of its highly acclaimed technical programmes.'

Don't choose Electrical Engineering

You've barely learned how to stand on your own two feet and are already asked to make a choice that will affect the rest of your life: what will you study? Fifty years ago, the choices for someone with beta talents were limited: crude mechanical engineering, incomprehensible physics or chemistry aboard an oil platform. As a young kid, I loved breaking apart electric devices to find the answer to such questions as where the sound in a radio came from. I was fascinated by how things work, so I messed around with trains, built my own calculator, that sort of thing. What I loved most of all was when something broke; how could I put it back together again? Electrical engineering was the answer for me.
Looking at it like that, you really have no choice. You often wonder how things work and what you can do with them. If you have never felt like that, don't waste your time with electrical engineering.

There are other reasons why you should not choose electrical engineering. It offers no guarantees for the future, but in all my years I have never had trouble finding great jobs. If you want to earn the big bucks, you should stay far away from electrical engineering. In fact, don't go to university at all and just do your own thing instead. Do business, close deals, take smooth and charm the pants off everyone you meet. Of course, you have to have a knack for that, because only the best businessmen and -women make it in this world. The rest of us ends up in the gutter.

Do you like to party, the more the better? Are you an easy-going sort of person who loves to chill out and have fun? Here is an ice-bucket challenge for you: electrical engineering is a devilish difficult programme. Party animals: seek your fortunes elsewhere. Electrical engineering requires mastery of myriad mathematical techniques. The first year is brutal. You often only realise what something is for when you understand the physical aspects of a problem. When the two come together and you suddenly see the big picture, it is a feeling like no other. Wait, am I promoting electrical engineering after all?
In the last fifty years, the field of electrical engineering has evolved from kilometre-long cables to transistors measured in nanometres. Countless technological innovations (vacuum tubes, transistors, chips, computers, artificial intelligence) have made the field into what it is today – and the end is nowhere in sight. Electrical engineering is essential to every aspect of



human progress: from autonomous vehicles and zero traffic casualties to a laboratory in your own stomach and putting the first men on Mars. You should definitely not study electrical engineering, because you will never be done! There will always be another challenge waiting for you. Something impossible that you have to pull off. If that sounds fun to you, welcome to the world of electrical engineering!

Marcel Pelgrom
UT alumnus, Honorary Professor KU Leuven Philips Research Department Head (1995-2003), 2017 IEEE Kirchhoff field award prize

Getting to the bottom

'I have always been interested in getting to the bottom of things and I refuse to accept something at face value. I have to know how something works.'

Traffic lights

'As an electrical engineering student, you look at the world around you from a different perspective. From boring traffic lights to the latest gadgets; I always wonder how something works and how I would have designed it differently. That is the great thing about this programme: you not only gain extensive theoretical knowledge, but also a ton of relevant practical expertise. After this, I plan to do my master's in Aerospace Engineering in Norway. I don't know what I want from my professional career yet. There are so many options to choose from.'

LAB-ON-A-CHIP

Electrical engineering is everywhere. The healthcare sector is no exception. Loes Segerink and Mathieu Odijk work as researchers at Biomedical and Environmental Sensorsystems (BIOS) Lab-on-a-Chip, a multidisciplinary research group where electrical engineering is essential – no, elementary.

Odijk: 'I studied electrical engineering myself, while Loes has a background in biomedical technology. That is nothing unusual at BIOS Lab-on-a-Chip. Chemistry, biology, physics: all backgrounds are accounted for here. At the same time, we are an excellent match for electrical engineering, I think.' Odijk continues: 'For lab-on-a-chip, sensing – the collection of data – is essential. Using electrical currents, we control and study fluids on a chip. The most famous example is the UT spin-off Medimate. This at-home testing device measures the amount of lithium in a person's blood. On the chip, a drop of blood flows through the fluid channels under the influence of an electrical field. Small changes in the conductivity make it possible to measure the concentration of lithium in the blood. Lithium is an important component in antidepressants, but too much of it can be dangerous. Under professional guidance, manic-depressive patients can measure the lithium content in their blood at home using the testing device, so the correct dose of lithium can be calculated with great precision.'

Segerink: 'My own research is dedicated to measuring cells. With our fertility chip, we measure the number of sperm cells and their quality with electrodes. Normally, a few million sperm cells are available, but some men have fewer than twenty. The fertility chip makes it possible to select the right sperm cell, which increases the chance of a successful fertilisation. At the moment, this selection process is completely random. I am working hard to make the fertility chip suitable for clinical laboratories. If I succeed, it will appear on the market in just a few years.'

Odijk: 'I am working on a needle that tries to detect neurotransmitters and electrical signals in the brain. These neurotransmitters are the chemical messengers of our brain. We use our needle to research severe migraine episodes. What happens in a patient's brain during such an attack? What causes migraines? Does anything precede an episode? Those are the questions we are trying to answer. I have a personal stake in the research. At one time in her life, my sister suffered migraine attacks two or three times a month. That gave me a strong motivation to dedicate myself to this research.'

Both Odijk and Segerink ultimately want to develop a tool that will make it possible to bring their research to market. What are the future applications of electrical engineering in the healthcare sector?

Odijk: 'When I think about the future, I expect the smartphone to play an even bigger part in our lives. The power of such an enormous platform will allow us to do more in terms of prevention. On a technological level, it is already possible to plug a chip into a smartphone and analyse someone's blood. The screen will show something along the lines of 'Go see your general practioner .''

Segerink: 'At the same time, there is a consideration to make. Should we really measure and know everything? That might have some serious implications. There is no point in releasing measurement technology on the market if there are no treatment methods to accompany it. That would only make someone unhappy.' ●

‘WE ARE AN EXCELLENT MATCH FOR ELECTRICAL ENGINEERING’

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

Text: **Frederike Krommendijk**
Photo: **Eric Brinkhorst**

MEET THE STUDENTS

Thomas Hoen (25)
double degree Master in ICDesign, NanoElectronics, Integrated Devices and Systems.

‘I have looked at a lot of different study programmes before I found the right one for me. Electrical Engineering (EE) proved to be the most fun and challenging of them all. The programme has direct impact on our daily lives and is very versatile. You can design, build and test everything from robots to nanoelectronics. Moreover, you can make the programme as theoretical or practical as you want. Why I chose the UT? Mostly because of the atmosphere here. The approachability and the campus are major pros.’

ALUMNUS

'Demand for electronics continues to grow'

Even as a child, Robert Brookhuis was fascinated by how electric devices work. After earning his higher education Bachelor's and Master's degree in Electrical Engineering, he wanted more: a PhD at the UT, specialising in Microsystems. Today, he can put his knowledge and experience into practice every day at Prodrive in Eindhoven.

In his younger years, Robert loved pulling things apart to see how they worked or to fix them. A technical study programme, such as electrical engineering, mechanical engineering or physics, was always in his cards. 'I am glad that I chose electrical engineering. My knowledge comes in handy in so many different ways. Power electronics, medical technology or photonics: I deal with all that and more at the company I now work for,' he says.

Robert is a systems architect at Prodrive, a major player in the high-tech industry and a supplier for companies such as Philips and ASML, among others. 'Simply put, we develop high-tech components or entire systems for our clients and handle nearly everything ourselves. The great thing about this approach is that you get to experience the whole product journey, from initial design to serial production.'

As a systems architect, he is responsible for the technical aspects of a system, such as a detector system in a machine for ASML. 'You are dealing with precise analog electronics, digital electronics, high speed data interfaces, but also fine mechanics, material science, and physics, that all come together in one system. It is like a puzzle that you and your team must solve using your experience and creativity. It feels amazing to finally pull it off.'

Brookhuis obtained his doctoral degree at the UT with research into nanotechnology. 'I was drawn to the fine nature of microsystems and microelectronics. In the Nanolab at the UT I gained a lot of hands-on experience and process knowledge. That is a great way to learn what works and what doesn't, and I still reap the benefits of it every day. At Prodrive, we often work on projects with a strict deadline. In those cases, it is good to not only master the theory, but also understand what is and isn't feasible in practice. When you have to finish something on time, a correct risk assessment is truly essential. The combination of theoretical knowledge and practical competence is in high demand at many organisations.'

Opportunities

The electrical engineering programme offers excellent career opportunities. Brookhuis knows that from first-hand experience. He never applied for a job at Prodrive; instead, he had such a great talk with the company's representatives during an open day that he was invited. 'In high school, career opportunities are the last thing you want to worry about. You want to do what you love. Luckily, those two aspects come together in the field of electrical engineering. Companies are desperately looking for new talent. I don't expect that to change any time soon, either. Whatever piece of technology you can think of, from medical equipment to your smartphone or an autonomous vehicle, everything has electrical engineering in it.'

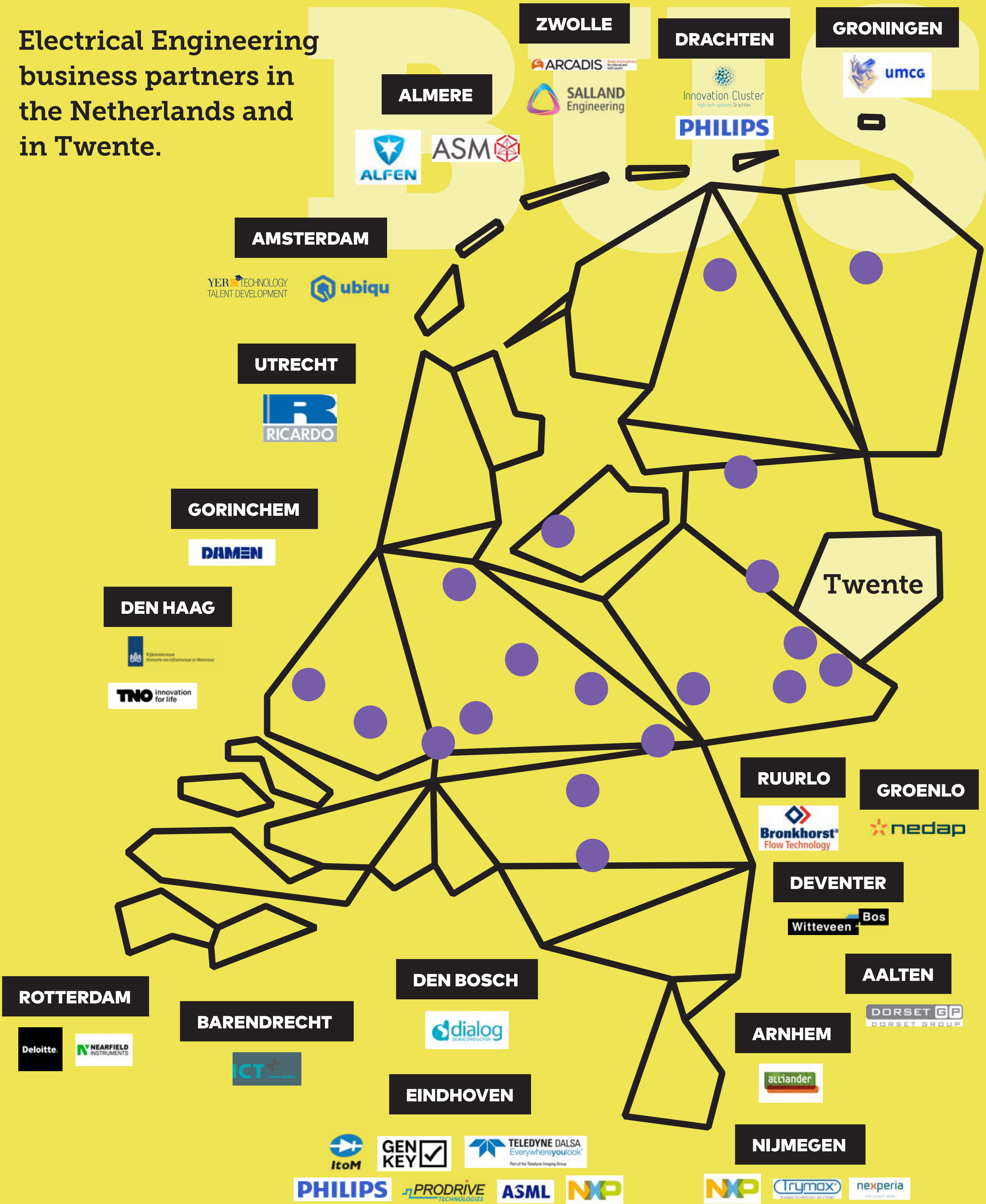
He recently visited the university to introduce the newest generation of students to Prodrive. 'I know from experience how well the programme ties into the practical reality of working in this field, because I am an alumnus myself. Electrical engineering is highly recommendable because it is such a comprehensive field. You have to be excited and feel the drive to achieve the best possible technical results. You always operate on the cutting edge of multiple fields, including mathematics and physics. The best feeling in the world is when your knowledge is applied in a practical solution.' ●

Bagpipe

'The most remarkable thing I have done during my studies was develop an electrically operated bagpipe. Near the end of my first bachelor year, a group of friends and I built a fairly functional device in just a few weeks' time. When you whistled a tune, the bagpipe played along with you. We could also control the device with a keyboard. Creativity is important during such projects. We used an old vacuum cleaner in reverse as a blower.'

'My master's thesis is about electronics at temperatures of -269 degrees Celsius. That is an extreme of an entirely different nature. After my master's, I want to obtain my doctoral degree at the UT. During my PhD I want to try to integrate more electrical components on a chip in order to increase its accuracy. After that, I will go looking for a new challenge.'

Electrical Engineering business partners in the Netherlands and in Twente.



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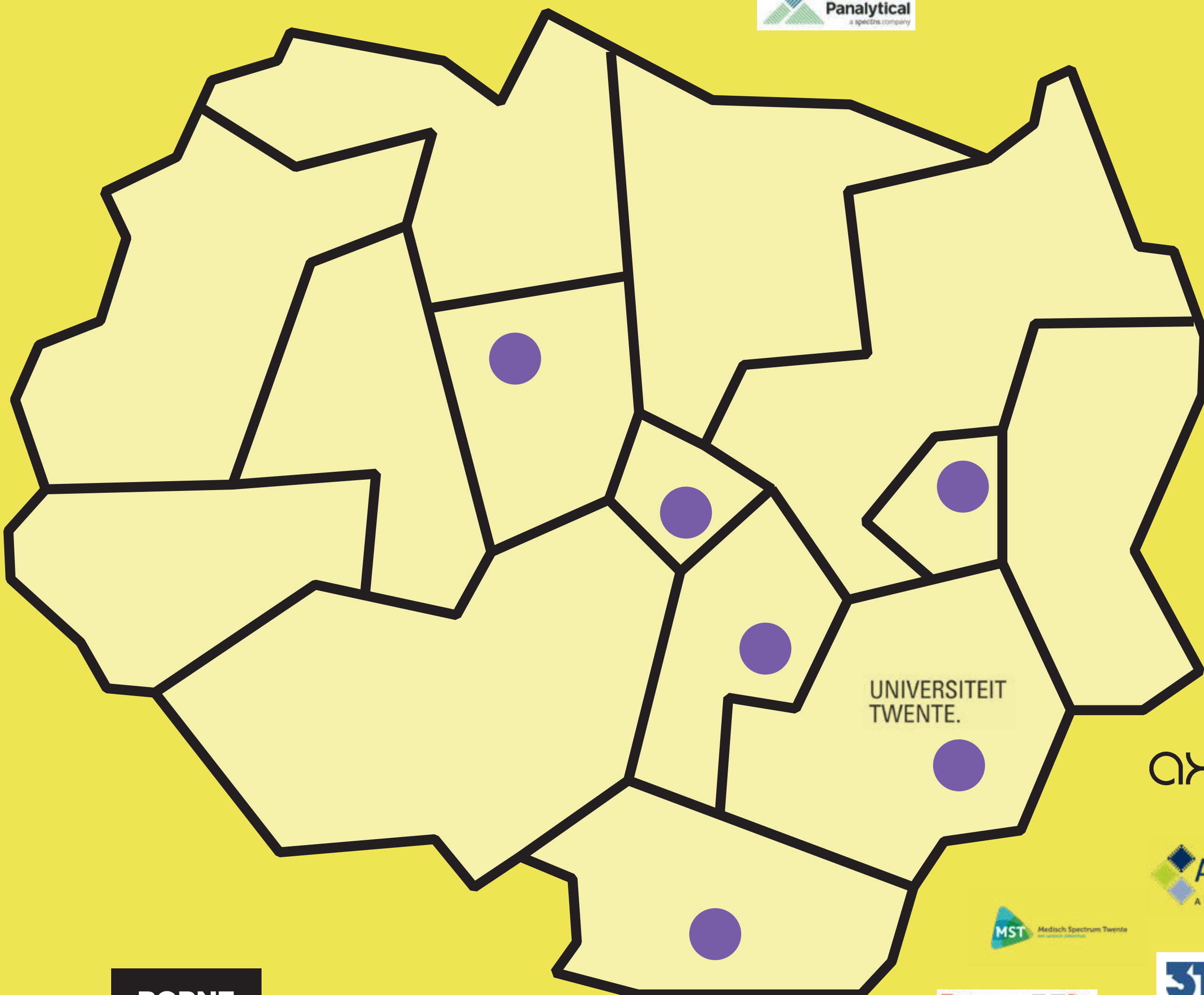
EE in Twente



ALMELO

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Sensata Technologies
dialog
THALES
sintecs
BILFINGER TEBODIN

OLDENZAAL

AEMICS smart products

ENSCHEDE

axign
TSST
AnSem A CYIENT COMPANY
FIGO
MST Medisch Spectrum Twente
3T
MST Medisch Spectrum Twente
LioniX INTERNATIONAL
TELEDYNE DALSA
AnSem
SCISPORTS
maxon motor driven by precision
ItoM
DEMCON
QBAYLOGIC

BORNE

dizain-sync

HAAKSBERGEN

TKH GROUP TKH AIRPORT SOLUTIONS

This infographic shows some examples of companies that Electrical Engineering of the UT is working with.

INTEGRATED CIRCUIT DESIGN

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

'THE MORE CHIP DESIGNERS, THE BETTER THE WORLD'

Integrated Circuit Design (ICD). The term might sound foreign to you, but you encounter it nearly every minute of every day. It's everywhere. 'It's so small that people don't notice it, but without it the world would be a total mess. Society without it is like stone age. We are the secret agents that make progress possible.' Those are the words of Jurriaan Schmitz and Bram Nauta, two UT professors describing their field of expertise: integrated circuits, more commonly known as chips. They discuss why the technology is so crucial for the future and hence why all their graduates receive job offers without even applying.

What is an 'integrated circuit'?

Nauta: 'Chips and microchips, electronic circuits integrated on a very small piece of semiconductor material. It is a very complex machine that can be made for very little money. Chips are in everything nowadays. Cars, phones, computers, even lightbulbs. LED is basically a computer that glows. To give my favourite example: if we didn't use microchips but discrete components that were common in the 1970's, the iPhone 5S would become bigger than the Eiffel Tower and it would require a huge nuclear powerplant to function as it does.'

Schmitz: 'Without chips there would be no smartphones, no Facebook, no Internet. We make internet possible. Electronics are in everything and it will only intensify in the future. A century ago everything became electric, now everything is becoming a computer. In the Netherlands we are leading the change and are worldwide an electrical engineering hotspot. All EE-associated companies are looking for thousands of engineers every year. If you study electrical engineering, they offer you a job even without you sending them an application.'

Nauta: 'True. I have never had a student that could not find a job.'

What does that job look like?

Nauta: 'It is so cool to be a chip designer. To clarify, my role is of the "architect", I design what the chip should look like and do. While Jurriaan is more of the "contractor", he needs to figure out how to build it. We both need each other. I love being a chip designer. You get to design something that is so small that you can't even see it. You have to imagine everything in your head, you need to have good abstract thinking. But if it works, it makes you feel very smart because you could not check it beforehand. Another advantage of this field is that experience is valued. The older you get, the better you are. It's not like being a software designer, when there is always someone younger and better than you. Experience counts here.'

Schmitz: 'That is why we also make sure to always have experienced people in the classroom, people who worked in companies, created something for the real life. That is what I really like about electrical engineering. It is always practical, there is always a clear purpose for what you are developing. You work on challenging problems, solving puzzles step by step until you create something that nobody before you ever made. We can make prosthetic legs for someone, legs that are so smart that they walk by themselves! If you want to build something that doesn't exist yet, you need electrical engineering.'

What didn't exist twenty years ago that ICD made possible?

Schmitz: 'Smartphones of course. Making a video call with a handheld device was considered a complete sci-fi until rather recently.'

Nauta: 'But we knew the future and we made it possible. We started doing research twenty years ago that you use in your smartphone today. It's a completely different world now. Twenty years ago you had to print your pictures to look at them, now your camera is a computer. Anybody can do video editing nowadays. That was completely impossible. You had to get a specialist who would physically cut the film and glue it back together. Cars didn't navigate, there was no OV chipcard, only paper tickets. Getting a flight ticket took days, now you can get it within minutes directly to your email.'

Schmitz: 'A lot needed to happen behind the scenes to make this possible. Electrical engineering makes everything possible. Google would not exist without it. If you think about it, the biggest companies of today didn't exist ten years ago. It used to be oil companies and banks ruling the world, now those barely need employees because everything is done digitally.'

Nauta: 'All because we do our job.'

You were able to foresee the future before. What type of developments will ICD make possible in the time to come?

Nauta: 'Electronics put into or onto our bodies, connecting our body to the cloud. Apps and phones might disappear.'

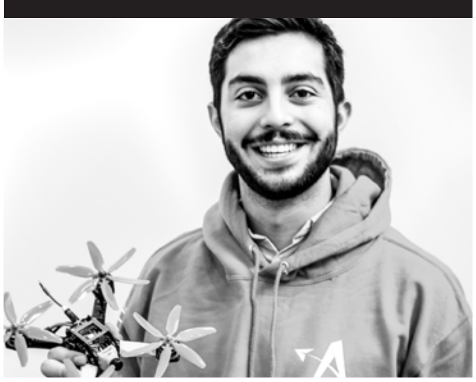
Schmitz: 'We will see smartphones only in movies and laugh about it. We will laugh about this age. You won't no longer need glasses to correct your eyesight. You can download the "correction". You can download a different eye colour. Things that sound ridiculous now will be possible thanks to this technology. We need to keep on innovating.'

Nauta: 'Yes. People often say "But I'm happy with my computer, happy with my phone. I don't need a better one." When they say that, I ask them to use the computer they had ten years ago. Nobody wants that. Our job is to design the stuff that makes the world better. The more chip designers, the better the world.' ●

COLUMN

Photo: **Yvon Gankema**

MEET THE STUDENTS



Gabriel Damian (22)
second-year bachelor's student

'The UT is the only Dutch university to offer the Electrical Engineering programme in English, which naturally appealed to me as a Canadian. I chose this study because it is the most impactful one for my generation – at least I think it is. I dare to say that electronics will play an even bigger role in our future than they do today. The study offers endless possibilities. Electronics are all around us and it is fantastic to use our knowledge to meet the world's electronic needs.'

Aerobotic Tech Team Twente
'In addition to my studies, I am an the team manager of A3T, the Aerobotic Tech Team Twente Drone Team. The team focuses on designing and building drones and does not

Engineering today's science fiction

More than a hundred years ago, ambitious inventors entered the magical world of electricity for the first time. Experimental scientists like Graham Bell and Nicola Tesla amazed the world with ground-breaking inventions such as the telephone and the electrical (AC) motor. Back in the day, these technologies were completely new to mankind and marked the beginning of an era full of technological progress.

Following these inventions, electricity quickly gained ground in daily life and provided everyone with a relatively cheap source of energy. It is still one of mankind's greatest inventions. The field of electrical engineering soared and the number of electrical applications grew exponentially. Even more amazing is the fact that it continues to grow to this day.

Current trends towards smaller and more low-power electronics allow for electrical enhancements in even more areas, providing the world with smart fridges, thermostats and security systems; all interconnected through the Internet of Things.

We owe much of the innovation in the field of electrical engineering to the strong collaboration between research institutes and industry. While the research institutes provide motivated students with a solid foundation to shape the world of the future, electrical industries make use of the knowledge provided by these engineers to develop the products of tomorrow. This is the very reason why curriculum topics closely relate to the knowledge required in industry and why engineers give guest lectures to students.

The field of electrical engineering is developing rapidly. The number of applications increases and their complexity keeps on growing. This requires students to specialize early on, to have enough time to shape the foundation needed for the continuous development of newer systems. This complexity is exactly what makes electrical engineering so rewarding and magical.

Although it is quite hard to imagine what forms the innovations of tomorrow will take, we can try to visualize what science fiction may become tomorrow's reality. As electrical engineering covers topics ranging from large radar systems to miniscule laboratory systems on a single chip, the technological development is huge. Think of implantable technologies that enhance our human capabilities or entire fleets of automated systems taking care of our healthcare and public services.

Today, these applications seem just as futuristic as back when Nicola Tesla developed the prototype of his revolutionary AC electromotor. One thing is for certain though: we will be amazed over and over again as Electrical Engineering students continue to engineer today's science fiction.

Stef van Zanten,
master student Electrical Engineering

consist only of electrical engineering students. This year is extremely important to A3T. Besides the competitions we take part in every year, we also face a new challenge: the Unmanned Aircraft Systems Challenge (UAS). This competition is about offering emergency aid with an Unmanned Aerial Vehicle or UAV. It is about helping victims in disaster areas. The UAVs are tested to see how well they handle tasks such as finding survivors of e.g. a flood or dropping medical supplies using parachutes. However, the main criterion of the UAS Challenge is safety. The competitions that A3T has taken part in before, DroneClash and MAAX Europe, demand entirely different things from a UAV, namely fighting and racing. Our team currently has twenty-seven members, which makes us one of the UT's largest student teams – second only to the Solar Team Twente. There are plenty of roles for an electrical engineering student in our team: from management to programming or even marketing.'

ELECTRICAL
ENGINEERING

FROM SCIENCE FICTION
TO SCIENCE FACTION

Do you want to know more about our study programmes at the UT? Check out these websites:

Bachelor programme
www.utwente.nl/go/ee-bsc/ut

Master programme
www.utwente.nl/go/ee-msc/ut

Master programme specializations
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