Connecthor 42

TU/e

Magazine of e.t.s.v. Thor and the department of Electrical Engineering at Eindhoven University of Technology

June 2018

Travel column | **PhD** research | Mjolnir | Open **house** day | Study trip **Romania**

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And before you know it, it's June again. The month before most of us take some time off from work to enjoy our yearly summer leave. But before you go, we present to you our newly printed Connecthor magazine. In this summer issue you will find many interesting articles to read.

To be able to keep on working and studying in a front-runner research environment, it is important to be critically evaluated by independent external experts on a regular basis. Our vice-dean Ton Koonen writes about the evaluation that took place just recently.

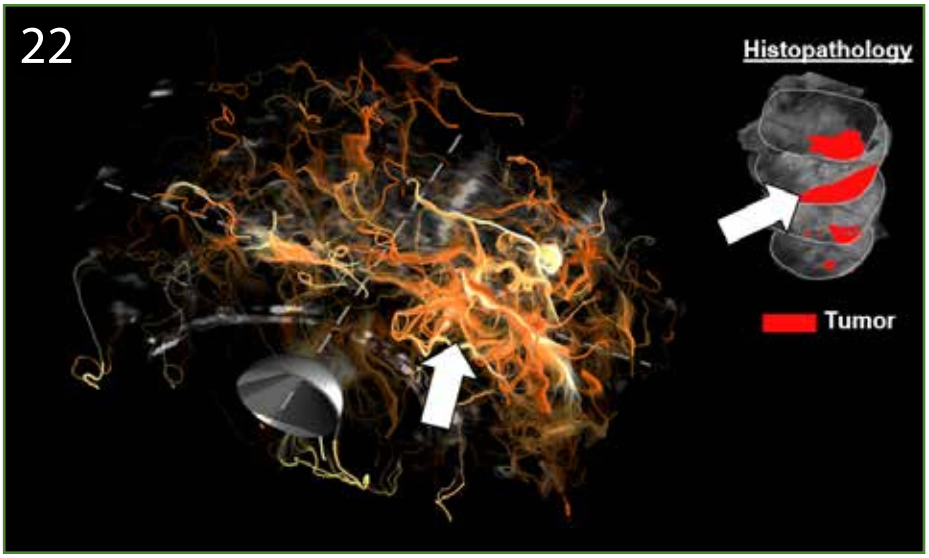
In this June issue you will find an article written by Robbert Schulpen about his PhD research on 5G millimeter-wave channel sounding, and another PhD research article written by Ruud van Sloun about his research on ultrasound markers for cancer.

Student team TU/ecomotive wrote an article to introduce the world's first circular car, Noah. One of our former editorial board members, Jeroen van Oorschot, shares his experiences about his internship abroad in Portugal. Read about Sander Verdiessen's world travels to exotic places in his new column. This time he traveled to Somaliland.

We hope you enjoy reading this June edition.

The Connecthor editorial board.

P.S.: The Connecthor editorial board has positions open for creative and enthusiastic employees of the Department of Electrical Engineering interested in joining us to make the Connecthor magazine. Up for a new challenge? Please contact us!! As always, we will be glad to receive your suggestions and nominations for the 'vlaai' and ideas for upcoming editions. You can contact us via connecthor@tue.nl. ■



Ultrasound markers for cancer
Could ultrasound imaging be used as an alternative to conventional methods? Read more about this on page 22.

Mjonir
Are you strong enough to lift Thor his new hammer? Check it out on page 14.

Intership Abroad
Still wondering where to go for your internship? You can find a good example on page 20

Week 1 in Somalia
Bored of your regular holidays? Read about Sander his trip to Somalia on page 18.

Icons of EE: Jack Kilby
Do you know where the integrated circuit originates from? Learn who made the first IC possible on page 28.

Board issues

By: Ton Koonen

The research activities in our department get much appreciation from many sides, and that is good not only for our staff, but also for our students who thus can be proud of being educated in a front-runner research environment. However, we have to stay keen on this pole position. It should be critically evaluated on a regular basis by independent external experts, and the lessons we learn from that can help us to stay at the top and even improve.

So we have had a review of our EE research activities by a committee of external experts who visited us on December 6, 2017. This review was also done at our sister EE departments at TU Delft and University of Twente. A lot of preparation work has been done, which already started in early 2017. At TU/e, the coordinating team consisted of Jan Vleeshouwers, Jan Bergmans, and Ton Koonen. Together with the responsible persons at TUD and UT we did careful alignment of the procedures to be followed. We have common EE interests to safeguard, such as the interests towards the politicians for getting sufficient financial support and interests towards the general public for getting recognition for the societal impact our work has. Hence we aligned the way of reporting and of the on-site interviews with our TUD and UT friends.

First of all, we agreed on a committee of experts of no more than seven people, who adequately covered all EE domains in TU/e, TUD and UT. As chairman we chose prof. Patrick Dewilde, who has extensive expertise in research assessment in many national and international committees, amongst others as KNAW member, chairman of STW, and director of Institute for Advanced Studies in TU Munich. Other members were prof. Piet Demeester (Univ. Ghent), prof. Rik de Doncker (RWTH Aachen), prof. Heikki Koivo (Aalto Univ.), prof. Robert Puers (KU Leuven), prof. Dominique Schreurs (KU Leuven), and dr. Leo Warmerdam (NXP). As prescribed by the new SEP (Standard Evaluation Protocol) 2015-2021 for Research Assessment in the Netherlands, the committee was tasked to judge the quality, societal relevance and viability of the research of the department as a whole, not of each group separately (which was the charter in previous SEP-s). The period to be covered was 2011-2016. We have already practised with this new SEP in the midterm review, done in 2015. From the midterm committee (in which prof. Dewilde also participated, but the other members were different) we got some advice which we could build on.

A lot of effort has been put in the self-assessment report, edited by Jan Vleeshouwers, for which extensive data were gathered among the groups, about PhD statistics, projects acquired, publication records, staff profiles, etc. It also describes strategic directions of the department and the organisational processes. As agreed with TUD and UT, we jointly made a visit to RWTH Aachen to learn about their research activities and the organization of those, and benchmark our activities to theirs. That was an insightful experience, the approach is quite different there, in smaller groups with very high pressure for funding the temporary people, but also with a well-organized new infrastructure ('Forschungscampus') to fill the TRL gap between academic research and industry. By the way, our new Photonic Integration Technology Centre (PITC) has the same intention. Separately from the report, a flyer was made which in a very concise (A5) manner gives the characteristics and highlights per research group.

The self-assessment report was sent well in advance to the committee. After they were welcomed the evening before in the hotel by our Rector Frank Baaijens and our faculty board, they came well-prepared to visit our department on December 6. First they got

an overall presentation by our Dean, Bart Smolders, where after there were extensive Q&A discussions with the EE faculty board. The committee split up in three sub teams and paid short visits to the individual groups (although the SEP does not ask for that, but together with TUD and UT we invited them to do so and thus get at least some qualitative remarks). Also they had a lunch meeting with some PhD students to gather some first-hand impressions from the 'work floor'.

At the end of a long day, the chairman presented some first impressions the committee got, praising the high quality of the research they saw, but also some lessons to be learned, more *in extenso* to be laid down in their final report.

So which lessons did we get from their final report? First of all, we got many great compliments. Just to name a few: we were praised for the excellent scientific output (both quality- and quantity-wise), for the excellent outreach to industry, for the great cooperative atmosphere between the groups. The starting of prototyping activities (cf. PITC) was lauded as a great step to bridge the gaps between academic research and industrial engineering, recognizing that industry is getting more and more short-term focussed. They also gave us various valuable advises. In general (this also holds for TUD and UT), we should create more visibility for our work, and stronger advocate the benefits EE has to offer to society in terms that are clearly received by the decision makers (politicians, funding agencies, …). Bringing out the overall EE strategy more clearly would help; the committee recognised the strategies at the various groups, but advises more emphasis on the symbiosis. They mentioned the relatively long duration of PhD trajectories, often more than five years whereas the norm is four years; pursuing publications and (external) presentations very early in the PhD phase may already help to lay an early foundation for a timely thesis. They recognised the increasing workload, in particular due to the booming student numbers and funding acquisition efforts. In response, and due to upcoming retirement of many staff members, much new staff has to be recruited. For this, and also with an eye on the gender issue, they advised to make our societal goals, expertise areas and major research questions better visible outside, and to hire more internationally, where in the EE domain typically more females are active. We should do more innovation scouting, looking for the diamonds to bring out and foster into start-ups or other (industrial) follow-ups. We should do more frequently benchmarking with other internationally leading universities (MIT, Stanford, ETH Zürich, KU Leuven, Oxford, …) and compare the choices we make with theirs.

The report gave us a lot of encouragement, and wise lessons to become even better; thanks to the committee for their valuable advice, and thanks to you for all the EE inputs! ■

Masterclass Enjoy Engineering 2018

By: Rian Hol

On Monday February 5th, 24 5VWO students were hosted for the annual edition of our Masterclass Enjoy Engineering. This year four different Masterclasses were offered. Over the four days groups of five to six students were researching one specific topic.

Led by a very enthusiastic Stijn Fransen, students worked on the Masterclass 'Kernfusie'. Several lectures under the heading 'plasma physics' were the start of various experiments in the TU/e plasma laboratory. The 'remote experiment' on the 'Tomamak Golem' situated in Prague University was definitely a highlight; the goal was to create an appropriate fusion plasma and determine its temperature.

Rob Kloosterman took care of the Masterclass 'Bicolored Optic Fiber Transmission'. Students were busy with an assignment in which they intended to combine text and music. This combined signal had to be transferred into light signals which go through a glass fiber. At the receiving end the signals have to be separated back into text and music; this technique is used by DJs and gives the opportunity to play music and display texts at the same time.

During the Masterclass 'Human Controller' Bram Witteman guided students in playing a game wireless. Acceleration sensors and ICs transfer movements into electrical signals which are used to play a video game or to control robots. The system has to detect and process the movement and send it wireless. Of course problems like disturbances play an important role, at the point where the sensors are placed. Next to that it's important that the signal really ends up at the pc.

The Masterclass 'Energy Challenge' by Horst Fietje gave students the assignment to drive around a circuit with a wirelessly controlled car. To do this accurately, it's important to know what speed is favorable and to ensure that this is the actual speed driven. Students learn to read electrical signals and how to calculate the velocity from this data.

On Saturday April 7th each group presented their project to their family and teachers in the 'Blauwe Zaal' of the Auditorium. The awaiting audience was looking forward to the results of four days of hard work. After the presentations the students also had the chance to further explain the posters presented in the 'Voorhof'.

With both students and parents beaming with pride we can conclude that the 2018 edition of Masterclass Enjoy Engineering was a great success. ■

Appointment Peter van der Wielen

Per March 1, 2018, Peter van der Wielen has been appointed part time professor 'Reliability Grid Components' in the group Electrical Energy Systems.

Goodbye Elwin

In December 2015, Elwin Hameleers joined the Connecthor team as one of our editors. After 2.5 years of taking care of the photo page, reaching out vlaais, getting other people to write articles and to edit them afterwards, Elwin has decided to step down from the board. We thank him for all of his hard work and enthusiasm.

Appointment Massimo Mischi

Massimo Mischi is appointed Professor in the area of: "'Model-based quantitative analysis of biomedical signals"'.

He leads the Biomedical Diagnostics (BM/d) Research Lab, which is part of the SPS Group

New TU/e Community and Research website live!

On April 6, 2018 the first webpages of the new TU/e Community and Research websites were launched!

Delivering good webpages is more important than launching a lot of new webpages at one moment: quality over quantity. For that reason the webpages will be launched step by step. Curious about the new website? Take a look now at the Research Homepage (www.tue.nl/en/research/) or the Community Homepage (www.tue.nl/universiteit/community/).

Eindhoven Workshop on Optical Communications - EWOC 2018

By: Chigo Okonkwo

The first Eindhoven Workshop on Optical Communications (EWOC 2018) jointly organized between the SPS and ECO research groups took place between the 8th and 10th of April in the Flux building. The workshop was sponsored by the EuroTech Alliance which aims to foster stronger collaboration between Technical University of Munich (TUM), Technical University of Denmark (DTU), École Polytechnique Fédérale de Lausanne (EPFL) and Eindhoven University of Technology. The workshop was organized and hosted by dr. Alex Alvarado (SPS), dr. Bin Chen (ECO/SPS) and dr. Chigo Okonkwo (ECO).

EWOC focused on Information theory for the optical channel, machine learning in optical communication, high capacity optical systems facilitated by multi-mode transmission and development of coded-modulation schemes. As such, EWOC attracted more than seventy registered participants from the optical communications community across Europe, Japan and the United States. After the welcome drinks on Sunday evening, the Monday morning session was kicked off with academic speakers prof. Erik Agrell (Chalmers University of Technology, Sweden) and prof. Gerhard Kramer (TUM), hosting a workshop with tutorials on the Information theory for fiber optical channel capacity. The increasing application of machine learning applied to optical communications, laser metrology and fiber sensing was discussed by dr. Darko Zibar (DTU).

Drawing on the strong industrial collaborations at the ECO and SPS groups, invited speaker dr. Laurent Schmalen from Nokia Bell Labs in Stuttgart gave a talk on spatially coupled LDPC for forward error correcting codes for application in the optical communications physical layer. From Fujitsu Labs of America in Dallas USA, dr. Olga Vassileva updated the audience on the state-of-the-art fiber non-linearity compensation techniques in coherent optical transmission systems and the session was nicely rounded off by dr. Ben Puttham of NICT Japan and dr. Haoshuo Chen from Nokia Bell Labs in New Jersey US, who gave an invited talk on the state-of-the-art space division multiplexing transmission experiments in multi-core and few-mode fibers as a path towards Petabit per second optical transmission systems.

After the well-attended poster session discussions, EWOC Monday session was concluded by dr. Aaron Albores-Mejia from the TU Eindhoven Spin-off company Effect Photonics. He gave an industrial perspective on the sub-system integration challenges and efforts required to develop cost-effective high speed optical transceivers for short-reach IMDD and coherent optical transmission applications. In addition to invited talks and presentations, EWOC offered a good opportunity for ECO laboratory visits and SPS demos on Flux floor 10, with visits to the High-Capacity optical transmission facility.

EWOC was highly successful and it facilitated very good discussions between our industrial and academic partners on Tuesday morning sessions which we expect will lead to collaborative EU and bilateral projects. Future EuroTech Alliance workshops on optical communications are planned to take place in Munich, Copenhagen, Lausanne or again in Eindhoven.

From the President

By: Laurens Kok

A few weeks back, I published a survey about Thor, to get a view of what people, whom are not necessarily active within Thor, think of Thor. The questions I asked concerned the atmosphere within Thor, connection to our students and how Thor is handling the growth of the number of students. These subjects are the focus points for our Board in making decisions and plans this year. After our year as Board members, Thor should have improved on these subjects, so us being halfway our Board year seemed like a good moment to poll how we are doing, and which points still need attention from our Board.

On the questions on growth, most people thought that in general Thor is handling the growth adequately. However, some responders also pointed out to us some challenges we should look into. For example, the amount of students active within Thor has grown with the study, so we need to think what we do with some of our committees, like the ACCI.

The ACCI normally is the committee in which second-year students learn how to organize activities within Thor. However, when you are part of a 35-member ACCI (like in our year), you sometimes miss the opportunity to really learn what you wanted to learn, as there are too many committee members for the amount of tasks. This year, we have tried to let the ACCI organize more activities and therefore increase the amount of work. This however also resulted in our agenda for quartile 4 being extremely full with activities, making it hard to plan other things.

To consider Thor's strategy on how we could handle problems like this one, we are putting together a group which will get to work on a growth study. This group will research the direct influences of the growth on our association, and will recommend a strategy for coming Boards. If you have ideas on how Thor should handle the increasing amount of students, please send an email to Vice-President@thor.edu. She is the one putting the group together.

On the questions in the survey about the atmosphere and involvement of different students we have got some concerning comments. Some people experienced Thor not as an open study association, but more as a closed-off group of friends. I understand where these thoughts might come from, since it is true that most of our active members are befriended with each other and have their own habits and inside humor. However, I have never experienced us not being open to any non-active member, or any student. The activities of Thor are open to anyone who wants to join, (active)member or non-member. Het Walhalla is the only pub on campus in which everyone is welcome on any day of the week. You are very welcome at our association, so please don't let our loud laughing scare you away, but get involved in laughing with us!

As a student I have always experienced us trying to involve everyone attending, especially during activities. If Thor has indeed failed to do this to other members, than that is something to be highly regretted. So if you have experienced Thor being unwelcoming to you as a member, please come to me, I will buy you a drink and we can discuss what happened and what we can do to prevent what you have experienced. Because Thor is not a study association for a small enclosed group of students, it is a study association for all students of Electrical Engineering and Automotive Technology. And therefore I truly believe that Thor is the coolest association in Eindhoven.

Veel Gedonder!
Laurens Kok
President of Thor ■

Introducing...

Hello everyone! My name is Kim Schellekens-Nicolaije. I grew up in Simpelveld (a small town in the South of Limburg) and moved to Utrecht to study Psychology in 2004. After obtaining my MSc degree in Social and Health Psychology, I worked as a PhD student at Tilburg University. Although I enjoyed doing research, I soon realized that I did not want to continue my career in research after obtaining my PhD: I loved working with students a lot more! Therefore, I started working as a teacher and tutor at Utrecht University in 2014.

Since February 2018, I am working as academic advisor for the Bachelor students of Electrical Engineering. As academic advisor, I deal with all sorts of questions from students, regarding for instance their study progress or the planning of their study program. Students can also come to me if they experience problems with their study, or personal problems. I find it very fulfilling to talk to students and to be able to help them get the most out of themselves and their study.

I currently live in Eindhoven, together with my husband Jan and our one-year-old daughter Julia. In my free time, I love spending time with Jan and Julia. Furthermore, I enjoy singing and doing fun things with my friends, such as escape rooms, pub quizzes, or going out for sushi or high tea. I look forward to see you all around! ■

My name is Peter van der Wielen. I was born in 1973 in Hulst (Zeeuws Vlaanderen, the Netherlands) and nowadays live in Nijmegen with my wife and two kids. I am Business Director Power Failure Investigations and Principal Consultant at the testing, certification and energy consulting firm DNV GL (formerly also known as KEMA) in the Netherlands. And since March 1, 2018, I may call myself also part-time Professor Reliability Grid Components at the Electrical Energy Systems group of the Eindhoven University of Technology. As business director, I am responsible for the power failure investigations business of DNV GL - Energy. As principal consultant, I acquired, managed and carried out many consultancy and investigation projects related to: testing & diagnostics, remaining life estimations, (underground and submarine) power cables, failure investigations, maintenance, risk assessment and asset management. In 2000 I received my MSc degree in Electrical Engineering and in 2005 I received my PhD degree, on this university, for my study on power cable diagnostics.

In my spare time, I like to travel, hike and camp. I love nature and especially mountains and bird watching. In winter time, I tend to go skiing with my family and friends. I like going to music performances (concerts) and for 1.5 years I also try to learn playing the piano, together with my daughter. But I have to admit: she learns it much faster than I do!

As a professor, I am looking forward to initiate, coordinate and perform research and teach students on subjects related to grid component reliability. And most of all, I hope to be able to learn students how fantastic and relevant this topic is. No power generation (renewable or not), power transmission or distribution grid or electricity application (smart or not) will work if the needed components are not sufficiently reliable. Assessing their reliability with advanced techniques and deep knowledge on how they can, could, or did fail is therefore crucial and fun to investigate (almost like CSI on television). ■

Some of you will already know me, from my involvement in Thor, my columns in the Connecthor or my efforts as a teaching assistant for various courses. Looks like I'll be spending some more years here, so allow me to properly introduce myself: I'm Tom van Nunen, originally from Deurne. I like to spend time with friends, fiddle around with electronics, and play the vibraphone in a jazz band.

My graduation project was with Ramiro Serra of the EES group, on the topic of EMC. Around halfway, a PhD project in the EM group was offered to me by Rob Mestrom and Mark Bentum. It didn't take me long to decide: this would be the next step in my career. The NESTOR project has the ambitious aim to make the blind see again. Together with hospitals in Amsterdam, Maastricht and Nijmegen, and a partner in Salt Lake City, we will develop a brain implant connected to a camera, that will allow for (a crude form of) artificial vision. My contributions to the project will be in wirelessly powering the implant, my colleague is in charge of the bidirectional wireless data transfer. I'm keen to be working on this project, and hope that my efforts will eventually be beneficial for lots of people. See you around! ■

Parents Open House Day

By: Daan Dekker

It is morning on the 21st of February. Several first year students are feeling stressed out to make all the necessary preparations. Illnesses have put more than the expected level of strain on the organization. But despite this, the Ivaldi Open House Day was poised to begin shortly. The Open House Day is a day were the parents of first year Electrical Engineering or Automotive students can come to the university. It is organized by Ivaldi, the first year committee of Thor.

Around 120 parents arrived in IPO. First, we welcomed the parents and informed them about the day's program. After this they were welcomed by the Dean. He gave the parents general information about the university and the two programs.

Now it was up to Marion Matters to show the parents what we actually learn. To really drive the point home, we asked her to give the entire Circuits course in 60 minutes. This also demonstrated that parents find it as hard to concentrate as students: many couldn't quite focus hard enough.

After this lecture, Peter Baltus gave a talk about the application of EE. This concerned wireless technologies, especially at his home. Despite some technical difficulties, the talk was found to be very interesting. The parents had sat down for about three hours at this point, so it was time to lunch. This consisted of various sandwiches.

Then the afternoon program started. The group was split into two. The first group was given a tour around the university in many smaller groups. Those were accompanied by first year students. The other group was given a practicum. These practicums were especially tuned to the study of the parent's child. The Electrical Engineering parents were given the task of building a band-pass filter. This was simple for some, but for most it proved to be very challenging. The Automotive parents studied a model of a simple airplane. They had to calculate and reason about a few parameters, as well as code a small program. This proved extremely difficult. It did however, for both studies, give a clear example of what kind of challenges the students are faced with.

After about one hour, the roles changed. People who did the practicums were taken on a tour, and vice versa. After another hour, the end was near. All were led back to Het Walhalla for a final (free) drink. The plan for a pub-quiz was dropped due to a lack of energy. After singing the Thor song quite loudly, the day had ended. Those parents that remained were asked to donate to the traditional 'fustenfonds', in an attempt to get a free keg of beer. This worked, and, despite happening for the first time, it has become tradition.

The whole day went by quite smoothly, except for the occasional logistical problem. The organization of the Open House Day was in the end quite pleased with the result. We wish those that will follow in our footsteps next year lots of success! ■

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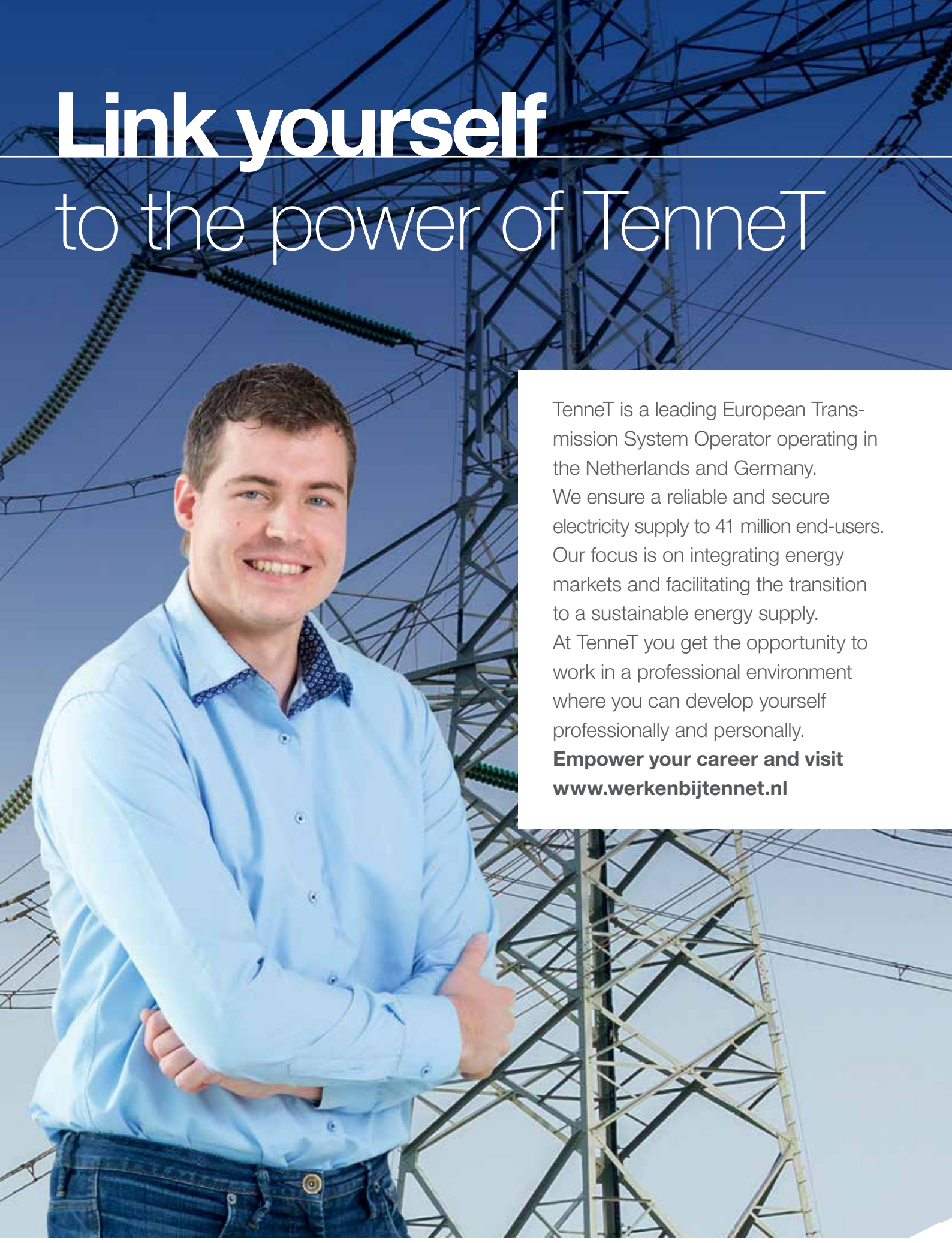

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Taking power further

TU/ecomotive's Noah will be world's first circular car

By: Cas Verstappen

Every year for the past few years, the TU/ecomotive team has built an electric concept city car of the future. It has only been a few weeks since they revealed their next project which they called Noah and is being built as the world's first circular car. This doesn't refer to its appearance but rather its sustainable production and usage, and its end-of-life recyclability. With Noah TU/ecomotive will make a car that is sustainable in every phase of its life. But is there a need for a circular car in today's society?

As the world continues to use more resources every year than can be replenished, World Overshoot Day – the calendar date on which humanity's resource consumption for the year exceeds earth's capacity to regenerate those resources within a year – has also inexorably moved as well. In 2017, it was August 2nd. The team believes that to solve this excessive use of resources, society has to adopt a circular economy. By recycling products, using renewable resources and by using smart design, fewer resources are taken from the planet.

This time the team will prove that circularity is already possible in complicated products (such as a car) today. This will be proven by making the first circular car in the world: Noah. To accomplish their goal TU/ecomotive will utilize renewable resources to further develop bio-based materials, drive fully electric and design Noah to be recycled. These leaps forward in circular mobility will make Noah the most sustainable car in the world. It will seat two persons and will be built out of sustainable materials to reduce the carbon dioxide footprint by reducing energy usage during production. As will be common in the near feature, Noah drives fully electric with its newly developed drivetrain, making use of smart modular battery packs. Noah's motors have a power of 15kW, with which Noah will reach a speed of approximately 100 km/h and a total range of 240 kilometers. In the end of the lifecycle, the car will be fully recyclable, which lowers the need for raw products and gives the used materials a new life. This all will ensure a sustainable path from cradle to cradle.

To empower their dream, the team wants to show that going green is not a trade-off with practicality or comfort. A feature of its practicality and comfort comes forward by the fact that Noah will be a connected car. In one touch, Noah will adapt itself to all the preferences of the driver, and by using NFC technology and Wi-Fi in the car Noah will be optimally equipped for car sharing, as car sharing will be an important step towards the sustainable use of our smart mobility.

TU/ecomotive will apply for a license plate for Noah. This requires the endurance of multiple tests, which are intended to prove the roadworthiness and overall safety of every automobile. By working closely with the RDW during the development of Noah, the team is minimizing the probability of issues during testing. To test the car, the team has chosen to not compete with it in the Shell Eco-marathon but in fact, test the car in real-world conditions. The team will travel with Noah to several major cities in Europe to show Noah's capabilities. ■

Norse mythology within e.t.s.v. Thor

By: Fer Radstake

Besides being named after the Norse god of thunder, e.t.s.v. Thor has much more to do with the Vikings. The names of committees like Ivaldi and Kvasir, our fileserver Mjolnir and our pub Het Walhalla all come from Norse mythology. Our members like to behave like a bunch of Vikings too, loudly chanting the Thor song on every occasion and cheerfully raiding the 'constitutieborrels' of the other associations, never returning without some kind of loot. In short, we're a real Viking association.

But what are all these names? Especially as a first-year student, all those names may overwhelm you. So here's a primer on Norse mythological names within Thor.

Thor (our association)

Thor is the god of thunder, a very fitting name for an Electrical Engineering society. Although more inclined to solve problems by use of force instead of diplomacy, he is a brave and honest god who for a while was the most popular god among the Vikings. He can especially be counted on to defend the earth against the machinations of evil giants. Whenever he meets an enemy, he strikes him so hard with his hammer Mjolnir that sparks fly around, thereby creating lightning.

When Thor was established in 1957, there were three possible names: Selecthe, Petrus van Musschenbroek (the inventor of the Leiden Jar) and Thor. On the 18 December (so after Thor had already been established on 28 November) Thor was voted as the name of our association, thereby setting a sharp contrast with the other old study associations of our university Simon Stevin and Jan Pieter Minckelers, both of which are named after scientists.

Oude Bokken (ex-Board members)

The name Oude Bokken (Old Billygoats) refers to the chariot in which Thor rides across the sky, drawn by his two goats Tanngrisnir and Tanngnjóstr. On his long travels, Thor often slaughters his goats for dinner, and as long as he keeps their bones intact, he can resurrect them the following morning. When he stayed with a peasant family once, the farmer's young son Þjálfi broke one of the goats' bones to suck out the marrow. This resulted in one of Thor's goats being lame. As compensation, Thor took away the young boy and his sister Röskva as his servants.

As the 'kartrekkers' (the driving force, lit. cart-pullers) of our association, Oude Bokken use their experience to give advice to the Board. More often than not, they're still very active and share their knowledge and enthusiasm with many committees.

ODIN (master association for communication technology)

Odin is traditionally seen as the head of the Norse pantheon and the father of Thor. The ancient Romans equated Odin with Mercury, the god of communication, among others. As such, it's a good name for a master association for students interested in the study track Connected World.

Waldur (master association for high currents)

Waldur is likely a misspelling of Bald(u)r, one of the fairest gods of the Norse pantheon. He was universally loved by gods and people alike and as such was seen as the god of light and joy.

Waldur focuses on students interested in the areas of Electric Energy Systems, Electromechanics, Power Electronics and Automotive. What exactly this has to do with the Norse god is not entirely clear, but I'm sure you'll find Waldur to be as joyful as the god was.

EIR (master association for care & cure)

EIR, our newest master association, is named after a Norse goddess associated with healthcare. This already shows EIR's target track: Care and Cure. If you're interested in this track, take a look at their activities.

Het Walhalla (our pub)

Valhalla (Walhalla in Dutch) is the name of a giant hall in Norse mythology and one of two places where those who die an honourable death in battle go. Here, they enjoy a limitless supply of beer and meat in their careless life after death, until the end of days, Ragnarök, comes. Then they're expected to fight along the gods against the forces of evil.

Valhalla is often equated to the Christian heaven, but there are several problems with this definition. First, Valhalla is only one of two places where heroes go (the other one is Fólkvangr). Also, not all good people go to either of these places. Everyone who dies of old age or illness goes to Hel, which as opposed to its Christian namesake hell is not necessarily an evil and unpleasant place. Lastly, it's not the final abode of anyone as Valhalla will be destroyed in Ragnarök and most of its inhabitants killed. After this, the worthy people will go to such places as Gimlé, Sindri and Brimir, which are in essence very similar to Valhalla. ▶

Like the heroes and gods in Valhalla, students and staff can enjoy an almost endless supply of beer in the company of friends. Never been to Het Walhalla? Find us on the 6th floor each working day between 16:30h and 19:00h and enjoy a cool pilsner, specialty beer or non-alcoholic refreshment on our roof terrace.

Heidrun (our portable beer tap)

The unlimited supply of alcohol in Valhalla comes for a large part from the goat Heiðrún. She eats the leaves of the tree Læraðr, which stands on top of the hall. Thanks to this nutritious food, her udders produce mead non-stop. The inhabitants of Valhalla make thankful use of this and milk the beverage into a large cask from which they fill their glasses whenever they wish.

Unfortunately our own Heidrun needs beer kegs before she starts to supply us with beer, but she's still a very valuable addition if we have an event outside of Het Walhalla.

Ivaldi (first-year committee)

Ivaldi himself is a dwarf we do not know much about. More famous are his sons though. Some of the most famous smiths of the era, they created such items as the spear of Odin, the ship of Freyr and the golden hair of the goddess Sif, after Loki cut off her real hair.

This name refers to two aspects of the committee. First, the members ('sons') of Ivaldi get the chance to organize lots of great activities, just like the sons of Ivaldi forged some of the most beautiful treasures of the gods.

Secondly, it's as much about the committee 'forging' its members into responsible adults from freshly graduated high school students. One of the biggest goals of Ivaldi is to teach our new students some essential business skills like organising events and holding efficient meetings.

If you'd like to learn these skills while organising fun activities such as a party or an open doors day for all parents, don't hesitate to ask one of the kandi's or Board members for more information!

Kvasir (excursion committee)

Kvasir was one of the wisest gods, and he travelled far and wide to spread his knowledge to the people. Jealous of his wisdom, the dwarves Fjalar and Galar ambushed him. They drained his blood and mixed it with honey; this mixture was called the Mead of Poetry and would make a poet or scholar of anyone drinking it.

Fjalar and Galar explained the disappearance of Kvasir by telling that the god had "suffocated in intelligence". Eventually the gods found out, and Odin stole the drink and shared it with mankind.

Like its mythological counterpart, the committee travels far and wide to show you the most interesting businesses and state-of-the-art technology. Why don't you join one of its excursions, and see if you become as smart as this god?

Mjolnir (our fileserver) and Brokkr (our server)

Mjolnir is the hammer of Thor. It was made by the dwarves Eitri and Brokkr in a bet against the god Loki that they could forge items more beautiful than those made by the sons of Ivaldi. When he saw he was losing the bet, Loki disguised himself as a fly and bit Brokkr in the eyelid. This distracted the dwarf long enough to stop working the bellows for a while, which caused the handle of Mjolnir to be shorter than designed. Despite this flaw, the dwarves win the bet and demand their prize: Loki's head. Loki notes that they may take his head, but that since his neck was not part of the bargain, they cannot damage it in the process. Eitri and Brokkr cannot find a way to take off Loki's head without damaging his neck, and thus the god keeps his head.

The name Mjolnir evokes how e.t.s.v. Thor cannot work without access to its files, just how Thor cannot fight giants without his trusted hammer. And just like the hammer wouldn't exist if not for its creator Brokkr, we need our own Brokkr to host our fileserver. ■

5G Millimeter-Wave Channel Sounding

By: Robbert Schulpen

The need for more capacity and higher data rates in cellular networks has led to the introduction of the millimeter-wave (mm-wave) band in 5G, the next generation of mobile communication. The use of these high frequencies poses new challenges and opportunities on the communication system and the wireless channel, which will be highly influenced by the displacement of everyday objects. Channel sounding, which is the process of characterizing the wireless channel via measurements, is essential to gain understanding of how mm-wave signals propagate in dynamic urban environments. My PhD project on 5G mm-wave channel sounding is part of the Flagship Telecom collaboration between TU/e and KPN, and executed within the Electromagnetics group.

Wireless communication has become an essential part of daily life. The ongoing wireless revolution has brought us from simple phone calls and texting towards high-quality video streaming and will bring us much more in the (near) future. Many of these applications will require a large capacity and/or high data rates, which cannot be achieved within the current 4G cellular network that uses the decimeter-band (0.3-3 GHz). In 5G, the millimeter-band (30-300 GHz) will be essential for ultra-high data rate applications.

Mm-wave cellular communication brings along new challenges and opportunities compared to the lower frequencies that are used nowadays. The path loss is larger due to smaller antennas, more scattering, larger penetration loss and less diffraction around corners. This can be compensated for by using smaller cells (area covered by one base station) and antenna arrays that consist of several antennas. The use of antenna arrays enables directional communication, meaning that the energy transmitted by the base station is directed towards the users using the principle of constructive and destructive interference. Multiple-Input Multiple-Output (MIMO) can be used to transmit different data streams towards users via multiple spatially separated paths.

"The millimeter-band will be essential for ultra-high data rate applications"

Let's look into the simplified urban scenario depicted in Fig. 1, where four paths between a base station (black dot) and two users are identified. Two paths are direct and two paths are reflected off the building with the grey rooftop. The user with the blue shirt is moving, while the user with the green shirt is standing still. We can choose to only use the 'strongest' direct paths (with lowest losses) or all paths to send data towards the users.

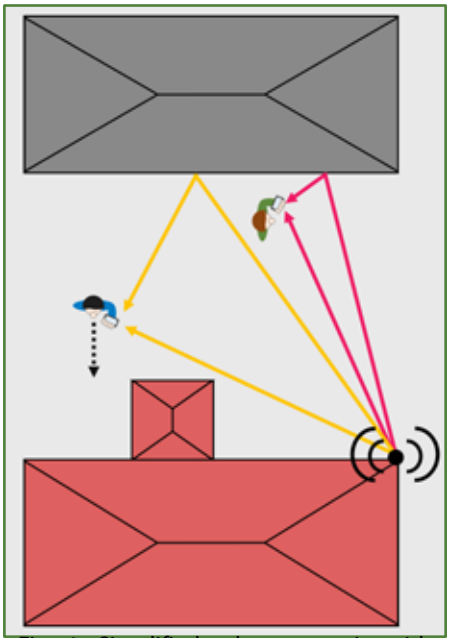

Fig. 1: Simplified urban scenario with multiple paths between the base station and users.

A second later, the environment might look as depicted in Fig. 2. The user in the blue shirt has moved towards the building with the red rooftop, losing its direct connection with the base station. Also, a truck has entered the scenario, blocking two paths and introducing a new path towards the user with the blue shirt. Within a second, most paths between the base station and the two users have changed significantly. In practice, a 5G base station will be able to re-estimate the paths towards a user up to 1600 times per second and adjust its beams accordingly. However, at mm-wave frequencies many ordinary objects and 'small' displacements are electrically large, meaning that even a very small movement can alter, eliminate or introduce paths.

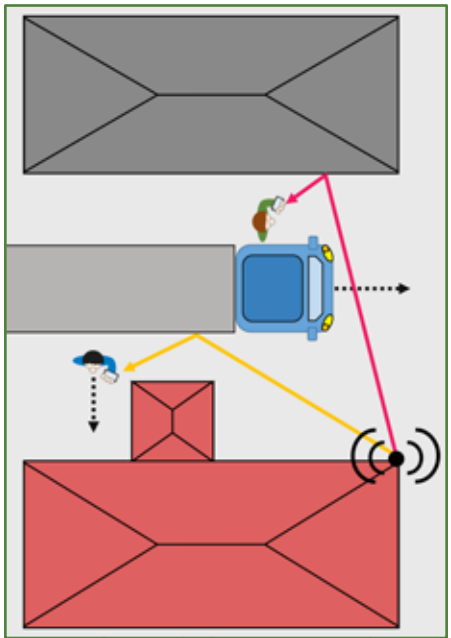

Fig. 2: Changed urban scenario where a truck has altered the paths.

The goal of my PhD project is to estimate the number of distinct paths and their stability in urban environments via channel sounding measurements. I will design a channel sounder (measurement system) that is capable of distinguishing between the paths in Fig. 1 and 2 in both time and angle at which the signals reach the users. By doing many measurements per second, it will be possible to determine the stability of the paths in both time and space. The results will indicate how many and which paths are suitable for communication, paving the way towards ultra-high data rate wireless communication. ■

'Master association' Eir

By: Niels Vertegaal

In an earlier edition of the Connecthor we introduced ourselves as a committee from Thor focusing on being the link between students and the department in the area of Care & Cure. Meanwhile, a lot has changed! We are now an official master association, there have been many activities and there is good schedule ahead. So, let's get to it and read all about our current status and future plans!

A few months ago, Thor only had two master associations, ODIN and Waldur, where ODIN was mostly specializing in the area of telecommunications and Waldur was focused more on power electronics. However, the department had started to invest and focus also on the Care & Cure. This track has gained a lot of attention in the last years with courses gaining 600% extra students year over year, but there was no association where interested students could connect with for activities like lunch lectures. That's when Rob Sanders came up with the idea of founding Eir together with Daan Daverveld and Niels Vertegaal. Eir has been a committee for two years, organizing activities and proving themselves capable with enough possible interested members.

Meanwhile, Eir has officially become a Master Association of Thor as of the 23rd of February. During the first general founding meeting our co-founder Rob Sanders installed us in the first Board of Eir. Us, being Daan Daverveld as Chairman, Jasper Sleumer as Secretary, Niels Vertegaal as Treasurer and Rowanne Steiner as Public Relations and Vice-Chairman. After an hour, we got through the agenda, got approval of the finances and gained our first members! Afterwards it was time for the people that were present to congratulate us on the result of two years of hard work.

So, what have we done? Well, it's quite a list, but I'll go through the highlights. In the first years we visited Kempenhaege in Heeze, where a medical congress was held. With a total of ten students we went through a full day's program filled with interesting lectures about neurocognition, memory, learning disorder and a session which started with the differences between technicians and clinicians. Before we knew it, it was half past 4 when the drinks started. It was a very interesting day for everyone present and we will be visiting the congress this year again!

In the end of last year, we also visited Erasmus MC, which is the largest academic hospital in the Netherlands, and more specifically the Erasmus MC Cancer institute, the largest cancer-focused clinic. Here we met with several researchers which introduced us to a few research topics including how patients are currently treated at the Cancer Institute with the new treatment method named Proton Therapy. With this treatment patients are being radiated with protons as opposed to photons. The advantage of proton therapy is that the administered dose to the patient is mostly concentrated on the tumor, and as a result there is very little exposure to other organs or tissue. After the lectures, we went to see the treatment rooms where we were introduced to the Cyberknife, a linear accelerator mounted on an industrial robot arm.

Next, as Thor was expecting a new master association, it was also time to organize a baby shower! With special thanks to Bart Straten and Stijn van Himste, several cocktails were designed, including, but not limited to, Ocean Eir, Baby Milk and 'Beschuit met muisjes' (usual Dutch birth celebration food, but this was in liquid form). In the end it was a successful cocktail party!

Now, these were just the highlights, but to see what else we have done, I would like to refer you to our website on the end of this article! At the time of writing we have planned to go for laser shooting again and visit Jülich, which is a German research institute. The theme of the excursion is 'Decoding of the Human Brain'. We think this is going to be very interesting! Thank you for reading and if you have any questions, don't hesitate to contact us and just give our website a visit at ma-eir.nl ■


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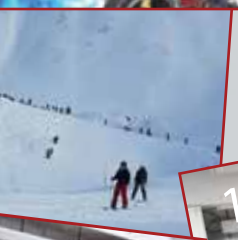

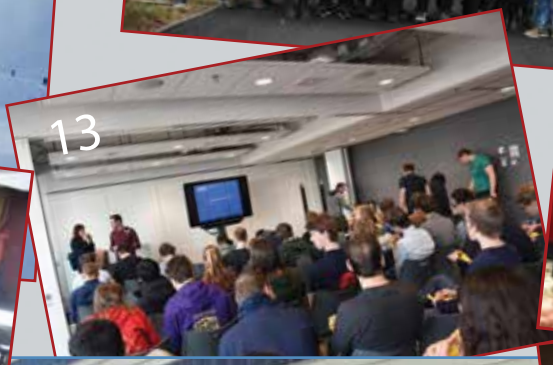

1. Exam training Signals 1
2. Exam training Electromechanics
3&4. WinTHORsport
5&6. Carnavalsparty
7 till 9. BuEx BAT
10. Ivaldi OHD
11&12. James Bond party
13. AME Lunch Lecture
14&15. Ivaldi Pirate party
17. TenneT pub Lecture
18. FoodCo Dinner
19. ASML Lunch Lecture
20. Thor and Japie keg race
21. Thales excursion
22. Vlaaimeeting
23. Ivaldi beer and hambugers party
24. DC party
25. Active Members Activity
26. Return of the Lundum
27. Ivaldi Dropping
28. Knakworsen Competition
29. Computation II exam practise
30. Back to the kelder party

Week 1 in Somalia

By: Sander Verdiesen

It is December 31st and only a couple of minutes till midnight. I am sipping a mocktail on a terrace in the city of Hargeisa, Somalia. I take out my phone to count down to 2018. The last seconds till midnight pass and I am the only one that faintly cheers as a new year rolls in. The only 'Happy New Year' I can hand-out is to my Somali friend I made earlier. The first few minutes of the year all I can think is 'How did I end up here in Somalia?' and 'What an amazing place!'

The first time I thought about travelling to Somalia was roughly five months prior to my actual visit. I did a lot of research and discovered that the northern region of Somalia is – relatively – safe. This region is called Somaliland. As I told my friends and family about my next travel destination I received a fairly similar response from all of them – 'Why on earth would you go there?!' I persevered and booked a return ticket to the capital of Ethiopia, Addis Ababa, for the Christmas holidays.

My reason to travel to Somaliland is mostly based on political interest, an itching curiosity for the unknown and an eagerness to debunk stereotypes created by our modern, and sometimes biased, media. Admittedly the adrenaline rush also plays a certain role.

After months of questioning myself, doing more research and convincing myself I would be fine I started my journey. I travelled to Ethiopia and I picked up my Somaliland visa from the consulate. I was all set to go to Somaliland. I got on a bus and made the journey to the Islamic city of Harer. After recuperating a few days in this amazing town – you can feed wild hyenas there! – I continued my journey to the border. Two busses later I arrived at the border town of Wajaale. Here I was able to get the exit stamp from Ethiopia, walk across the border and officially enter Somaliland in under twenty minutes. One last bus journey of three hours and I arrived in Hargeisa on the last day of 2017.

I was officially in the capital of Somaliland. The city and most of the country was devastated by a brutal civil war 25 years ago. The country has fought for international recognition ever since. It has held five democratic elections since its establishment, all of which were peaceful. This is extremely rare in the whole of Africa. Thus far the history lesson.

Hargeisa is a bustling city with street side markets everywhere. These shops sell anything from spices to second-hand clothes to camels. Yes there is an actual camel market. Due to the many unpaved roads and lack of tall buildings the city does not look like much. However, as I uncovered more of the city's mysteries I found out it is quite developed. Fun fact: its economy is almost entirely cashless, almost all transactions are done through mobile phones. By far the most amazing thing about Hargeisa is the genuine people that I met while walking throughout the city. Not many westerners visit the city and people are delighted to finally see tourists in their city. This experience is very rewarding!

As foreigners are not allowed by law to leave the capital without an armed guard – this is more of an extreme precaution than a necessity – I did not spend much time outside of the capital. Outside of Hargeisa I visited the cave paintings of Laas Geel, which is a must-see when in Somaliland. Next to this I spent one night in the coastal town of Berbera.

If you are looking for some adventure and are willing to change your perception of the region I can recommend anyone to travel to Somaliland and do a similar trip!

After returning to Hargeisa I met a Somali surgeon who works at the local hospital. He showed me around, introduced me to his friends and helped me to gain a better understanding of Somaliland. I am very grateful for his help and I am happy to call him a friend. This encounter showed me once again that there are friendly, helpful and genuine people wherever one goes – especially when the media tells you otherwise. ■

Study trip to Romania

By: Bram Lustenhouwer

When we announced which country we were going to the reaction of the members was clear: why Romania? The reason we chose Romania was clear: we wanted to visit a country that you would never visit. Also, Romania has more to offer than you think. There are multiple companies that are interesting for Electrical Engineering students, and Romania has its own culture, for example Transylvania and the communistic influences of Nicolae Ceaușescu in Bucharest.

On Tuesday the 13th of February it was finally time for us to leave for our study trip. We flew from Eindhoven to Cluj-Napoca. As we arrived at half past 9 in our hostel, there was no time left to do anything else except for eating. We went to a local restaurant where you could only order one thing on the menu (it was nice though). After a stop in a 24-hour shop and buying a 3-liter bottle of beer we had a good start of the week.

The next day started early. We were picked up by local students who guided us through the day. We started at the University of Cluj-Napoca, where we got a presentation and a tour from the dean of the Electrical Engineering department. A nice fact is that they have a man cave for the teachers where they can play with virtual reality games. Even the accompanying students were amazed by this. Then we visited the location where all the labs are situated.

That afternoon we had some free time to explore the city, and the students were so kind to show us around. They even brought us to a mega mall. We spent the evening in a local student bar where they served great cocktails.

The next day started with a long bus trip to Sighișoara, where everybody had some time to explore the city where Vlad Tepes (Dracula) was born. Also, the story of Dracula is written here by Bram Stoker. Because it had snowed that week, we had a snowball fight with local students and some people took their chance to produce a snow angel. After another long bus trip we arrived at Bran castle. This castle was the home of Vlad Tepes, where he performed his infamous torture methods. After a tour through the castle we had some time left to walk around the local souvenir market and have some dinner. One participant couldn't resist the challenge to test the ice on the pond..

On Friday we had our first day in Bucharest, where we visited Microchip Romania and Asti Automation. At Asti we even played with the robots that they have there. That evening we had a pub crawl in the city, in which we introduced the Romanian people to the carnival song 'de Kneu' and the polonaise.

The last day of the trip people had spare time to explore the city, or spent time in bed recovering of the night before. That afternoon we had a tour through the palace of parliament, build by Nicolae Ceaușescu. This palace is also known as the heaviest building in the world. This imposing building includes a 5-ton(!) chandelier, and a 3-ton(!) carpet for which you need at least 30 people to unroll it. Afterwards we went for dinner with the 25 participants at "Caru' cu bere", where we had dinner for 50 (literally). The next day we had an early morning flight back to Eindhoven where the amazing study trip came to an end. ■

Wintering in Portugal

By: Jeroen van Oorschot

About a year ago, I enrolled to the course 'pulsed power' and I was immediately excited about it. I wanted to know more about the subject and asked the lecturer for internship options. Then I got a number of options for projects and locations. Soon I decided it would be very nice to spend the winter in a more sunny and warmer place than the Netherlands, so the option of Lisbon was one of the best. I had never been there and it appeared to be an interesting and old city.

Pulsed power

Pulsed Power is about concentrating energy in very small pulses. For instance 10 Watts of continuous power can be converted to pulses of 1 microsecond with 100Hz, with 100.000 Watt of power in the pulses. This high power pulse has such high voltage that all kinds of fun things can happen. It can be used to make lighting (sparks), to kill or perforate biological cells, or to make ozone in a plasma.

A small university spin-off company in Lisbon had developed a device to make these kind of pulses, based on a Marx generator. It was designed originally to apply pulses to all kinds of fruit, like apples, grapes and olives, in order to damage the cell structure to be able to press it to juice with less force. To expand their market, they are looking into all kinds of other applications for their devices. One of those is creating ozone using non-thermal plasma, which is one of the research areas in Eindhoven. For this, they planned to ship their pulse generator to Eindhoven for some tests, but instead I went to them together with some equipment from Eindhoven.

View over Lisbon from the plane

Lisbon

The trip went without any problems; I got in the bus to Eindhoven Airport just in front of my student home, and about three hours later I was at Lisbon Airport. There my landlady was awaiting me, for the next months I had a bedroom in her apartment. We drove to her home together were we drank some port wine together and she showed me the room. Before starting on the project, I took a few days to discover were I had landed. In those days I went for some long walks to discover the city, visited the large aqueduct and took the train to Sintra, a small fairytale-like town near the Atlantic Ocean.

Starting

The next week I started at the company, which is like an electronics workshop with a few desks placed inside. I felt at home immediately. About six man did circuit design, PCB design, research for components, and finally building and soldering the devices together. Next to the work on new machines, a lot of time was spent just building more pulse generators to deliver to industry and universities. This last thing was bad luck for me, as those machines need to be delivered before someone had time to get me started. After a few days of walking from home to the company and back, a colleague let me use one of his mountain bikes. Although biking in the city of seven hills can be hard and sometimes a little dangerous, it was a big improvement for my travel time.

I started with reading some background information and about a week later the equipment from Eindhoven arrived. In the meantime my generator was finished and we tried to make some plasma. Soon we discovered that the generator's pulse voltage was not high enough, and we made a small coil to make a resonant circuit which boosts the voltage. We finally had some plasma! Because of the

One of the Miradouros with a beautiful view

Me and my landlady near the Christ the Redeemer'-statue (an imitation of the statue in Rio which was visited during the Prosperando study trip).

rapid changing conductivity of the plasma, together with the resonance of the coil, a lot of electromagnetic interference was created. The control board usually stopped after a few seconds, so doing research on the plasma was not yet possible.

Visits and holidays

The big advantage of an internship abroad, but not too far away, is that people can come over easily. As it was time for a Board weekend with our 58th Thor Board anyway, we decided that (most of) the others came to visit me in Lisbon. Together we tasted Piriquita in Sintra (a recommendation) and climbed all the way up the mountain to the old Moorish castle. The next day we visited the village of Belem in a thunderstorm (not a recommendation). We have seen a lot of places, and had a lot of fun, but unfortunately these few days the weather was the worst of all my time there.

When it was almost Christmas, many outdoor winter markets popped up in the city, together with lots of Christmas lights. Those markets were the places to be during the weekends. It was even possible to go ice-skating at 15 degrees above zero. With the company, we had Christmas lunch with traditional squid, smoked sausage and of course wine.

At the first Christmas day, a colleague invited me to come lunch with his (very friendly) family in his mother's house in Sintra. Part of his family originated from the Madeira Island, and they had made some of the traditional dishes from there. It was delicious.

For New Year 's Eve, another colleague invited me at his house. He had emigrated from Belarus a few years ago and they organized a dinner (the whole evening) with a few other immigrants. At 9 O'clock we toasted for the Russian New Year, at 10 for the Ukrainian New Year and at 11 for the Dutch New Year, as Portugal is one hour behind of most of Europe. Then we rushed to the metro to the city center to watch the city's fireworks. We arrived just after midnight but the show was beautiful. Very different from Eindhoven, where everyone has his own fireworks.

Sunset at the Tagus river

At Cabo da Roca

Measuring and finishing

Back at work, I had found and solved most problems. This included replacing the sixteen power mosfets of the board multiple times, as well as replacing a lot of tiny SMD components. My soldering skills definitely improved and I could start to do measurements and gather results. Until my very last day, I did measurements, so I had to finish the report when back in the Netherlands.

A part of my desk with the research setup

On the last Sunday, I went mountain biking with the colleague who lent me the bike. He suggested to do this already at the beginning of my internship, but unfortunately he didn't have much time during the weekends. Together with two of his friends we visited the nicest 'miradouros' (viewpoints) on the highest points of the city. First to the St. Jorge castle, then along the river and finally back through some dirt roads in the Monsanto park.

Finally, I took a few days off before going back home. One of the touristic points I still needed to visit was the 'Cabo da Roca', the most western point of mainland Europa. Although the geographic coordinates don't say a lot about the place, it really was beautiful. Large cliffs and extreme strong winds, and almost a view on America.

Internship abroad

Sometimes it was difficult to manage everything in an unknow city where you don't speak the language and don't know anyone (at least, in the beginning), but it were also those things what makes life interesting and give new experiences and skills. I can definitely recommend an internship abroad! Next to this, I really enjoyed working at a company compared to a university. It gives a better insight in what one could do as a job instead of doing (only) research work. ■

Ultrasound markers for cancer

By: Ruud van Sloun

Each year, over 8 million people die of cancer. Diagnostic imaging plays a critical role in cancer care, being a fundamental asset for timely cancer diagnosis, disease staging and management as well as for treatment choice, planning, guidance, and follow up. One essential limitation is that today's most promising approaches are largely based on highly expensive MRI. The growing burden of healthcare costs on our society motivates the use of sustainable modalities. While a pivotal role of ultrasound would represent an excellent cost effective and widely accessible alternative, the accuracy of current ultrasound-based methods typically falls behind those of advanced MRI strategies however.

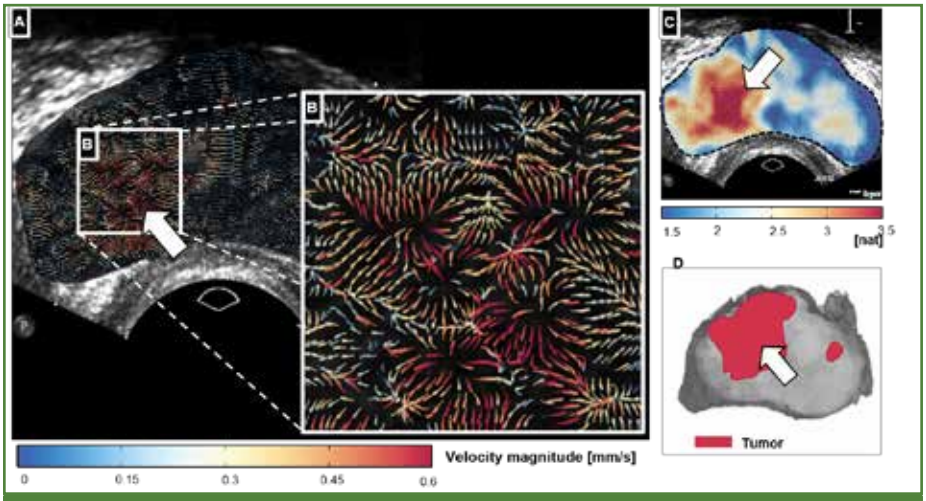

Figure 1: (A) Ultrasound-based estimation of blood flow patterns in the prostate of a patient with prostatic cancer, and (B) zoom of a malignant region. The heterogeneity of flow in cancer causes a high local entropy, as shown in (C), and corresponds to the histopathological ground truth (D).

Worldwide, about 14 million new cancer cases occur every year, and over 8 million people die from it in the same period. The increasing life expectancy causes the number of new cancer cases to rise moreover: if rates do not change, the global cancer burden is expected to increase to 21.7 million cases and 13 million deaths by 2030. Breast cancer is the most common cancer in women, accounting for about 25% of all cases worldwide. For western men, prostate cancer has the highest incidence (23%).

The risk of being diagnosed with cancer increases substantially with age. In economically developed countries, 58% of all newly diagnosed cancer cases occur at 65 years of age and older, compared with 40% in developing countries. This variation is predominantly caused by differences in age structure of the populations; developing countries have a smaller number of elderly people. According to the World Health Organization, the impact of cancer is even more severe in low- and middle-income countries, where there is a lack of access to information about prevention, early detection, and treatment, as well as an inadequate medical and public health infrastructure. As a result, cancers are often diagnosed at a late stage, and people suffer needlessly from inadequate palliative care.

Along with the human toll of cancer, the financial cost is substantial. This obviously includes expenditures for treatment, as well as the cost of care and rehabilitation related to the disease. But also indirect costs such as the loss of economic output due to morbidity (missed work) and mortality (premature death) are sizeable. For example, the estimated cost of lost productivity due to premature cancer mortality in Europe in 2008 was €75 billion. The exact total global cost of cancer is unknown, but it is estimated to be in the hundreds of billions of euros per year. This number is expected to rise even further due to the increased amount of new cancer cases, as well as the increasing cost of cancer therapies.

Timely and tailored treatment saves lives and is invaluable for reducing the burden on our society. Yet, it is limited by the complexity, cost, and/or invasiveness of available diagnostics today. A combination of complicated and expensive imaging modalities, along with invasive biopsy procedures, is usually required for cancer diagnosis. Choosing optimal therapeutic strategies relies on such diagnostic means; The extent and type of systemic (e.g. chemo) treatment depends on whether cancer has migrated from the primary tumor towards distant sites, such as other organs and lymph nodes; The use of focal therapies dictates knowing the exact location of the tumor; Active surveillance instead of immediate treatment demands highly reliable monitoring of disease progression. In this context, diagnostic imaging is a fundamental asset for timely cancer diagnosis, disease staging and management as well as for treatment choice, planning, guidance, and follow up.

On the other hand, ultrasound, or echography, has the remarkable potential to shine as a non-ionizing and cost-effective technique that can limit the diagnostic burden on the healthcare system and the patient via an effective and accurate imaging protocol. In ultrasound imaging, high-frequency acoustic pulses are transmitted into tissue by a transducer, after which their pulse-echoes originating from inhomogeneities in the medium (e.g. tissue interfaces) are used to derive various properties such as echo intensity. The diagnostic accuracy of today's ultrasound imaging techniques for cancer fall behind those obtained with MRI or CT however. If ultrasound imaging could be advanced to such a level that it allows accurate cancer diagnosis through timely and accurate assessment of both tumor location and aggressiveness, a major socioeconomic problem would be solved. To achieve this, ultrasound imaging should be exploited to its full potential.

At the vascular level the impact of cancer is striking. Cancer vasculature is chaotic, characterized by increased microvascular density and tortuosity, as well as by the presence of ▶

Figure 2: Ultrasound tractography of blood flow patterns to reveal vascular structures. Note how an area of enhanced vascularity in ultrasound tractography corresponds to the presence of cancer as confirmed by histology (white arrows)

irregular branching and arteriovenous shunts. The process that governs these vascular alterations is angiogenesis, a biomarker that is strongly associated to lethal cancer phenotypes. To expose these processes, we first inject tiny gas-filled microbubbles in the bloodstream after which we apply a series of ultrasound pulses to the area of interest.

We then measure the acoustical signals originating from the ultrasound-activated resonating microbubbles using an array of closely-spaced sensors, from which we can reconstruct a microbubble image using a time-of-flight principle. As these microbubbles are similarly sized as red blood cells, they pass through the complete microvasculature and remain fully intravascular.

Using sequences of such microbubble images (contrast-enhanced ultrasound videos) as an input, we developed several signal processing systems that adequately assess a variety of macroscopic motion kinetics relevant to detection of vascular irregularity, ranging from microbubble dispersion, microbubble flow fields and flow heterogeneity. Figure 1 shows an example microbubble flow fields and flow heterogeneity in a patient diagnosed with prostate cancer. Comparing this with a microscopic assessment of cell types (histopathology) post-surgery reveals that our analyses adequately localized the tumor. The methods are also applicable in 3D, where we moreover showed that it is possible to visualize these processes by adapting a technique known from MRI, called tractography, to render vascular patterns (figure 2). Beyond these macroscopic blood flow markers, we also strived to extract information at a microscopic scale. Here we used another trick from a different domain, and applied a Nobel-prize winning concept from chemistry (super-resolved fluorescence microscopy) to our microbubble images. This allowed us to surpass the physical diffraction limit of sound and achieve vascular imaging at microscopic resolution (figure 3).

Along with these vascular markers, cancer tissue exhibits a specific set of characteristics. First of all, cancers are stiff compared to benign tissue. Physicians typically assess nodular firmness by palpation, a subjective technique with a long history in medicine. Recently, an ultrasound technique called shear wave elasticity imaging was developed. This method uses a high-intensity acoustical "push" pulse to produce shear waves, whose velocity can be estimated and linked to the elasticity of the medium trough which it propagates. Yet, not only elasticity, but also viscosity plays an important role in the propagation process of these shear waves. In fact, viscosity is in itself a parameter of diagnostic value for detection and characterization of malignant lesions. We therefore developed a new method that enables imaging of both viscosity and elasticity using shear waves, by applying local model-based system identification techniques. We showed how this approach was for the first time able to provide high resolution viscosity maps using ultrasound, while jointly improving the elasticity estimates.

Another typical characteristic of cancer relates to fluid in its interstitium. Interstitial fluid is restricted by its cellular environment, and governed by factors such as cellular packing, intracellular elements, membranes, and macromolecules. In cancer, the amount of fluid is typically greatly increased, poorly drained and highly restricted. Now, realizing that the generation of harmonics in the due to nonlinear propagation of acoustical waves is dependent on the water content, we also pursued the development of a method that enables measurement of this nonlinearity.

The heterogeneous nature of cancer and the wide range of tumor phenotypes makes it highly challenging (and perhaps, unlikely) to find a single feature to characterize them all. Our chance of success is likely to increase when harvesting as much relevant information as possible. On their own, the above developments provide a step in the direction of accurate assessment of several specific cancer markers. Together they provide a broad spectrum of anatomical and functional information for ultrasound-based cancer imaging, while retaining the high cost-effectiveness that makes ultrasound so appealing. ■

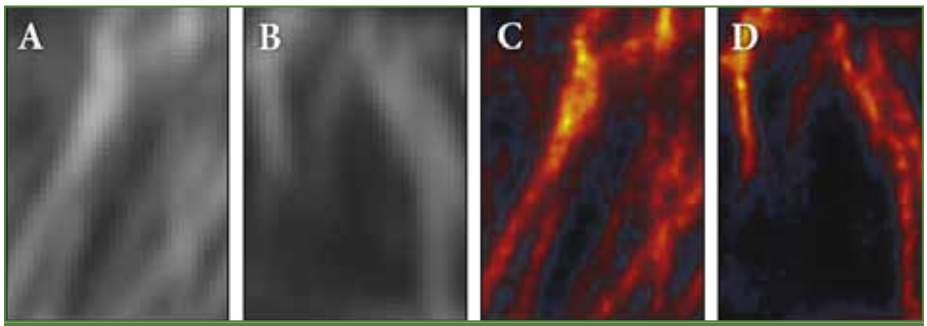

Figure 3: (A, B) conventional contrast-enhanced ultrasound with Doppler imaging to enhance vasculature, and (C, D) corresponding super-resolution ultrasound vascular reconstruction

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These days, you can find 16 GB USB sticks on supermarket shelves for as little as €10. In hospitals, a camera the size of a pill can be swallowed to survey a patient's intestines. And in the oceans, tiny GPS transmitters track endangered turtles to help protect them. While each of these devices is incredibly small, it actually represents a big milestone in technological progress.

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WinThorsport 2018

By: David van Son

During the first week of quartile 3, the SnowCo organised their yearly skiing trip for the second time. This year, the trip was to the village of Belle Plagne in the French Alps. Located at 2050m altitude, the village sits halfway down the ski slope, so every morning we could see the ski slope from our beds! This motivated us to get out of bed early in the morning so we could enjoy the slopes even more.

The skiing trip started at 19:00h at P+R Meerhoven, though most of us were there earlier, to enjoy a healthy meal at the nearby fast food chain. The trip to Belle Plagne was well over twelve hours long, so when the bus driver announced that there was beer available in the bus, we almost instantly bought everything.

The next morning at around 9:00h we finally arrived in Belle Plagne. Those who brought their own equipment dressed up and went down the slopes, while the others went off to rent their equipment. Groups were quickly formed based on skill levels, so that everyone could ski at their desired pace. When the day finally came to an end, we were all hungry, so it was cooking time. Each of the four rooms we had was assigned to do a part of the meal, each part was then brought together in the room of the SnowCo, where we all ate together.

After dinner we were anxious to go out and see the bars of the village. We decided to do a pubcrawl, so we could see all the bars on the first day, and then decide which one we liked best. However, there were only three bars, so the pubcrawl was finished sooner than planned. Since we did not particularly like any of the bars, we went back to the hotel, where we drank our own beers till late in the night.

The rest of the week the planning was exactly the same thing, consisting of waking up, skiing, eating and going out. So by the fourth day we had seen almost the entire skiing area, luckily however, there was a second area where we could ski, called Les Arcs. So that day we spent most of our time at the other area. That evening, we met some French guys who were very intrigued by the SnowCo's sweaters. Since the SnowCo was unwilling to give them away, we gave them each a Thor sticker instead, which was good enough for them as well.

On the fifth day, we went skiing with the whole group, and some guys brought beer with them. To get a beer you had to participate in a challenge, which we of course all did. The challenge was to finish your beer before you got down the slope. After doing several runs of this challenge, the day passed by very quickly, and soon we were all out of beers.

On the sixth and last skiing day, we went back to Les Arcs, where we spent the day drinking beers on the ski slopes and enjoying the view. The day went by quickly, and soon we had to go back to the hotel, so that the rented equipment could be returned on time. In the bus back to the Netherlands, everyone slept as soon as the lights went off.

Even though it was exhausting, skiing for almost hours per day for six days in a row, it was an awesome week, with lots of skiing, lots of fun and lots of beer. The only thing now left to do is to wait for next year's skiing trip enrolment list to open up. ■

Whose desk is this?

By: Jan Vleeshouwers

Quite a busy desk this time. When taking the picture, the desk owner was reviewing some journal articles, preparing a paper for a conference in Cyprus and checking several student reports. But there are several objects on this desk balancing this state of being busy.

You might think the little red ball is an anti-stress-ball but actually it is not. It is a small attempt to do a bit of physical training while doing brain work: it trains finger and hand muscles, which is welcome considering the desk-owner's hobby, climbing.

The mouse mat and the keyboard also reflect his careful attitude towards hands and wrists. The mat has a smart dimple where the wrist rests on it, and the keyboard is exceptionally gentle to the touch.

You already noticed the flower to the left? The desk lamp it is attached to, is a souvenir from Potentiaal. It still carries the old THE-logo and dates from times where weight was still a design benefit. The flower is a gift from his wife, from the Rotterdam Erasmus MC bookshop. Its symbolic message is to always help your students.

An important way of dealing with work stress is listening to music. His headphones are always within reach. Their blackness doesn't show, but they are quality headphones. If you listen to music often, you better do it right.

The most important token of work balance is the small icon below the monitor. It is a transparent image of Saint Silouan, a 20th century ascetic, monk and poet who lived on the Greek Athos peninsula. You can see the map on the monitor. Silouan is known for God saying to him "keep thy mind in hell and despair not", an urge for humility and stillness. ■

Thales excursion

By: Yasmine Bartelds

The day began as an early morning for the twelve students that went to the Thales excursion. The main office of Thales is in Hengelo, so we had to travel for a while. After two and a half hours, we arrived at Thales. The first things that we noticed, were the huge radars that were placed around the buildings of Thales. We were welcomed at Thales and got a small introduction about the company. After that, we got a presentation about what radars they make in general and what challenges they meet to build a radar that can detect a missile from 2000 km away.

After a delicious lunch, we got what we were waiting for: a tour around Thales! We started at their new building where we saw their workplaces, but they also had an experience room, where we could see how it feels like to be in the 'radar room' of a ship. After that, we went to see the radars from really close by. We went to the development rooms of these radars where we stood next to a radar of eight meters long! They also showed us many other radars with all kinds of different purposes. From small radars that were used for military to walk around with, to radars which were many years old and still went under another name than Thales.

After this amazing tour, we had a very interesting presentation given by an employee who went on a mission to test one of their biggest radars. Together with the Americans, he tested the radar by launching a missile, which was detected by the radar and intercepted.

Afterwards, we had a small closure and a drink. At the end of the afternoon, we still had to travel all the way back to Eindhoven, but it was definitely worth it. ■

Icons of EE: Jack Kilby

By: Matthijs van Oort

There is no invention which has changed the way we work as electrical engineers in the past few decades, as the invention of the integrated circuit (also known as IC's). They can be found on nearly every printed circuit board which brought into production nowadays and can be used for a lot of applications. While the invention of the semiconductor transistor by Bardeen, Shockley and Brattain was already a start for this revolution, it still needed to be implemented in a way in which it could be used in practical applications. And this is where Jack Kilby comes into play.

Jack was born in the year 1923 as the son of Hubert and Vina in the state of Missouri. His father was the director of the Kansas Power Company, so Jack went to school in Kansas as well. Already at young age, Jack got fascinated by physics and especially electronics. When he graduated from middle school, he tried to apply for the Massachusetts Institute of Technology. While his entrance test was quite good, he was declined by the fact that he missed 3 out of the necessary 500 points which were needed for his application. He eventually received his bachelor in Electrical Engineering on the University of Illinois. He took a break from this study during World War II, to fulfill his duty and work as a radio repairman in the army in India.

After his time in the army, graduating as a master in Electrical Engineering at the University of Wisconsin and working a couple of years for smaller companies, Jack started working at Texas Instruments. In the years Kilby started working for TI, it gradually shifted its scope from the military equipment to more consumer products. In his first summer, because he didn't have the right to have vacation, Jack worked on a solution to make the production of electronics easier. In these days it required a lot of handwork with all kinds of wires which had to be attached to different components. Jack came with a solution of integrating the different components into one small component.

This solution could offer an improved manufacturability and a more accurate circuit than the circuits built before. In order to prove that his solution could work, Kilby designed an oscillator on a piece of germanium and attached an oscilloscope to it. When the oscilloscope was showing a continuous sine wave, his management was impressed and they started working on integrated circuits. A few months after his invention, Robert Noyce came with an easy to manufacture variant of this invention. And so the revolution of the IC was born.

When he finished the first IC implementation and showed that it worked, Jack started working in various groups within Texas Instruments, from military to industrial products, in order to pioneer in microchip technology. After a few years of IC development, the director of TI challenged Kilby to design a small electronic calculator which could do the same as the heavy electromechanical calculators of that time. The size of the calculator would have to be small enough to fit into someone's pocket for user convenience.

Next to the invention of the IC and the development of the pocket calculator, Jack is also known for the invention of JK-flipflops and thermal printers.

Jack Kilby has received the Nobel Prize of Physics for his findings and development of IC's which created the information and communication technology which we use nowadays. Next to this Jack also received an IEEE Medal of Honor in 1986, the American National Medal of Science in 1970, and is included in the National Inventors Hall of Fame 1982. Jack died in June 2005 at the age of 81, while being diagnosed with cancer.

Overall, Jack has dedicated his life on inventing and developing integrated circuits which we now use without even thinking about where they originated from. He took the invention of the semiconductor one step higher by making it available for use in all kind of applications. If he would not be contracted by Texas Instruments, it would possibly still be spending its time with oil and gas instead of being one of the market leaders in integrated circuits. ■

First implementation of an integrated circuit

Mjölnir

By: Jorn de Vries

One of Thor's most well-known features is his famous hammer Mjölnir, which he throws around like a boomerang and can only be picked up by those who are worthy. Recently Volundr, aptly named after the blacksmith in Norse mythology, recreated Mjölnir. Volundr is a committee of Thor and gives workshops with the focal point on the more tangible side of Electrical Engineering. Often, their workshops involve creating a prototype with whatever is available, in Dutch called 'beunen'. The members of Volundr are regularly found working on some side project. In this article, they will explain how they built Mjölnir and how you can build Thor's very own hammer yourself. This project can be divided into three different sections, namely electrical, mechanical and appearance.

The reason no one can pick up our hammer is because it is pulled to our iron surface with a big transformer we scavenged from an old microwave oven. We cut the transformer core open to change it into an E-core and removed the secondary coil to end up with a powerful electromagnet. The electromagnet is both the largest and heaviest part of the hammer and we built the hull around this. We first made a mock-up from fiberboard which gave us a rough idea of the dimensions of the hammer and what room we had to work with where we could stuff our electronics. We designed the hammer with use by a Thor member in mind, it had to withstand most of the abuse without structural damages.

Figure 1: The E-core

After the E-core was exposed, it was attached to a thick slab of wood with corner profiles and some screws. On the other side of the wood we fastened a flange with screw thread for the handle. Both are made from galvanized steel so they can survive the manhandling of our members.

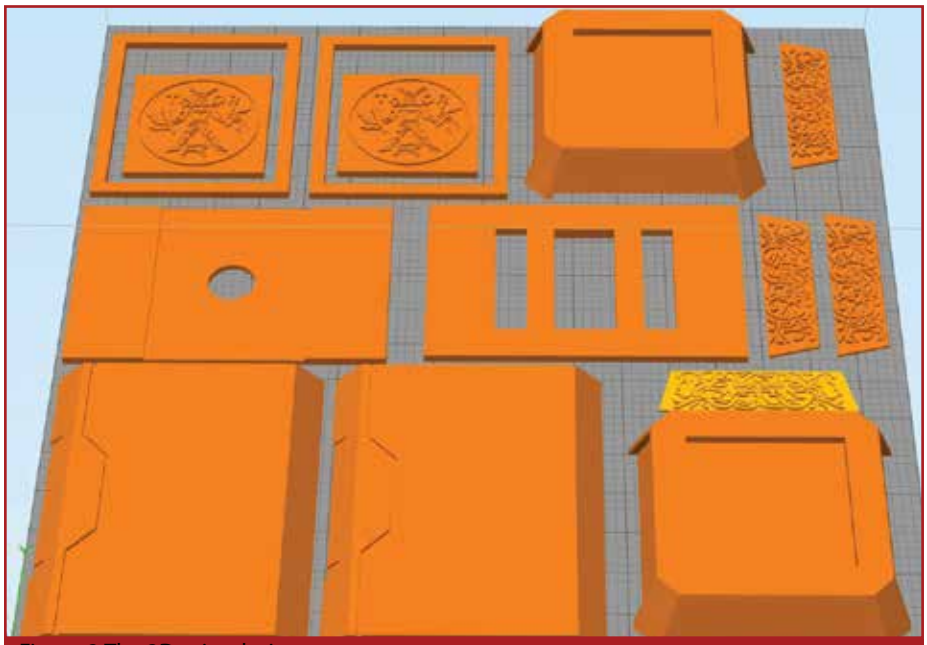


Figure 2:The 3D print design

Mjölnir is a hammer of old Norse design with two square heads and a short handle, decorated with runes on the slanted sides. Because we wanted people to instantly recognize the hammer as Mjölnir, we decided to replicate the look in the Marvel movie Thor using OpenSCAD. OpenSCAD is a freeware CAD program with a focus on letting programmers design solid objects. OpenSCAD is not an interactive modeler like Siemens NX which is used by mechanical engineers, but instead behaves like a 3D compiler which reads scripts and renders the model from this file.

Since we plan to 3D print the hull we have to design it in a way that has little overhanging parts and that the parts that require a lot of detail are printed from the ground up. In the end we had split up the hull into seven different pieces that took up to seventy hours of printing time. Since the hammer would suffer a lot of abuse we printed everything in PETG, a polymer which has the same strength and flexibility of ABS while maintaining the ease of printing of PLA, which is much stiffer, but also more prone to shattering instead of flexing.

To power the electromagnet, we connected four protected lithium-ion batteries in series to obtain a nominal voltage of 15.4V. Lithium-ion batteries have a reasonably high energy density and are far safer than lithium-polymer batteries, which are prone to ignite or explode when getting over-discharged, or manhandled in general.

Now we can power our electromagnet, but we want to be able to switch our magnet on and off whenever we want without disconnecting the power. To achieve that we added our trusty NodeMCU microcontroller with WiFi capabilities so we can switch the magnet remotely. The NodeMCU is a 3.3V based device, but can be powered by a 5V source. To ensure a stable 5V line we place a LM2596 step-down converter between the batteries and the MCU.

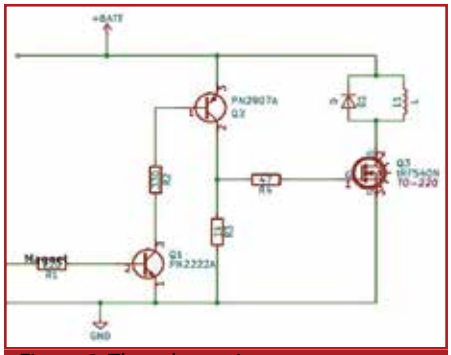


Figure 3: The schematics

The electromagnet can demand quite a bit of current which can't be supplied by the microcontroller, so we need to design a circuit that switches the 15.4V from the batteries on when the pin on the MCU is pulled high. For this we selected a MOSFET that can withstand the current drawn by the electromagnet and has a low on-resistance. With an I_D of 7A and an $r_{DS(on)}$ of 44mΩ, the IRF540N is perfect for this. However, to have a high enough drain current, the gate-source voltage of the MOSFET must be at least 4.5V, meaning we can't switch the gate with our MCU, which has a logic level of 3.3V. So, we must add two extra transistors with some resistors for biasing. Lastly, we added a freewheeling diode in parallel with the coil to move the energy when the transistor is turned off to prevent high voltage spikes. The end result is the final design seen in figure 3.

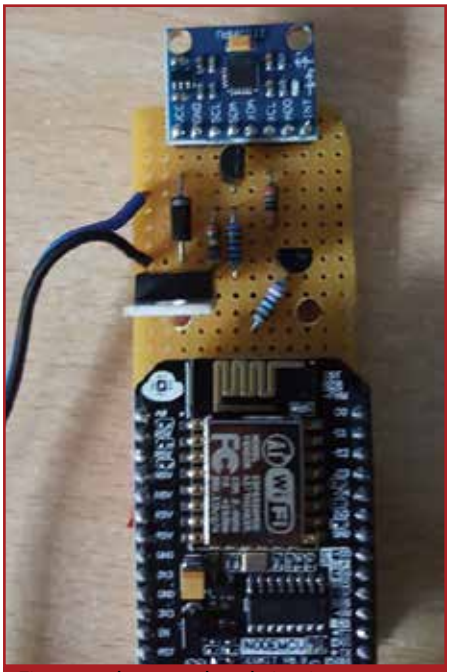


Figure 4: the completed circuit

Having the electromagnet on all the time consumes a lot of power, so we only want to switch on the magnet when someone tries to pick it up. To achieve that we implemented two sensors: the MPU6050 gyro-, and accelerometer and the TTP223 capacitive touch sensor. When someone tries to move the hammer the MPU6050 will register that and the NodeMCU will output a high signal to the magnet which will turn on. To prevent false positives due to noise the signal is filtered and a lockout timer makes sure that the magnet can't switch on and off too fast to extend the life of the MOSFET. In the end, the MPU6050 worked so well, we removed the TTP223 because it wasn't necessary. Finally, we added a voltage divider to scale the battery voltage to a range between 0 and 1 volt, which is the input range of the analog pin of the NodeMCU so we can monitor the batteries, and see when they are out of juice, and lastly a mechanical switch hidden in the handle to completely shut down the hammer.

Figure 5: The finished product

All the 3D printed parts were glued together with CA glue, the control board was screwed to the hardwood plate and the battery pack was lowered into one of the cavities on the sides of the hull. Then we lowered the electromagnet in and discovered that we had some extra space which caused the magnet to move inside. To remedy this, we designed and printed spacers holding the magnet snug to the bottom.

In the future, we would like to upgrade Mjolnir with a plug and play charging circuit, some form of owner recognition and we would like to experiment with swapping the primary coil for the secondary to lower the current through the windings making it more energy efficient.

This was quite an interesting project to do, bringing together multiple disciplines. And beside it just being very cool, it also got us tickets to the premier viewing of Thor Ragnarok, where we demonstrated the hammer in front of unsuspecting visitors alongside a cosplaying Thor from the movie. The movie was fantastic, it was the first time that we experienced Dolby Cinema and it creates a new emersion. ■

Figure 6: Volundr with Mjölnir

Pie for bad luck

Pie for bad luck

This edition's pie for bad luck was presented to Anouk Hubrechsen, who broke her leg during the WinThorsport activity. Get well soon Anouk!

Puzzle

Can you identify this common sequence:

Objective / Rules

Try to find the common sequence in the image to the left.

You can send your solution to connecthor@thor.edu

Winner previous puzzle

The winner of the previous puzzle is Michiel Arts!

Puzzle solution March edition (Connecthor 41)
Question 1 can't be A, as this would mean that Q1 was the first question with B as the answer and therefore contradict itself.

Q1 can't be B as this would mean Q4 was the first question with B as the answer, but Q1 would actually be the first question with B as the answer. If we test Q1 as having answer C, you'll see that Q3 points back to Q1 correctly and is logically consistent. This is a possibility.

If we test Q1 as having answer D, then Q2's answer is B, which points to Q4's answer being A, which means that there are 3 questions with D as the answer. Which would mean that Q3 and Q5 were both D, but Q3 would have to be A, as we're testing that Q1 is D.

Therefore Q1 has answer C. Since Q1 has answer C, we know Q3 has answer B.

Looking at Q4 (how many questions can have D as the answer), clearly it can't be D (zero), as this would contradict itself. It can't be A (three) as we only have 2 questions without an answer.

If Q4 was B, then the remaining questions (Q2 and Q5) would both be D, which would make Q2 point to Q4 having C as an answer, which contradicts our guess of Q4 being B.
So Q4 must be C.Which means that Q2 has answer D.Which means that Q5 has answer B (as no other option is allowed and we must have two questions with answer B). QED!

Michiel with his prize

Artificial vision for the blind

By: Tom van Nunen

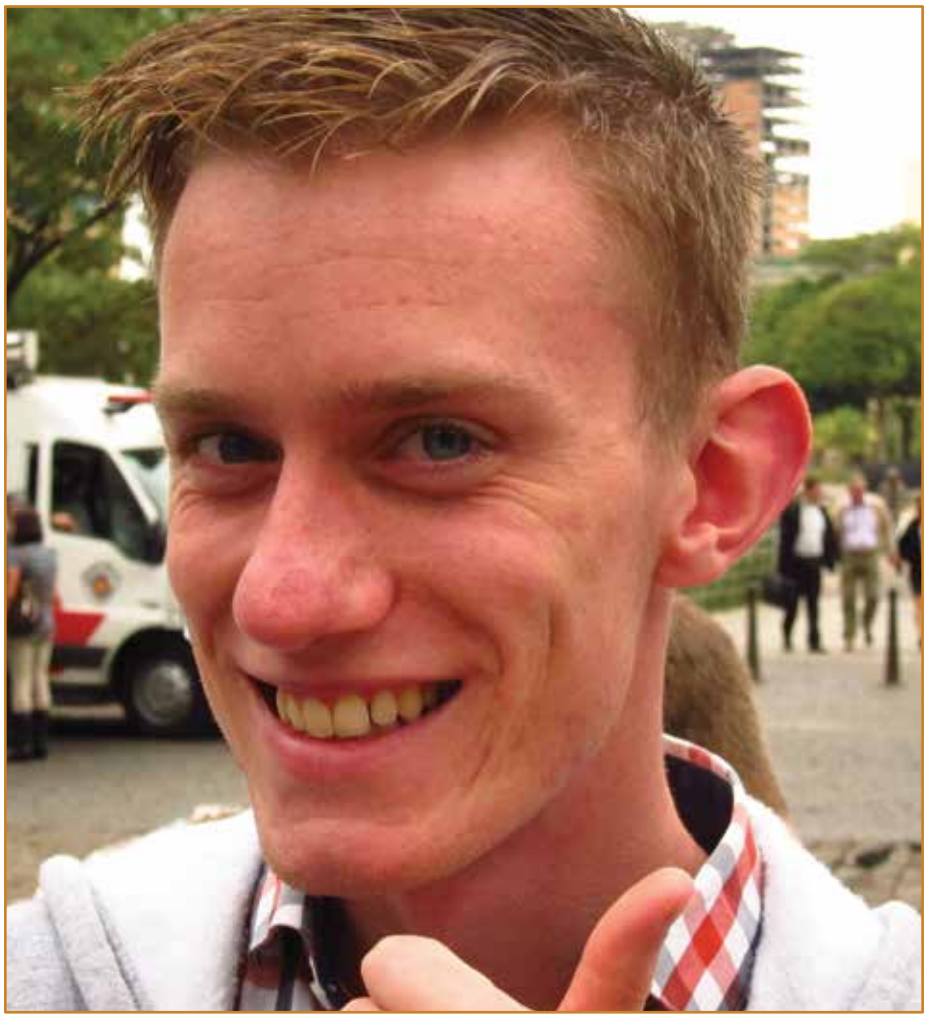
Already for some months now, I've been working on my PhD project within the electromagnetics (EM) department. They gave me an office on the 9th floor, with a nice view over the campus and the city. It didn't take me long to feel at home on my new spot. I always like to hear about all the different kinds of research that's taking place on our university, so let me tell you what I'll be working on for the coming four years, I'm sure it'll intrigue you.

In 1929 and 1931, researchers discovered that electrical stimulation of the visual cortex can produce well-defined sensations of light in patients who lost their sight during their lives. This research was continued by various groups all over the world. To put it simply, they found out that, when you put an electrode directly on/in the visual cortex, and you apply a certain voltage, the patient 'sees' a bright spot of light, called a phosphene. When you move the electrode, the spot of light also moves and does so in a fairly predictable manner. A set of electrodes can generate recognizable patterns.

For at least 50 years now, this principle has been regarded as a possible visual prosthesis, that will allow blind people to experience a sensation of seeing again, allowing them to take notion of the world around them, move around without cane or dog, maybe even letting them read again. Some efforts have already resulted in prototypes for this cause, but until now, no safe, reliable, and practically useful solution has been presented.

Pieter Roelfsema, president of the Dutch brain institute and my program leader, wants to build the world's first visual brain implant that can eventually be implanted in humans, and will produce a kind of artificial vision that will actually improve the life of the patient. Together with professors from Amsterdam, Eindhoven, Maastricht and Nijmegen, he wrote a proposal and received a grant from NWO/STW for his project called NESTOR.

The idea is that we use an existing camera (a Google Glass for example) and extract features from the video it records. These can be, for example, obstacles, doors, edges of the walkway, but maybe even text. These features are mapped to the known electrode positions, to determine which electrodes should be switched on and which ones should stay



off, and that information is transmitted to the implant wirelessly. The implant is to be powered wirelessly as well. Within our project, some resus monkeys will be implanted with the system, so we can investigate its functionality. Furthermore, researchers in our project are already looking at how this system can be implanted in human patients.

In charge of the wireless part is Mark Bentum, who started as a professor at the TU/e last September. Together with Huib Visser and Rob Mestrom they supervise Adedayo and me, two PhD candidates, responsible for the data and power transfer, respectively.

For now, the focus is on a system with about 1000 electrodes, although this could still change in the future. To some, this number might sound small; it's only about 32x32 pixels. To someone with functional sight, this number is indeed low, but to someone with no sight at all, this is a huge improvement. We've had presentations from patients who've been implanted with a comparable system, and their stories are truly impressive, even though they only have 58 or 96 pixels. The amount of freedom this small number of pixels gives them is hard to imagine, so I'll just have to go by their stories, but then imagine what it would mean when that number would increase to 1000!

I'm looking forward to working on the project. Keep an eye (hah) on the news, we've already gotten quite some coverage. ■

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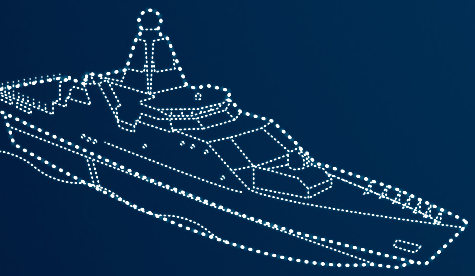

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