TU/e
connecthor 43
Magazine of e.t.s.v. Thor and the department of Electrical Engineering at Eindhoven University of Technology
September 2018

Introduction week | **Promovendi** research | BEP prize | **Education** day | Internship **abroad**

Connecthor

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With the summer holiday period, the introduction week for new bachelor students and the kick-off for new master students all behind us, the new academic year has officially started. For the first time in the history of TU/e, a 10-hour timetable has been put in to use. We expect that some of you might be a little confused at first about the altered hours, but we are convinced that you will all get used to it soon.

In this new Connecthor magazine in front of you, you will find many interesting articles written by staff and by students. Our dean Bart Smolders answers the question whether it's possible to complete a PhD program within 4 four years. Sjoerd Hulshof, our director of education, has written a warm welcome to our new students and concludes his story with some good advice.

In this September issue you will also find different articles written by promovendi about their PhD research.

The candidate board members of Thor introduce themselves in this issue. Laurens Kok, President of Thor wrote his last "From the president". Sebastiaan Goossens shares his experiences about his internship abroad in Dallas, USA. Read more about Sander Verdiesen's world travels to yet another exotic place; this time he explores Iraq.

We hope you enjoy reading this September edition.

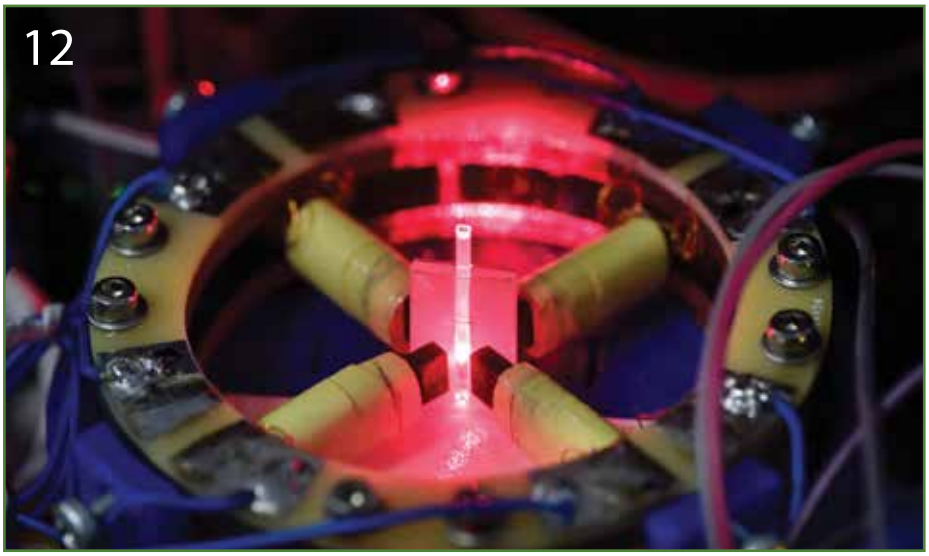
The Connecthor editorial board.

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.

Education day
Discover what the department is going to do to pave the way towards 2030 on page 8.

Introducing candidate Board Thor
Have you met the new board already? They will introduce themselves on page 14.

Internship Abroad
Still wondering where to go for your internship? There is a good example on page 32.



TU/e Sensing Team
Read more about them and what they do on page 12

Can a PhD program in Electrical Engineering be completed in 4 years?

By: prof. dr. ir. Bart Smolders

A simple answer is: yes, it can be done. There are several European Universities with a PhD program of only 3 years, for example at DTU in Denmark. DTU is a highly-ranked technical university, partner of the EuroTech alliance in which TU/e also participates. My personal experience also confirms this answer: I finished my PhD in 1994 in approximately 3.5 years, stimulated by the fact that there was simply not more funding available.

In December 2017, our department was evaluated by an international committee. Overall, the committee was very positive about the performance and scientific quality of our department. However, one of the more critical remarks of the committee concerned our PhD program, and in particular the extensions beyond four years: "As the PhD period is to be considered a learning phase, it is not advisable to extend it beyond four years. PhDs have to move on into society after their doctoral period, for their own benefit, but also for society's benefit." It should be noted that our colleagues in Delft and Twente received similar recommendations.

Let us take a closer look at the situation in our department by considering the PhD cohort of 2013. In total 66 PhD students started in 2013 in our department, quite uniformly distributed over our nine research groups. The situation of this cohort in 2018 is shown in Fig. 1, where the progress of the 2013 cohort is shown for each of the research groups. In total only 50% of the PhD students have obtained a degree (blue bars). In addition, we can observe a large variation along the research groups, with extreme cases in which all PhD students have completed within 4 years to none.

In the past months we have discussed this issue in our department, for example by looking for best practices. It turns out that group 1 and 2 in Fig. 1 both use a quite strict process during the 4-year PhD program. Students need to write a white paper after nine months and need to present this to a panel of experts. Also in the second and third year, students need to present their progress and plans to a panel of experts. Another best-practice in our own department is our PDEng program in which more than 95% of the students finish within two years. In the next months our Graduate School director dr. Huug de Waardt will collect all best practices and other ideas to construct a new PhD program with improved success rates.

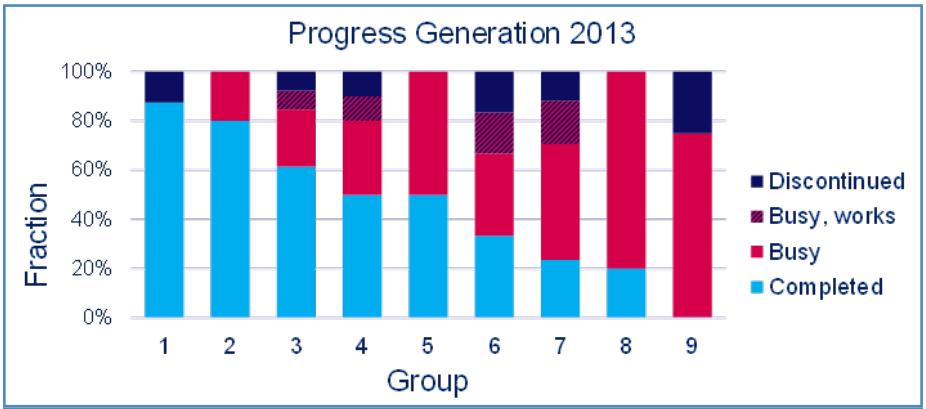


Fig 1. Progress of 2013 cohort of PhD students in Electrical Engineering. Status in Q1 2018 is shown.

Bart Smolders

a.b.smolders@tue.nl

From the President

By: Laurens Kok

After a year of hard work, our Board year is coming to a close. It has been an enormously moving year and it has taught me so much about who I am and who I aspire to be. I walk away from this event in my life with a lot of inspiration. I feel really motivated to get studying again and to learn more about what our beautiful field has to offer. I have quite some courses to catch up on, so I will be around for a while. That however does not bother me at all since I enjoy being here so much. I look forward to the coming years and I wonder what will be in store for me and for Thor.

I hope some of the trends of last year will continue, like the increasing involvement of Automotive students, the growth in the amount of active members and great collaboration with the faculty. We have seen some great changes and additions to Thor, like the informal meeting room next to the Board room and the upcoming places for the master associations on floor 6. I think we have made some great steps this year and I look back proudly at what we have achieved. I am convinced that our efforts have made a difference for the students of Electrical Engineering and Automotive Technology.

I hope the next years bring a higher interest in our excursions and other career-oriented events that don't involve free lunch. The TU/e is not ranked greatly for its preparation on your professional career, however you should not forget that the TU/e is unique in letting the study associations arrange this all. We have had some difficult times getting our excursions full enough to let them continue which, considering the growing number of students, should not be happening. I encourage you to broaden your view of the field of Electrical Engineering and join one of our excursions next year. I have always enjoyed seeing the application of our knowledge in the field and I am sure you will as well!

To the new first year students I want to give this tip: take your studies very seriously, you have chosen one of the hardest studies there is. Give it all you have from the start, to make sure you can stay. Do however not forget to have fun and to broaden yourself. Join an association (Thor for example!), join their activities and most of all: make friends. Your student time will be the greatest time of your life, so you better share it with some great people around you!

I am glad we have inspired our seven successors to put their best feet forward in the coming year. They have some interesting plans and I look forward to seeing them being realized. They will meet some of the same challenges we have faced this year, but they will also have some of the amazing experiences we had this year. I think they can inspire the new first year students to make the best of their studies. I certainly think we have. I wish them the best of luck, and please remember that it's never a bad thing to ask for help.

I thank everyone who has been a part of this year, the students, our active members, the faculty, the FSE and especially my friends, family and girlfriend for always supporting me during this demanding year. Most of all, I thank my Board. Marrit, Meeuwis, Marjolijn, Bram, Arwin, Mariska & Bart, thank you so much for your immense efforts this year and for the great times we have had together.

Veel gedonder!
Laurens Kok
President of Thor ■

Meint Smit receives IPRM award

The IPRM award 2018 has been presented to Professor Meint Smit, for his key contributions in the field of photonic integrated circuits including the invention of the arrayed waveguide grating and for pioneering the concept of generic photonic integration. Meint has been instrumental in establishing the joint European platform for photonic integrated components and circuits (JePPIX).

Gift from Philips

The departments Electrical Engineering and Applied Physics have received measuring equipment from Philips. The equipment will be placed in different groups of the two departments.

Ronald Aarts wins award

Prof. dr. Ronald Aarts (EE) will receive the Philips Research diamond medal invention award for his 100th patent application.

60 years of Thor gift

For their 60th anniversary, study association Thor has received a 3D printer from the faculty board.

ACCI weekend

By: Renate Debets

On the 27th of April, around sixty members of Thor that had gathered in front of the Flux building, took their seats in a bus heading abroad. Since this year was a Lustrum year for Thor, the ACCI weekend would be a special edition and would take place in The Ardennes. The trip was long, but as we neared our destination, the view became more interesting and the bus driver's beerstock became smaller and smaller. After several hours, we arrived at a site for large scouting groups in a tiny village, so we had plenty of space where we could sleep, eat, relax, and entertain ourselves. There was also a tiny forest nearby, where we played games during the first night and gathered wood for the huge campfire.

The next day, we took the bus again and were brought to the brewery of La Chouffe. We were shown around and got to look at all the installations, while we were told how beer was made. Afterwards, we could taste some of their most interesting beers, and for quite a few people, this was their favorite part of this year's ACCI weekend. The beers we could taste were so delicious apparently, that several people decided to buy a beer or two, or three, or a lot more, to take home.

That evening, we stayed at our site and played some board or card games, such as Risk and Monopoly. Some of them had a nice twist to them, such as Battleship and Checkers: all the traditional pieces were replaced by shots. And of course, there was a beer pong tournament, that took place on the main stage.

On the last morning, everything had to be cleaned up before we could leave. This took quite some effort since several objects were duct-taped to poles and walls of the building. Eventually, we could leave and arrived in Eindhoven again in the afternoon of the 29th of April. ■

Introducing...

Hello everyone. My name is Firat Tigrek. After living in Delft for almost five years and receiving our PhD degrees in 2010, my wife, Muge Tanyer-Tigrek, and I returned back to Turkey in 2011. Now we are back in the Netherlands with our daughters, Beren and Pelin.

During the last seven years in Turkey I worked as a radar systems engineer, where I had the chance to work on the development of advanced radar systems. Applying the theory on a system and seeing that system function beyond expectations was very satisfactory, and my research background allowed me to make many significant contributions. Yet, the tight schedules with strict deadlines meant that I had to postpone seeking answers to many research questions that emerged during this period. Returning to the university after my experience in the industry is very refreshing, now it is time to concentrate on seeking the answers to my questions and asking many new questions together with my fellow researchers here at the ICT Lab of the SPS group in Electrical Engineering.

And now it is time for us, as a family, to settle down and enjoy our time in the Netherlands. We have a long list of fun things to do and new places to explore. We have many bike paths to travel, parks to enjoy and people to meet from many different places of the world. We are excited to start a new chapter of our lives here in Eindhoven. ■

Hello everyone! My name is Valeria Tapia. I am Chilean and I grew up in Santiago, the capital city of my country. I recently have moved with my partner to live in Eindhoven to start my PDEng studies at TU/e.

I got my BSc Electrical Engineering and MSc from Universidad de Chile. Later on, I worked as a research assistant on the development of radio astronomy instruments for the ALMA observatory. It is the largest radio observatory in operation, constructed over 5000 m above sea level, in the middle of the driest desert in the world, and provides unprecedented sensitivity and resolution for the study of the universe, an amazing mankind project! I learned a lot from the ALMA project, but at some point, I was curious about how this technology could be applied to the high-tech industry. Hence, I started to look for PhDs oriented to technological applications and thankfully, I have found the PDEng, better orientated to what I was looking for.

Thanks to my last job, I had the pleasure of visiting many places, but it is my first time in the Netherlands. So, I am enjoying discovering the cities, the culture, and the food. Stroopwafels are amazing!

In my free time, I like dancing salsa, practicing yoga and trekking. At the moment, I have not had the opportunity to discover the nature around Eindhoven, so I would appreciate it if you could share with me your favorite places to go for a walk. ■

Graduates May 2018

Graduates Master Electrical Engineering – May 1, 2018

Hassan, A.U. (Aftab Ul)
Pelzers, K.M.P. (Kevin Maximil Pierre)
Berntsen, R.W.H. (Roger Willem Harrie)
Hoang, T.D. (Tuan Dat)
Xue, Q. (Qinyi)
Adi Kuswanto (not in the picture)
Ye, X. (Xin) (not in the picture - will receive diploma in July)

Congratulations!

Education Day

By: Gijs Neerhof

Every year, the department organizes the Education Day for all staff members and students within the department involved in education. This year, it was held in the Van Abbe museum with as main theme "Paving the way towards 2030". While 2030 still seems far away, the university is already preparing a strategy. The plans for 2030 were presented by Lex Lemmens as part of the morning program. Next to that, Jim Bergmans presented the 10-hour schedule, which should be introduced by now. With the lack of space around the campus (at the time of writing this, the plans of closing the Pavilion building when Atlas opens are still current), and the increasing number of students, there is a lack of all room sizes on the campus. With the 10-hour schedule, this is still not completely solved, but it decreases the space pressure on all rooms. The working group reviewed plenty of different schedule configurations, and the one being implemented was simply the best. During the lunch, the morning program could be reviewed and there was a possibility to visit the museum.

In the afternoon, the participants could join two of the three workshops. The first workshop, "engaging students", was given by Kees Goossens. He noticed that the expectations of teachers and students are not always aligned and wanted to share his observations and some possible solutions. From a students' perspective, it was interesting to see that teachers really do care about the courses they teach and want to motivate students to pass the course. Multiple teachers shared their findings and opinions on the subject, which lead to an interesting discussion.

The second workshop was given by Miguel Bruns on "BEP in Innovation Space", where he showed a group of students from different departments coming together in a multi-disciplinary BEP. It was interesting to see the different requirements set by the different departments, and how every student had their own responsibilities within the project. Next year, I might even do an interdisciplinary BEP in the TU/e innovation Space!

The third workshop focused on designing an online course in Canvas. This workshop was focused more on the organizational side of teaching. Sadly, I had no chance to join this workshop, but I heard it was interesting as well!

Like every year, the educational awards were awarded to the best first, second and third year bachelor teachers. The winners of this year were: Marion Matters for the first-year course Circuits, Rob Mestrom for the second-year course Electromagnetics I, and Peter Baltus for the third-year course Electronic Circuits II. I want to congratulate the winners of this year! While these teachers were voted to be the best by the students, of course we have plenty of other great teachers within the department!

In the end, the Education Day showed new insights for both teachers and students present on how to continue in the future. Short-term focusing on the 10-hour schedule and with a long-term vision towards 2030. I would like to thank everyone present for their participation and I hope to see you all on next year's edition!

If you are interested in becoming part of the decision-making process concerning education, there are plenty of opportunities for both students and teachers to get involved. Do not hesitate to contact me for more information (Studentlid.E@tue.nl) or find me around the Flux building. ■

A warm welcome to our new students!

By: Sjoerd Hulshof

It is a great honor for me to welcome you to the Department of Electrical Engineering. By the time you are reading this article, you have already started your new adventure. Most of you (around 300 students) have started their bachelor studies in either Electrical Engineering or Automotive Technology. You will probably also have experienced the difference with your prior studies in secondary school already: larger amounts of study material, a shorter time to digest new information and train new insights, getting used to a new study environment and starting a new life in general. Also, chances are you're not even 18 years old. So, we are asking quite a lot of our freshmen. Therefore, I cannot emphasize the importance of a solid start enough. What I mean by this, is that you should consider your studies as a full-time job. As you know, each quarter consists of ten weeks where you have to gain 15 credits to keep on track. 15 credits is equivalent to 420 study load hours, implying 42 hours of study per week. How you plan these 42 hours is up to you! Since you have a maximum of 24 contact hours per week, this means that there are still at least 18 hours of self-study and meetings with your fellow students to plan.

Fortunately, you are not alone. Your student mentor, your study counselor and your electives coach are here to support you in all decisions you make, so please take my advice on this and make sure you keep in contact with all three of them, especially during your first semester. As you know, you will have to pass 75% of your first-year courses to be able to continue your studies next year. This is certainly doable, but only with the right mindset and a healthy work spirit.

Besides your studies, you have plenty of opportunities to make your student life even more interesting by means of sports, cultural activities and study & student associations. My advice is to find the right balance between studying and leisure time. You need both to finish your studies successfully.

Each one of you has dreams and ambitions to pursue. My advice is to remember these dreams and ambitions regularly, but also live, experience and enjoy the present day. After all, for most of you this will be a once-in-a-lifetime experience. Good luck!

Sjoerd Hulshof

Director of Education
Bachelor Electrical Engineering and Automotive Technology ■

Whose desk is this?

By: Jan Vleeshouwers

From the partly hidden book on the right of this desk, you should be able to conclude right away whose desk this is. The book on the left also shows that the owner of this desk is heavily involved in electronics, which would be confirmed if you were able to read the titles of the papers. These are partly his own, and the others are from the PhD-students he supervises.

The personal stuff on this desk is limited, but no less important. There is a picture of his wife, smiling at him. The mug contains pictures of his two kids. The image of the sailboat is not an indication of his hobby, but a souvenir from the farewell trip for a colleague who retired two years ago. There is also a practically unnoticeable small charm hanging at the right of his monitor, a present from one of his PhDs.

Two post-its on his monitor are there to remind him of a couple of important dates and to help him type Cyrillic characters on a plain keyboard. On the very left border of the picture you see a small plate, with some apples. Not his absolute favorite, he admits, it could have been bananas as well.

In the window sill there are more personal objects: a couple of Father's Day presents and some plants. Not the roses he cherishes at home: they wouldn't survive here, unfortunately.

Find out whose desk this is on page 34. ■

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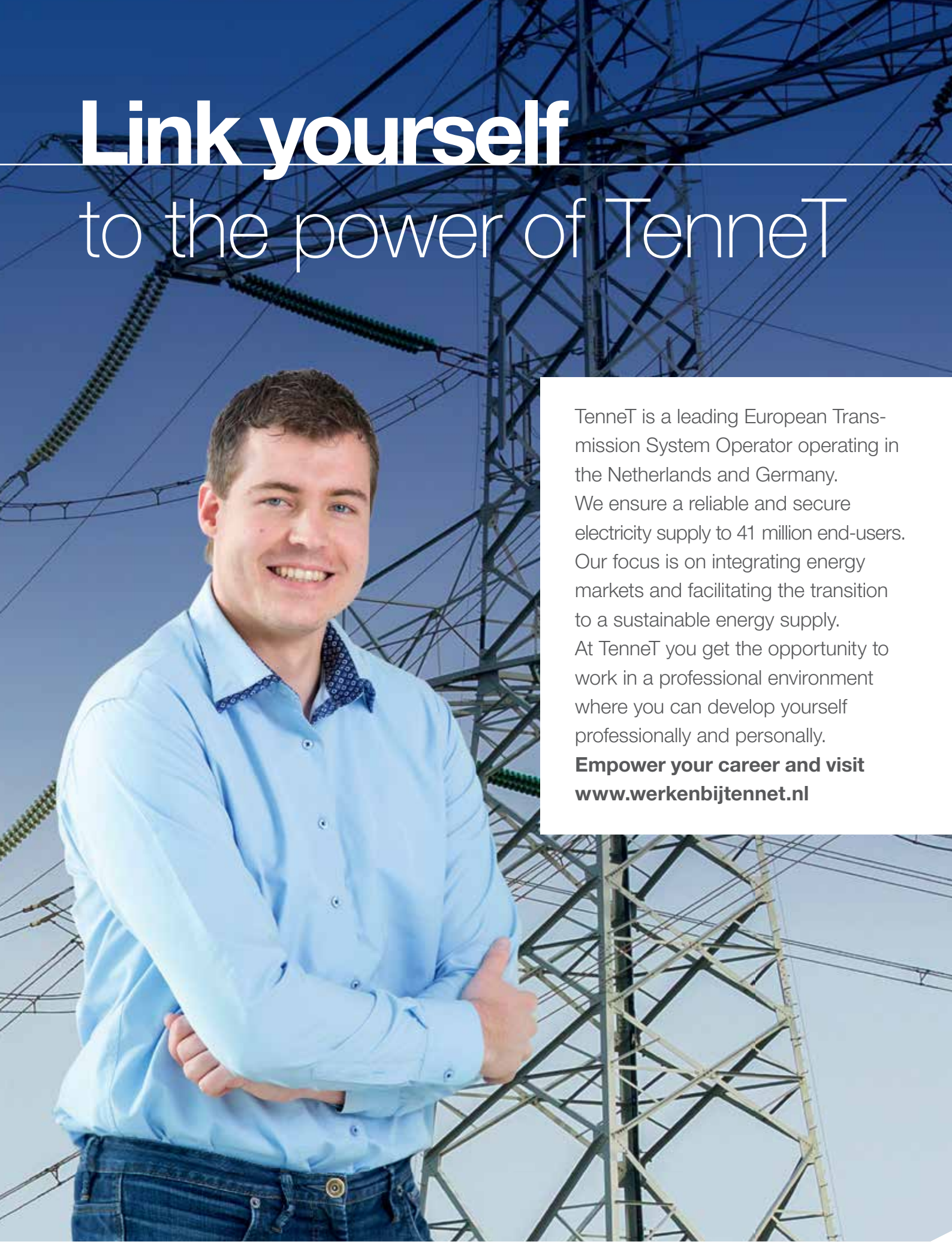

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Introduction Week

By: Gijs Neerhof

Every year, just before the start of the new academic year, the introduction week takes place. During this week, the new generation of students is introduced to the university, the city, but mainly to student life. As you might have seen, the week is filled with fun and interesting activities, ranging from the Green Strip Market, where all communities on the campus present themselves, to parties in the evening on the Flux field.

The week started on Monday early in the morning, when the prospective students arrived from all over the country. This trip from the station, over the Limbopad, towards one of the buildings on the campus would be the first of many. The eager faces of people not quite knowing what to expect of the week were welcomed in the Auditorium building by our dean, program director and the excited parents who would be meeting their "kiddos" moments from then. The week started off with an engineering case where circuits must be assembled on a breadboard. The kiddos got to know each other, their parents, the department, and of course, the kandis! Hopeful to become next year's board of Thor, they set out during the introduction week to entertain the kiddos whenever they could.

During the department tour on Tuesday, the upcoming freshmen visited some labs in the Flux building to show the cutting-edge research happening within the department. In the afternoon, all communities on the university represented themselves on the Green Strip Market. The FSE associations united by a giant blow-up slip 'n slide, surrounded by pools. Later that afternoon, the kandis proved their incapability yet again by losing all important General Members Meeting artifacts. Luckily, with some help of the parents and kiddos, they could be retrieved in exchange for some 'bitterballen' and beer. During the barbecue that followed, the brand new 'tapauto' (draft car) was shown off. With the beautiful blue-gold color scheme (observe the gold accent on the antenna!) it drew a lot of attention!

With no lack of parties throughout the rest of the week, with the highlight of course on 'doorhaaldonderdag' (no-sleep Thursday), the first hungry faces showed up as early as 6AM for the last hangover breakfast of the week on Friday morning…

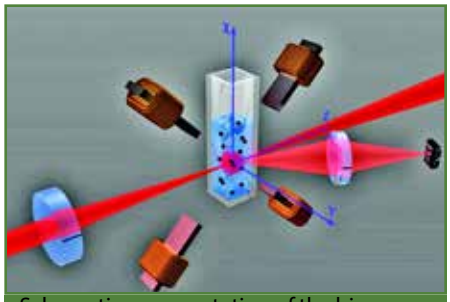
The introduction week this year was definitely a success. I think the next generation of students is readily informed about all possibilities and communities on the campus. I want to wish them good luck in the start of their first year and hope to see them around! ■

TU/e Sensing Team

By: Leander van Eekelen

With the increasing pressure on doctors and healthcare to treat ever larger volumes of patients, smarter solutions are needed if we are to keep up the same quality of healthcare in the future. We from the TU/e Sensing Team (T.E.S.T.) believe that biosensors will play a critical role in ushering in this future, where medical tests are fast, cheap and only a finger prick away.

A biosensor is, simply put, a sensor that allows for the measurement and detection of a 'biomarker', be it a protein, enzyme, mineral, bodily waste product or carbohydrate. Their presence and concentration in the body tell the doctor about the state of processes happening inside and, in turn, your health: biomarkers could indicate sickness, a lack of sleep, stress, organ failure and much more.



Schematic representation of the biosensor

The progress of biosensing

Traditionally, doctors would measure these biomarkers by drawing some blood from you, sending this off to the lab and waiting for the results. In the lab, huge machines perform hundreds of tests per hour in batches containing various patients – in effect, huge biosensors, that have the downside of being immovable. However, nanotechnology and electronics has allowed manufacturers to begin building biosensors that fit onto a table by smart utilization of microfluidics and microcircuitry. This reduction of size allows for far more flexibility: now, instead of a syringe full of blood, a finger prick with a microneedle is used, drawing only a single drop of blood. Biosensors can now finally be put into the same room as the patient, allowing for much faster time to results. A patient can walk into the general practitioner's office and be checked for an infection within 15 minutes, whereas only a few years ago, this speed of diagnosis was unthinkable.

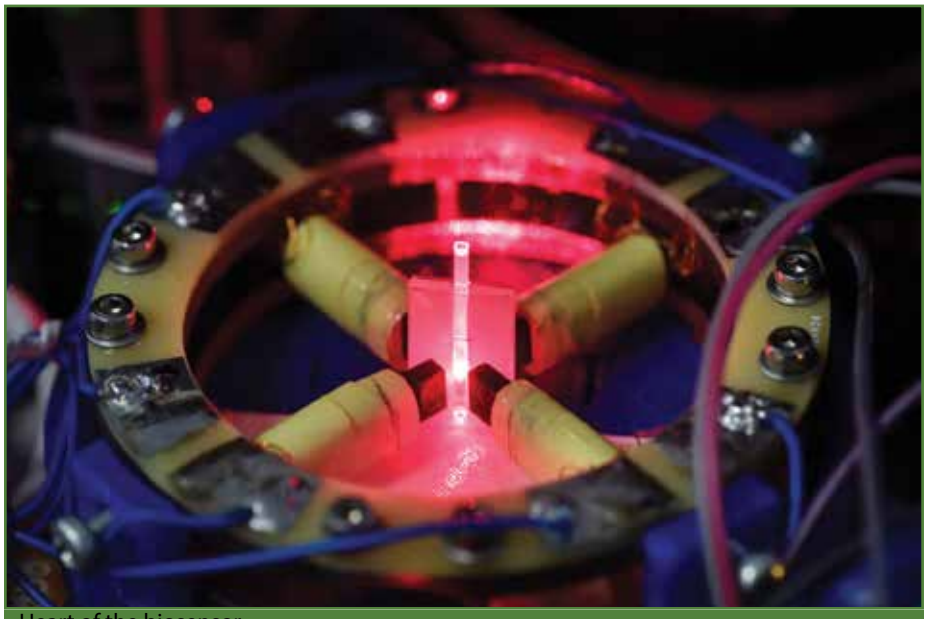
But the work is not done yet. We cannot measure every biomarker out there yet and one dream alludes us: continuous measurement of biomarker levels for multiple hours or even days in the same patient, instead of a single test. That single test is simply a snapshot of the patient's status: much more information can be gathered from monitoring biomarker levels over time. Is the patient experiencing a temporary problem? Should the patient take more medicine to suppress a sudden onset of symptoms? More research is needed to achieve this continuous measuring and offer true convenience for the patient.

This is why we from student team T.E.S.T. compete in the annual SensUs competition: an international student competition organized each year here in Eindhoven that challenges teams from all over the world to build a biosensor for a specific biomarker (different every year). In the first week of September, all teams come to Eindhoven to show off their design and share their found knowledge. This open way of innovation stimulates advancement in the research on biosensors – each year, steps are taken towards a better and healthier future.

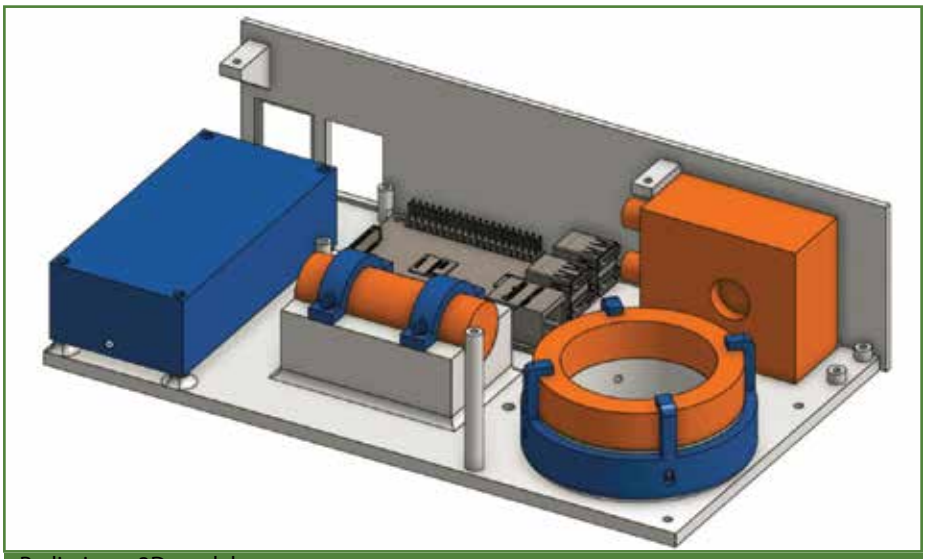
The challenges

The work for the SensUs competition each year starts in October, when a team of bachelor and master students is formed, from all departments across campus. Then, the painstaking process of developing a biosensor begins, according to the specifications laid out by the SensUs organization. To drive us to innovate, the competition sets forth specifications that consistently push the boundaries of what is possible with current biosensing technology.

For one, the dimensions of the biosensor must not exceed that of a typical laptop, which is a tall order, considering contemporary biosensors fill a kitchen countertop. We are allowed to take only 20 µL from the blood samples we are tasked to measure, while a typical drop of blood is already 50 µL. Of course, we need to measure our biomarker accurately, within an accuracy rivaling that of the machines in hospitals. Last but not least, we must generate a result under five minutes, while contemporary machines take upwards of 10 minutes to get a result. To meet these high standards, we spent our first months thoroughly researching literature to find publications of measurement principles we believe could live up to the requirements and be feasible to build within half a year.



Heart of the biosensor



Preliminary 3D model

This year, we must measure vancomycin, an antibiotic administered to patients after severe surgery. It is important that the vancomycin level in blood stays stable, lest it drop to a point where it has no effect or shoot up to an overdose. Measurement with a biosensor nearby could help indicate medical personnel whether to administer either more or less vancomycin to promote stable levels.

The biosensor itself

The measurement principle we have selected this year was developed by Andrea Ranzoni here at the TU/e: an optomagnetic cluster assay. It relies on the usage of superparamagnetic beads that can be manipulated by a (rotating) magnetic field. The particles, half a micron in diameter and made of polystyrene with ferrite particles in them, are coated with (bound) vancomycin, the biomarker we want to measure. These particles are added to our blood sample containing (free) vancomycin in a glass cuvette, after which we add antibodies. They can act like crosslinkers to form bridges between the vancomycin-coated beads to form two attached beads (i.e. dimers), or bind to the free vancomycin of the blood sample, in which case no bead dimers are formed. As the concentration of free vancomycin in the blood sample increases, it becomes increasingly likely that the antibodies will bind to the free vancomycin and not the vancomycin-coated beads, resulting in less dimers. The amount of dimers in solution is thus a measure for our biomarker in our sample.

Here, the electrical engineering comes into play: this chemical process above has to be translated into an actual, measurable signal. Because of the handy superparamagnetic properties of the beads, the number of dimers in solution can be determined. We can rotate all the beads in solution by applying a 5 Hz rotating magnetic field using magnetic coils that surrounds the fluid-holding cuvette. If a laser is then sent through the cuvette in the plane of rotation, the beads will begin scattering light. This light can be collected by a photodiode set at a 90 degree angle to the laser after which the signal is analyzed. The optical cross-section of dimers varies because of its rotation, alternating between the cross-section of one and two beads with the frequency of two times the field rotation speed. This means that the scattered light intensity registered by the photodiode will be time-dependent. Performing a Fourier transformation of the signal and then taking the amplitude of the 10 Hz signal thus gives us a measure for the number of dimers. Contrary, the single beads have no time-dependent signal and are thus ignored by Fourier transformation.

All of the components of the assay require a lot of know-how on electrical engineering, but were a lot of fun to design. The SensUs organization gives free reign over this: the participating teams are responsible for the selection and purchasing of parts, the budgeting and the execution. This all leads to a project of very large scale and is true application of the skills gained over our study. Signal processing, electromagnetism and a large amount of circuitry to support the central workings of the biosensor all come along. In addition, we learn valuable things about consumer electronics: suddenly, because we're building a product meant for hospitals, we had to take into account laser and magnetic field safety, in addition to medical safety of the plastic.

Interested?

With all of the amazing technology and hard work put into the biosensor, we hope to win this year's SensUs competition, which takes place on the 7th and 8th of September in the Auditorium of the TU/e. Come visit our stand and see our biosensor in person! Are you interested in getting hands on a large, practical project that will test your skills and simultaneously contribute to healthcare? We are looking for electrical engineers for the 2019 team! In many ways, T.E.S.T. is a unique student team. We are part time (~10 hours/week) and have no set roles, meaning you can also involve yourself in acquiring sponsors, making business cases, or managing public relationships. Send us an email at info@tuetest.nl if you're interested! ■

Introducing candidate Board Thor

Hello everyone, my name is Dana de Vreede and I am the candidate President of e.t.s.v. Thor. Next year I will take on what will probably be the busiest year of my whole student life. However, this does not reduce my excitement for the year to come at all. After an amazing introduction week, I knew I wanted to become an active member, which I did by joining Ivaldi. In my second year I joined the ACCI, Volundr, FotoCo and the Growth report committee. All this while feeling completely at home at the sixth floor of Flux. I hope that everyone will enjoy the same welcome feeling in the upcoming year as I have been able to enjoy for the past two years. I know I can speak on behalf of all seven of us when I say that we will certainly do our best to make it an amazing year.

Geen gedonder! ■

Hello everyone! My name is Renate Debets and I am the candidate Secretary. I come from Oosthuizen, a village near Amsterdam. I wasn't very experienced with electronics before I started studying, but I dream of building my own electric guitar one day, so I chose to study Electrical Engineering.

During the introduction week and the weeks after, I made a lot of friends because of Thor. However, besides uniting people and organizing many activities, Thor also creates the opportunity to step out of your comfort zone and try new things. Soon I found myself spending more time on committees than on my courses.

I decided that a board year would be the perfect way to challenge myself and contribute to Thor even more. I hope that I will manage to make other people realize that too, and have a good time here, just like I am having right now!

Geen gedonder! ■

Hi everyone, my name is Ronald Janssen and I want to become the next Treasurer of Thor. I grew up in a town close to Nijmegen, called Wijchen.

After high school I started my study of Astrophysics in Nijmegen. When the courses in the second year became more in-depth, I noticed that I only liked the electromagnetic courses. That's when I came to Eindhoven and immediately decided I wanted to study Electrical Engineering.

After the introduction week I knew I wanted to become an active member of Thor and joined Ivaldi. In Ivaldi I organized the Neon party, and the Mario skelter activity. Last year I joined ACCI, the Tappersgilde, and Aegir.

I had a great time because of our study association and I want to give everyone the same experience. That's why I want to become a board member of Thor.

Geen gedonder! ■

Hi everyone! I am Niek Brekelmans and I want to become the next Commissioner of Internal Relations and Vice-President of Thor.

As a baby, I was always drawn to (light) switches, which frequently lead to my house being shrouded in darkness. This evolved into doing electronic projects at home. It was therefore not a weird decision to study Electrical Engineering. When I finished my high school, I could finally get out of my parent's house in Geldermalsen and study in Eindhoven.

I am really glad to have started this study, as it allowed me to join Thor, where I became an active member and Tapper. Nowadays, floor 6 in Flux feels like my third home, where I can find my friends and Het Walhalla. I want to have an amazing year and learn a lot next year as a Board member, but more importantly, I would like to give all (new) students at our faculty the chance to be welcomed the way I was!

Geen gedonder! ■

Hey everyone! My name is David van Son and I am the candidate Commissioner of Het Walhalla. I was born in Nijmegen and raised in Malden, a small village just to the south. During my secondary education I learned how awesome electronics are, and I soon decided I wanted to become an Electrical Engineer.

I learned how awesome Thor is during the introduction week, but I came here to study, so I did. This soon became boring, and since I had met a lot of fun people in Het Walhalla, I joined Ivaldi. I very much liked the committee work, so in my second year I joined the ACCI and became Tapper.

Next year I hope the seven of us can deliver yet another amazing year that will never be forgotten.

Op Het Walhalla en Geen gedonder! ■

In the upcoming year we will do our utmost best to make our board year as successful as possible. If you are ever stuck with a question or just want to relax for a little while, don't be afraid to come and talk to us.

You can find us at the board room in Flux 6.154 and at any of the activities Thor organizes for its members. Whether you want to come to our educational activities such as the exam trainings, our career-oriented activities like lunch lectures or excursions, or just want to come to Het Walhalla for a chat or a drink, we hope you know you are always welcome!

Geen Gedonder! ■

Hi, I am Thijs Lacquet, the candidate Commissioner of Education. I grew up in Rosmalen, a small town near Den Bosch.

I always wanted to do something in engineering. In third grade, during a "profielkeuze" day at the TU/e with my high school, I first got into contact with Electrical Engineering. I ended up doubting between Electrical Engineering and Computer Science. I chose for Electrical Engineering, but after my first year I decided to do both.

During the first half of my first year, I mainly focused on studying and getting my BSA. In the second half of the year I became more active at Thor and I decided that I wanted to join the ACCI and LANCo. I liked doing committees so much that I also joined the ReisCo and TACo later that year, and decided that I wanted to become a board member.

Geen gedonder! ■

Hi all, I am Martyn and I want to become the next Commissioner of Public Relations of e.t.s.v. Thor.

I am 22 years old and spent most of my life in Geleen where I grew up as a child.

My story is somewhat different than that of most of my fellow candidate Board members, because I joined Thor four years ago. Immediately I was hooked onto Thor and the student life in general.

I was a really shy guy at my primary school. At my secondary school I started to shift away from this shyness and even more when I became a student. During my years at Thor I learned a lot from organizing all kinds of events, most of which cannot be learned from textbooks.

I hope to learn a lot from my Board year and develop myself. I would like to give everyone the same opportunities Thor gives me.

Geen gedonder! ■

Bachelor Final Projects completed

By: Jan Vleeshouwers

In the week of June 18th, about a hundred EE and AU students completed their Final Bachelor Projects, with the involvement of about as many staff. Each student wrote a paper on his or her project results and presented the work in ten minutes before a panel.

Two students have been nominated for the SMIT award, a national prize for energy-related projects. They will present their work in March next year to a jury, who will decide who wins the award.

For the KIVI award, there were four contestants this year. They presented their work on Friday June 22nd, during a session before an audience of mostly external people, family, friends, and some KIVI members. Their work showed a high quality and an amazing variety of topics. The KIVI jury, Steven Luitjens, Eric Persoon and Paul van Moerkerken, studied the papers in advance, and prepared a couple of tough questions for the four students.

Jorn van Kampen – converter for a battery-powered bicycle

Jorn van Kampen designed a converter for a battery-powered bicycle. The converter works in two directions: it powers the bicycle when going uphill, but it also recharges the battery pack when braking downhill. Rather remarkably, he started with a very practical test to see if all the envisioned equipment could be hooked up to a cycle. Starting in this way is unusual, but often gives valuable information for the more theoretical analysis, design and simulation phases of the project. The project also stood out because of the elaborate modeling and subsequent identification of the battery. The jury's main concern was if this system hadn't already been built yet, but for the current application in bicycles, this approach is new. The project was supervised by Mircea Lazar.

Daniël van de Klooster – power source with integrated measurement facility

The 2nd contestant was Daniël van de Klooster, who came to his project after consulting his current employer, Vention, which develops prototypes in a whole range of different areas. They needed a cheap general power source of about 40 W with an integrated voltage and current measurement facility. Daniël designed, simulated and partly realized such a system, for about a sixth of the regular costs but with similar specifications. He gave a live demonstration of the PCB he made. The measurement part triggered the most questions from the jury, because the µA measurement-accuracy Daniël claims may be endangered by temperature effects and by disturbances from the 700 kHz converter in the power circuit. So far, no such effects have been noticed but Daniël confirms that these will be checked carefully in a next, more final prototype. The project was supervised by Peter Baltus.

Jasper de Graaf – low loss, low crosstalk and small area waveguide crossing

Jasper de Graaf obtained his project assignment from the area of photonics. He has been working on low (insertion) loss, low-crosstalk waveguide crossings. Common solutions to the very obvious problem of how to have two light beams cross each other in a single plane suffer from quite substantial losses and of crosstalk. Jasper designed and realized a waveguide crossing based on multi-mode interference, with loss- and crosstalk figures similar to current state of the art solutions, but with a much lower wafer footprint. The jury mainly discussed this last claim, because it doubted the space savings. Although Jasper did not have specific images to show, he managed to convince the jury. The project was supervised by Yuqing Jiao and Jorn van Engelen.

Bart van Erp – deep learning application to fetal heart rate measurement

The final project was a study into the use of Deep Learning to extract the fetal heart rate from an electrocardiogram (ECG), by Bart van Erp. Monitoring fetal heart rate can be crucial if a pregnancy is at risk, but it is notoriously difficult to filter the signal from ECG data. Currently, the best results are obtained using model-driven algorithms. This study replaces these algorithms by a neural network, which is trained using several hours combined ECG measurements and "true" heart rates measured invasively. The results were still

Jorn van Kampen

Daniël van de Klooster


Bart van Erp


Jasper de Graaf


Daniël receiving his prize

inconclusive: although the neural network tracks fetal heart rate, its accuracy is insufficient, and it misses to identify periods in which the heart rate drops below dangerous levels. Bart expects that further study still may lead to significant improvement, given the achievements in a limited period of time. The jury asked about comparable equipment, some of which is even commercially available. Bart answered that all this equipment suffers from the same principle difficulty of extracting meaningful data from a large amount of noise, and that some equipment is even considered unfit for monitoring if not used by qualified personnel. The project was supervised by Rik Vullings and Ruud van Sloun.

Daniël van de Klooster wins KIVI prize

After a short deliberation, and with the remark that the quality of the work of the contestants was high and hard to discriminate, the jury decided to award the KIVI prize to Daniël van der Klooster. In the eyes of the jury, all four did a good job of analyzing the original assignment and in designing and motivating their solution, but the jury was pleased by the fact that Daniël was also able to build a well-functioning prototype.

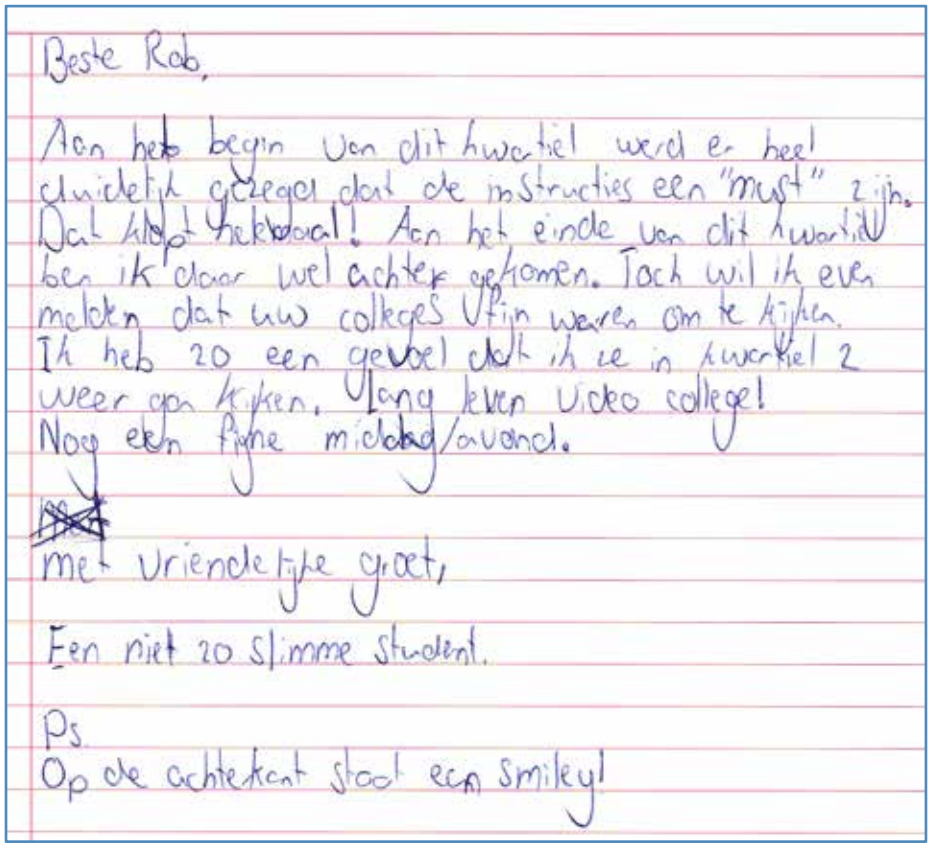
As a general remark, the jury also advised the contestants – and through them the staff present – to try to give a little more attention to presenting the context of the project in the papers, to previously done work, to already available solutions and to their advantages and disadvantages. KIVI would also like to see this afternoon meeting, with four high-quality projects being presented, turn into a full BEP-project wrap-up for staff and students, to stress and show the results of this valuable joint effort in which a large part of the faculty is involved. ■

Remarkable examination work

By: Jan Vleeshouwers

Failing is a good way to learn, some even say it is the only way to learn ("The greatest teacher, failure is." – Yoda, Star Wars: The Last Jedi). In that respect the university has given in quite substantially the past decades. By stressing that a student should study in a nominal pace, that "registering = taking part = passing", by enlarging financial burdens for those who study slower, the university deprives students of the most effective way of learning, namely to underestimate a course and then just plainly flunk.

The more admirable, against this background, is the student who fails and in the process admits that teacher was right after all in warning that actively attending the tutorials was a simple necessity. The text is from an Electromagnetics 1 exam. You might say it came too late, but I'm quite convinced that this reflection in combination with a proper dose of honesty is what is needed from academics, perhaps even more than being smart. I am reproducing this work anonymously, but this student's attitude deserves a compliment. ■


Beste Rob,

Aan het begin van dit kwartiel werd er heel duidelijk gezegd dat de instructies een "must" zijn. Dat klopt helemaal! Aan het einde van dit kwartiel ben ik daar wel achter gekomen. Toch wil ik even melden dat uw collegas U fijn waren om te kijken. Ik heb 20 een gevoel dat ik ze in kwartiel 2 weer ga kijken. Lang leven Video college!
Nog een fijne middag/avond.

met vriendelijke groet,

Een niet zo slimme student.

Ps
Op de achterkant staat een smiley!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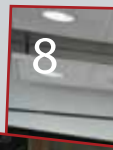
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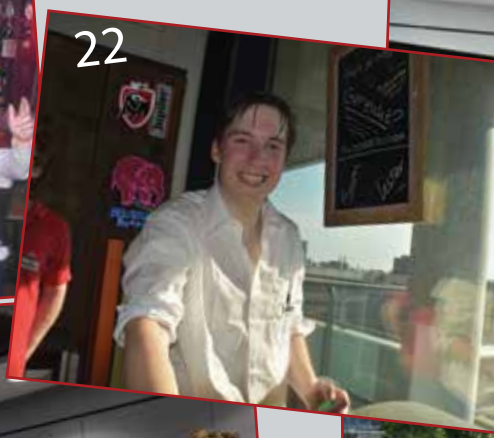
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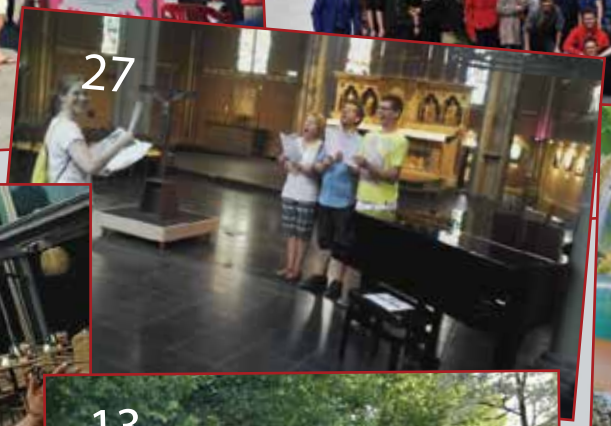
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1. Batavierenrace
2. ACCI Macgala
3 & 4. ACCI weekend
5. 236th GGM
6. Tappersopdracht Niek
7. Partysub
8. Lunch lecture HyTEPS
9. ACCI & Pattern Drinkolympics
10. Lunch lecture Rijkswaterstaat
11. ACCI Archery Tag
12. Ivaldi Wathoractivity
13. FoodCo BBQ
14. Excursion Vanderlande
15. Free icecream
16. Ivaldi Beachparty
17. LED's Party
18. The 61 Bananaparty
19. ACCI kinderfeestje
20. Dagopdracht Ronald
21. ACCI Pillowfight
22 & 23. Tappersopdracht David
24. Volundr Foxhunt
25. Ivaldi Levend sjoelen
26 and 27. Faculty trip

Niche construction

By: Jan Vleeshouwers

Part of Jon McCormack Niche Constructions, 2008/2009

In my attempt to understand the forces of technology and the double-hearted attitude of man towards it, I came across the concept of 'niche construction'. I was deeply surprised to find that a concept as simple at this, with large implications for the interpretation of the role of technology in society, seems to lack general recognition and acceptance.

Perhaps it is the phrasing. 'Niche construction' (NC) is whatever organisms do to alter the environment they live in. Of course, technology is just that, but the concept of niche construction originates from an unrelated area of science, namely from a critical assessment of standard evolution theory. Lewontin (1983)[1] formulates this critique in a couple of equations which look very familiar to engineers. The process of evolution as formulated by Darwin, can be described by:

$$\frac{dL}{dt} = f(L,E) \qquad (1a)$$

$$\frac{dE}{dt} = g(E) \qquad (1b)$$

where E is the environment, L is life (an individual organism, a species or in fact any group) and t is time. The derivative d/dt shouldn't be taken too literally: it denotes the direction of change over time; similarly f and g denote general relationships. Equation (1a) says that changes to life are a function of the current state of life and environment. Equation (1b) formulates that the environment is not a constant: it changes as a function of the current state of the environment.

Lewontin's objection to (1) is that it neglects the fact that life modifies its environment. So instead of (1), the equations should read:

$$\frac{dL}{dt} = f(L,E) \qquad (2a)$$

$$\frac{dE}{dt} = g(L,E) \qquad (2b)$$

Equation (2b) now includes life as a source of change to the environment. The difference is just a single variable in (2b), but the consequences for evolution are quite profound. Reading Niche Construction [2], I get the impression that evolutionary biologists hesitate to adopt (2) because of the added complexity. Engineers would not: there is elegance in the symmetry and the introduction of mutual feedback between life and environment is what engineers love.

Of course, introducing this additional dependency must be founded in the real world. But if you think of it, examples are plentiful. The air that we breathe contains oxygen we need to stay alive, and it contains this oxygen only because of the activities of plants during millions of years. The top soil of most of the earth provides a base for the life of myriads of organisms, but would not have existed if not for the activities of these organisms during a long period of time. The oceans wouldn't be the oceans without the activities of large amounts of plankton. The list can easily be extended to include many changes to the environment which are effected by organisms. And last but not least, the current dominant factor is Homo Sapiens.

The most essential observation from modelling evolution according to (2), is that it allows for a much wider range of ways in which life reacts to changes in the environment. Organisms are not just reacting to environmental changes, but they actively counteract them, or even improve on them. NC activities may speed up the process of genetic adaptation, but they may as well stop them completely. You'll find plenty of examples in [2].

Once evolution of life is considered as a bidirectional process between life and environment, technology's role is immediately obvious. Survival of the fittest is no longer a passive and random process that befalls organisms, but an active process, and technology is how life attempts to harness the changing environment. Beautiful, isn't it?

Of course, answering one question leaves many others to be answered. Knowing technology is an elementary force in the development of life on earth (which we actually already knew long ago), makes it even more urgent to ask and answer where our human technology should be directed at. If human activity on earth is actually transiting from being evolutionary negligible into being evolutionary defining, what responsibility does that bring? Shouldn't we do the utmost to grasp the extent and consequences of human activities, and to control them?

Closer to home, the insight that technology is a prime evolutionary force leads to an interesting conclusion for the engineering profession. Many species use some sort of technology to adapt their surroundings, but the human capacities in this area are extreme, and brought about evolutionary success for the species. This implies that the human capacity for creating technology has been subject to evolutionary pressure, and therefore must have a genetic basis, at least partially or indirectly. Which in plain speech means that every human is an engineer. We shouldn't have to worry about influx ever again. ■

[1] R.C. Lewontin, Gene, *Organism* and Environment. In *Evolution from Molecule to Men*, edited by D.S. Bendall, Cambridge University Press, 1983.
[2] F. John Odling-Smee, Kevin N. Laland, Marcus W. Feldman, *Niche Construction – The Neglected Process in Evolution*. Monographs in Population Biology #37. Princeton University Press, 2003.

Xplore Your Master

By: Robin Steenbakkers

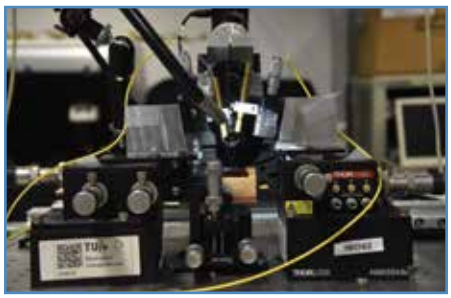
This year the StudentBody has been very active once again. We organized a dinner with the dean and program directors, we collected information for the prizes for the best teachers, organized a barbecue for the students and staff involved in the year councils, organized Xplore Your Master and of course the year councils themselves.

The organization of Xplore Your Master took much time this year due to a new setup. Instead of just attending the presentations, the day has been given a complete make-over. The research groups are spread over four days. One day with the research groups from outside our department, one day with the groups around floor two, one with groups from around floor five and one with groups around floor nine. The days started with a presentation from Harald van den Meerendonk about the master itself, after which the students went to all the different research groups. The first day was for the research groups from other departments. They all gave a presentation; this day was set up like the previous years. The other days the students were divided in three groups and they saw three different research groups in parallel. Each research group started their timeslot with a general presentation about their research group after which they took the students to their group to see some of the research projects that were done or that were still being done.

At the Electro-Optical Communications group the students were shown different project of different PhD students about the possibility of sharing information quicker through fibers and the techniques that are used for this. The students were listening attentively to the stories of the researchers. At the Electromagnetics group, the students were shown the anechoic chamber. In this chamber, the performance of the in-house designed antennas can be measured very accurately. Another PhD student told the students about channel sounding. Channel sounding is used to measure the performance of the wireless channel, in terms of reflections and losses. This is interesting since in 5G the frequencies increase (and thus the wavelength decreases), and objects like building, cars and trees will reflect and/or absorb the electromagnetic waves in a different way compared to 4G frequencies. The students were asking many questions to the research group personnel and were very enthusiastic. They were also asking a lot about doing a PhD and the master itself. These are some examples of the information the students received during the days.

After all the changes, the students were very enthusiastic about the new setup of Xplore Your Master. They saw much more about the research groups than they normally would have. They were able to get a better view of all the possibilities within a group of Electrical Engineering itself for that matter. But not only the students were very enthusiastic; also the staff members enjoyed the day. They found it a little difficult to decide which projects to show and what to tell the student. But they liked that the students were so enthusiastic. Because of the new design the research groups had more time to show the students everything and they also got motivated students because the students would decide beforehand which groups they found interesting and of which they wanted to attend the presentations.

After the success of Xplore Your Master, the StudentBody wanted to end the year just as positive with a nice barbecue. Every student that attended the year councils and helped improve the quality of our education was invited to this barbecue. Many decided to attend. But also a couple of employees involved with these year councils decided to attend. It was a nice barbecue with the students and the staff members. Everyone liked the food and the leftovers were divided over the other students who stayed in the building. ■



The complexity of automated wireless charging

At Prodrive Technologies we develop & deliver a wide range of highly competitive products, systems, and solutions which employ techniques that are highly efficient and often unique to Prodrive Technologies. We develop products for virtually every conceivable market in-house, using the very latest process techniques; most of which we have developed ourselves.

On average 50% of our design team is focused on (embedded) software development. Our architects and designers are part of many small, efficient & fully autonomous teams that are guaranteed all the facilities they need. These teams accomplish the research and development for our client's systems by utilising our state-of-the-art laboratory. Our average age is 28 and our part-time students, interns, and graduates all equally contribute to our success.

Almost two years ago, Prodrive Technologies started the development of an automatic wireless charging system (AWC) for electric vehicles. It eliminates the hassle of cables and plugs to charge the car battery.

In general the system consists out of three main components:

- A wall box mounted on the wall.
- A ground assembly located on the (garage) floor.
- A vehicle assembly mounted in the vehicle.

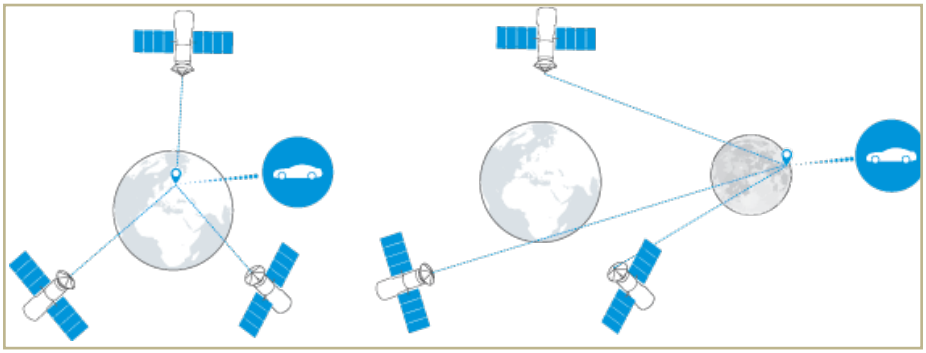
The wall box and the ground assembly run Linux as their OS. The vehicle assembly runs AUTOSAR, a software architecture specifically designed for automotive applications, which is currently the standard within the automotive industry.

The complexity of the system can already be seen by looking at the external interfaces involved:
WiFi - Used as access point while connected to the customer's home area network as client. Allows the user to configure the system via its web interface, hosted on the wallbox.
PLC - (power line communication) - Used to discover energy managers and smart meters. The PLC provides real-time information regarding the main's power limitations to ensure that the system does not cause a blackout at the customers' household.
WiFi - between ground and vehicle assembly - Based on developing standards to prepare for future interoperability.
CAN - Used to communicate between the vehicle assembly and the vehicle's on-board network. The vehicle assembly requires full integration in the car's CAN network.

TThe core functionality of the system is charging. Yet to ensure high-efficiency charging, the vehicle needs to be aligned within certain limits of the ground assembly. Therefore a vehicle guidance system (positioning) is a core part of the AWC system's functions. Next to this, the safety of the user and the system is guaranteed using two integrated safety-systems.

Our living object safety-system monitors the surface of the ground assembly using a network of sensors. A sleeping cat, or human limb above the ground assembly, must be detected to interrupt charging. This safety feature prevents exposure to the magnetic field between the ground assembly and vehicle assembly. When the cat leaves, charging automatically continues.

Inductive heating of metal objects on the ground assembly should also be prevented, as these objects may cause damage to the ground assembly surface by induced heat. Here lies a big challenge. Small metal objects need to be detected, whilst the metal of the vehicle above remains ignored. And one must not forget that this environment is rather dynamic.



PRODRIVE TECHNOLOGIES

False positives of the safety-system should be avoided as this requires user interaction and lowers the comfortable functioning of the system. Having to walk to your car after one of the safety system is triggered is considered to be a similar hassle to plugging in a cable.

The vehicle guidance system (POS) is developed to help the driver align their car to the optimal position above the ground assembly. The position of the ground assembly with respect to the vehicle is visualised on the vehicle's display and can also be used to automatically park above the ground assembly. The challenge for positioning is locating something that is outside the area encircled by antennas or beacons (with sub-centimeter accuracy). As an analogy; instead of locating an object on earth using GPS satellites, use those same satellites to locate an object on the moon.

Apart from these functions, there is also a connection to the household energy manager to ensure that the main fuse does not trip whilst simultaneously charging with 11 kW, and switching on your induction cooktop. That charging limit can be manually configured in a web-interface or dynamically controlled by an energy manager. Other functions of the web-interface include: managing charging statistics & multiple vehicles, updating firmware, etc.

Furthermore, the diversity of our software challenges are very broad; ranging from VHDL code (low level embedded) to a web-interface (application). The necessary software development includes: bootloaders, FPGAs, internal networking, system diagnostics, code generation from control models, (secured) flash partitioning, data storage, web development, security, etc. Typically used software tools are: MATLAB Simulink, Visual studio, Vivado, Vector automotive tooling, etc. ■

High-throughput testing for photonic chips

By: Sonja Knols-Jacobs

Photonic integration technology is on the verge of breaking through to large-scale production. But to be able to guarantee the quality of photonic integration circuits, tests that enable high throughput process control are essential. At the Photonic Integration group, PhD student Dzmitry Pustakhod developed high-throughput, high-quality testing methods for different levels in the production process.

In the semiconductor industry, standardized, automated testing procedures are applied to guarantee the quality and performance of the produced electronic circuits. For photonic circuits, the development of similar process control modules is more challenging. Electronic contacts have a large contact area, and can be found on top of the chip. Their optical counterparts are often only accessible from the side of the chip, so the wafer should be cleaved. And the access areas typically range from 10 micron to submicron dimensions.

As part of the NWO-TTW project ProCon, Dzmitry Pustakhod developed new methods to provide foundries with the means to test performance of the individual photonic building blocks and complete photonic circuits in a fast, detailed and reproducible way.

High level functional testing

'Before this project started, there were some testing methods available already,' Pustakhod says. 'But most of them are slow, hard to operate and require manual operation or inspection. Also, the vast majority of the previously available testing methods was aimed at detecting low-level errors in for example material properties or geometry. We focused on higher level functional testing on different levels,' he explains. 'Usually, foundries can only test individual building blocks and low-level processes. But they cannot measure circuits. Customers on the other hand can only measure circuits, and don't have any insights in the separate building blocks. We wanted to correlate those two, to identify if a problem in performance is caused by the circuit design, or by the fabrication process.'

Figure 1: Micrograph of the chip with test structures manufactured by Smart Photonics.

On a components level, Pustakhod developed methods to measure gain and absorption. 'Some of the challenges were which method to choose to get accurate data in a fast and reliable way, and how to design and develop the setup to actually perform the measurements. Furthermore, for the absorption measurements, we first had to gain full understanding of the behavior of the circuit to be able to interpret the spectra we were measuring.' This worked out well, and finally, he was able to model and calculate the expected absorption, and measure it reliably.

On a circuit level, a very sensitive, small-sized multi-wavelength meter was developed that is able to measure wavelengths with a resolution of 0,32 picometer (a millionth of a millionth of a meter), over a range of 10 nanometer. 'To our knowledge this is the best relative resolution currently available for these types of systems. Therefore, our method can also be relevant for sensing applications.'

Toward automated testing

All of the methods Pustakhod developed so far have been implemented in the standard practice of the PhI lab. 'With these methods, we can compare different fabrication processes or different wafers processed in the same foundry and get quick and reliable results. We will use this information to improve and calibrate our models further and optimize fabrication technology, closing the gap between design intent and product that can be manufactured. The final aim is to establish a complete infrastructure for automated testing, which enables a computer to automatically determine the quality of the produced chip, similar to the current practice in electronics.'

After defending his PhD thesis, Pustakhod will stay in Eindhoven: he has been appointed as a researcher at the recently established Photonic Integration Technology Center, where he will develop the testing methods further.

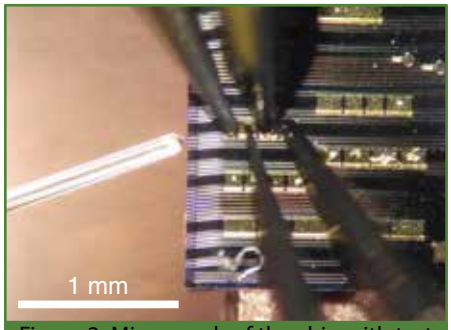


Figure 2: Micrograph of the chip with test structures manufactured in an MPW runby Smart Photonics. The chip is installed on a copper chuck and four electrical probeneedles are contacting the pads of the structure. The lensed fiber is aligned to the angled output waveguide

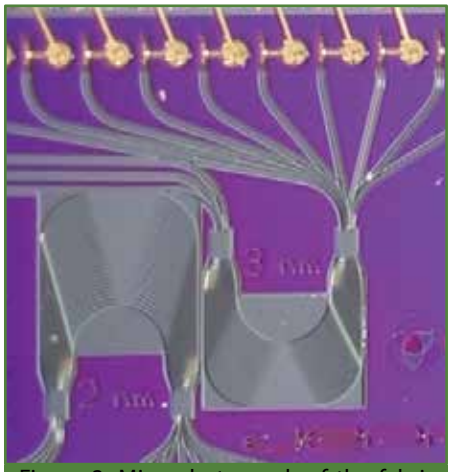


Figure 3: Microphotograph of the fabricated multi-wavelength meter, made by Oclaro

Dzmitry Pustakhod defended his thesis entitled 'Process Control Modules for Photonic Integration Technology' on Wednesday July 4th at Eindhoven University of Technology. Promotors prof. dr. K. A. Williams, dr. X. J. M. Leijtens. ■

Superfast indoor wireless networks

By: Sonja Knols-Jacobs

It is a growing source of frustration: poor indoor Wi-Fi coverage caused by the fact that a multitude of devices tries to connect to the same Wi-Fi router, which often is located inside a meter cabinet or utility room that attenuates the radio signal. Recently, two PhD students from the ECO group defended their theses in which they propose new solutions to enable high data rates indoor.

The basic idea both of the PhD candidates started to work on is to transport the data through optical fibers from the central unit in the meter cabinet to antenna access points within the various rooms in the building (a residential home, office building, hospital, shop, …). Such a fiber backbone network thus establishes wireless links with the users in those rooms, either by using optical wireless beams or radio wireless beams. This way, the wireless signal doesn't have to penetrate walls, and maximum signal quality and bandwidth can be guaranteed. An additional advantage is that the emitted wireless power can be minimized, thus elongating battery lifetimes of the user equipment.

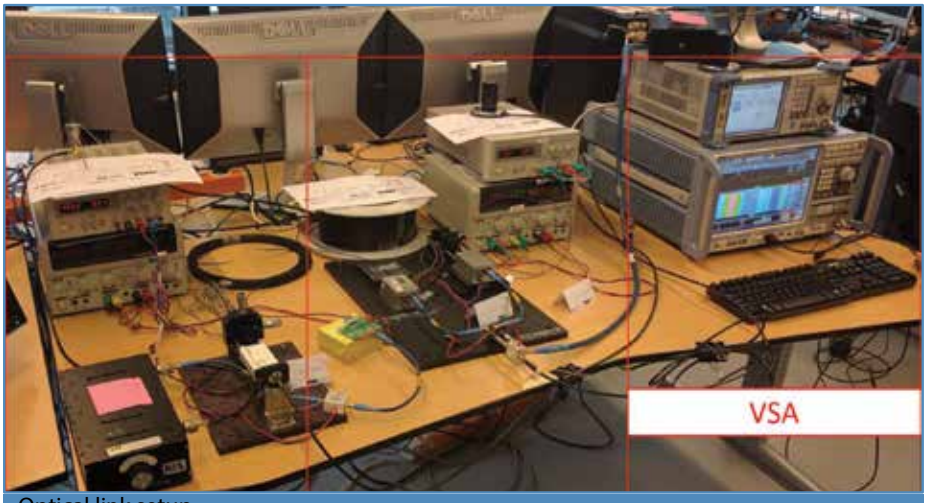
Do it yourself in-home technology with plastic optical fibres

As part of the NWO-funded FlexCom project, the first PhD student, Italian Federico Forni, together with the company Genexis explored the use of plastic optical fibers to transport the data to the different antenna access points in rooms. 'This set-up is aimed to be a relatively cheap do-it-yourself solution for in-home networks,' Forni explains. 'Plastic optical fibers are low-cost and very easy to use. The fibers have a large core diameter and you don't need any specific connectors. You just cut the fiber and plug it into the device, or put the bare fibers together in simple fiber-to-fiber connections. Furthermore, we use visible light to transmit the data, so if you see a red dot coming out of your fiber, you easily know it works.' Another advantage of Forni's set-up is that the central unit in the meter cabinet does all the processing, so that is the only component that has to be smart, and thus somewhat more expensive. The access units in the different rooms only need to contain a LED, a photodiode, an amplifier and an antenna, and can be relatively cheap.

Combining broadband services

The main problem Forni had to overcome was that plastic optical fibers in principle are only suitable to transport narrow bandwidth signals. 'But to keep things simple, we want to use these fibers to transmit Wi-Fi, 4G or 5G wireless signals, and baseband signals – the ones you use for your fixed phone line or smart TV – all together in a single fiber, and exactly in the way they are. We optimized the optical source, the fiber and the receivers and developed signal processing methods to enable equal but high-quality transmission of all of these types of signals.'

In experiments, Forni showed that this concept works rather well. 'We have successfully demonstrated the simultaneous transmission of both multi-gigabit baseband and radio signals over a 50-meter plastic fiber and 12-meter wireless link. I think plastic optical fibers are very promising to increase the available capacity of networks inside buildings and houses in the future in a cost-effective way.'



Optical link setup

Ultrahigh data rate communication with infrared optical beams

His colleague Ketemaw Mekonnen focused on a different configuration to achieve high data rates in indoor wireless networks. In the ERC-funded Advanced Grant BROWSE-project, the Ethiopian PhD student developed a revolutionary set-up that combines infrared wireless optical data transmission with flexible 60 GHz radio communication techniques to realize networks with very high upstream and downstream capacities.

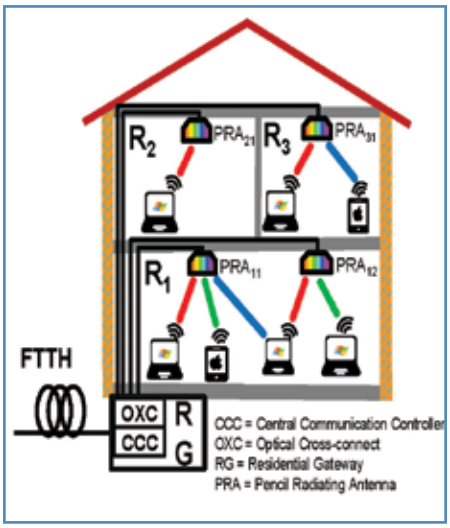
'I investigated three different configurations to realize high quality, fast bidirectional communication: all-optical-wireless, hybrid optical/radio-wireless, and all-optical-wireless backed-up with 60 GHz radio techniques. We have demonstrated that with these configurations it is possible to achieve both upstream and downstream transmission rates up to 50 gigabits per second, per user,' he says with pride.

Finding the user

One of the challenges of the proposed system is that the position of the user has to be known in order to setup the communication link. 'The optical beams we use for the wireless communication are narrow, so we need to localize the users with adequate resolution, which is difficult to achieve using the current radio-based localization techniques alone.' To overcome this problem, the student designed a radio-optical method in which the already mature radio localization techniques are employed to determine the estimated location of the access point with respect to the user terminal, and then the user sends out a wide-spectrum beam from an integrated transceiver unit towards the ceiling-mounted access point. The 2D gratings module at the access point in the ceiling then filters the appropriate wavelength according to the angle-of-arrival of the beam. This is facilitated by the narrow spatial filtering functionality of the gratings module which allows us to determine the wavelength required precisely. 'Every user is assigned a different wavelength depending on

his or her position, since the beam steering is wavelength-based. Every time the user moves to another location, the new wavelength is determined and the communication link is re-established.'

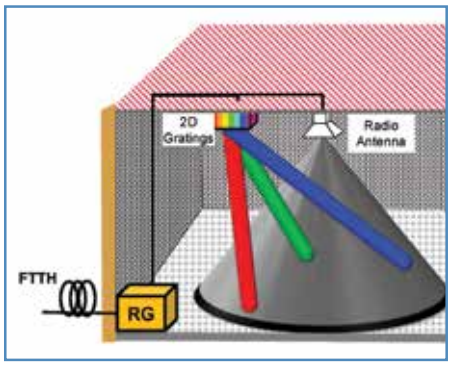
Another possible issue with optical wireless communication is that as soon as something blocks the line-of-sight between the user and the transceiver, the connection is lost. To guarantee continuous network connection, Mekonnen implemented a flexible 60 GHz radio system to provide the user with a lower speed back-up alternative in case of an optical link failure.



The indoor fiber backbone network then becomes crucial in orchestrating the overall functionality of the network, including the network management and control, the localization, and the optical and radio-wireless communication links in a dynamic and cost-efficient way, he says. Mekonnen developed a centralized network architecture, where costly components and all network control functions are kept at a central site somewhere in the building, where costs are shared. 'This way the access points and user terminals can be made simpler and more cost-efficient, and the whole capacity can be dynamically routed to the rooms where and when it is needed.'

Increasing the bandwidth during nomadic behavior

The system he developed is not meant to fully replace Wi-Fi, the PhD student emphasizes. This technology is meant for nomadic behavior, for example when office workers are using laptops and want to move but do not need to communicate when moving. If everyone is using Wi-Fi, the communication channel becomes congested. With this system, you can have the speed of a wired optical system in a wireless fashion. Other mobile users using low-to-moderate speeds are not hindered by you, and they can share the Wi-Fi bandwidth.'



Federico Forni defended his thesis entitled 'Indoor Optical Network Technologies for Multiple Services Provisioning' on Tuesday June 26th at Eindhoven University of Technology. Promotor prof.ir. A.M.J. Koonen, co-promotors dr.ir. E. Tangdiongga and N.C. Tran PhD (Genexis BV).

Ketemaw Mekonnen defended his thesis entitled 'Dynamic Ultrahigh-Capacity Indoor Wireless Communication Using Optical-Wireless and Millimeter-Wave Radio Techniques' on Thursday June 28th at Eindhoven University of Technology. Promotor prof.ir. A.M.J. Koonen, co-promotor dr.ir. E. Tangdiongga. ■

Time ticks faster at NIST

By: Sander Bronckers

Wait, what? What does that even mean? Literally? Or figuratively speaking? Well, NIST (the United States' National Institute of Standards and Technology) keeps track of time, more accurately than the current SI definition of the second. They achieve this by, among other things, using a higher frequency (optical) than 'conventional' atomic clocks (which run in the microwave regime). So, in that sense they have more 'ticks' per second. Their current record on keeping time is a relative precision of $2.5 \cdot 10^{-19}$ – that's roughly equivalent to a maximum deviation of 100 ms on the lifetime of the universe. Yet that's not all there is to it. More on that later.

Guest Researcher at NIST

I have been working as a visiting researcher in the metrology for wireless systems group at NIST for about two and a half months now, out of six months I will spend performing research here in Boulder. This falls under the umbrella of my PhD research on tunable smartphone antennas for 5G communications at TU/e within the Electromagnetics group.

NIST does a lot of work on metrology (the science of measuring) and has two main locations: Gaithersburg and Boulder. The Boulder location is the smaller of the two, and is situated on a Department of Commerce (which NIST is part of) campus shared with NOAA – an institute for meteorology. As you can see from Figure 1, this is quite a nice location. You can see some outliers of the Rocky Mountains, with a couple of the famous 'flat-irons' rock formations in the background. At their Boulder facilities, the research activities include cryogenics, frequency and time, and wireless systems. It is here that UTC (NIST) – NIST is a contributor to UTC time, their contribution being denoted by UTC (NIST) – is 'created', syncing, among other things, US official time and Wall Street transactions. UTC is created using a collection ('ensemble') of atomic clocks – cesium beam, and hydrogen maser. These, in turn, are periodically calibrated using a frequency reference (a cesium fountain atomic clock). So, in the end, this is the current reference for time. Getting to see this frequency reference was a really cool experience!

Antenna Measurements

While keeping track of time is very interesting, my own research at NIST is on over-the-air (OtA) measurements in reverberation ▶

chambers (RCs), more specifically antenna measurements in RCs. This is a relatively new approach to antenna measurements, which have conventionally been performed in anechoic chambers (ACs). The design of an antenna can be very challenging, and often has to be designed for a variety of requirements. Mostly the design is first tested and developed using simulations, but these simulations are not perfect. Therefore, the design should also be manufactured and measured. For the sake of this article, I will focus on a selection of antenna metrics, namely input reflection, radiation pattern and efficiency.

Figure 1: The NIST main building in Boulder. Some flatirons are visible in the background.

Since I am measuring at high frequencies (my own work is between 750 MHz and 6 GHz, but antenna measurements can extend into the terahertz regime), it is very hard to measure voltage and current. However, there are other ways a system can be characterized. When a wave travelling along a transmission line (which has its own impedance) encounters a change in impedance (mismatch), part of it will reflect. This information can be obtained from the (antenna or system's) S-parameters, which can be measured using a vector network analyzer (VNA). For a two-port system (i.e. two antennas) this is a 2x2 complex matrix for each frequency point. You can think of S21 (either of the diagonal elements), S11 (top left) and S22 (bottom right) as the transmission coefficient and reflection coefficients from port 1 and 2, respectively. For a single antenna only S11, the antenna's input reflection coefficient, remains. This impedance match of an antenna is assessed by looking at the antenna's input reflection, S11. Ideally, this is done under circumstances that are representative for the antenna's intended application. The radiation pattern gives the antenna's radiated power as a function of horizontal and/or vertical angle. Finally, the efficiency relates the input power (depending on the definition including or excluding the mismatch losses) and radiated power of the antenna. Which of these antenna metrics is most important depends on the application. This transfers to a choice of measurement method, as not all of these metrics can be accurately measured using a single method within a reasonable amount of time. So, let's have a look at the two different approaches: anechoic or reverberation.

The idea behind an anechoic chamber is to simulate infinitely extending free space. Such a chamber is usually constructed as a Faraday cage interiorly lined with absorbers, which usually have a pyramidal shape – as shown in Figure 2, a picture of the anechoic chamber at TU/e. The Faraday cage decreases the effect of outside interferers, while the absorbers are there to dampen a wave hitting them. Like most practical things, anechoic chambers are not perfect: the Faraday cage will leak, especially below (dominant H-field) or above (any gap becomes electrically large) the specified frequency range, and the absorbers will still reflect part of each wave that hits them. Still, an AC is very useful for antenna radiation pattern measurements. For this kind of measurement, the radiated power of an antenna under test (AUT) is measured as a function of its angles with respect to the horizontal and/or vertical line. However, a measurement of the antenna's efficiency requires a reference antenna, a path loss estimation, and an accurate directivity measurement. The latter requires us to measure the radiation pattern over the full sphere, a very time-consuming task. The obtained pattern is then integrated over all angles to obtain a single number – the directivity. In addition, the AUT will have to be somehow mounted in the chamber – which will disturb the radiation pattern, in particular at angles where the mount blocks the path between the AUT and the reference antenna.

Figure 2: Anechoic chamber at TU/e

The RC (one of those at NIST is shown in Figure 3) takes the opposite approach from an AC: instead of trying to dampen out all emitted radiation, we try to keep all radiated energy within the room for as long as possible. We still have the Faraday cage, but we don't line it with absorbers. So what will happen? Let's consider one specific frequency for the moment. If we have a rectangular metal cavity with a given source point, its boundary conditions will enforce a deterministic mode pattern in the room. For a very small room (compared to the wavelength) this might be a half-period of a sinusoid for the E-field in one of the three directions. As the frequency increases, the number of wavelengths that 'fits' in the room will increase. Now consider the addition of a large metal object within the room. The same principles apply, only now the mode pattern will be perturbed by this metal object. If we change the metal object, the mode pattern will again be different, and so on. The idea behind an RC is that, if we change the mode pattern in a quasi-random way, there will be a volume in the center of the room where the field distribution seen by an object is 'statistically uniform'. By that, we mean that, on average, the field distribution is the same everywhere within this volume (often called the working volume). In other words, we get rid of the angular dependence. Obviously, this means that we cannot obtain the radiation pattern any more. However, it also means that the integration over all angles is performed using physics! We also get rid of the effect of unwanted reflections

present in the AC, the need to align the antennas, and the need for an antenna holder (we can just use a piece of Styrofoam). And the input reflection can still be obtained by correctly averaging the measurement results.

Of course, in the real world the RC is not perfect. The metal walls will be lossy. The chamber will leak. The field samples for each stirrer position will not be independent. The fields, strictly speaking, become uniform only for an infinite amount of samples. Nevertheless, a good RC can have a quality factor in the tens of thousands, and we can perform experiments on how much we need to move the stirrer to get a new independent sample. The high quality factor of the chamber gives us another advantage: neighboring frequency points can be uncorrelated from the chamber's point of view, but correlated from the AUT's point of view. This means that we can, within a certain bandwidth, take the average not only over stirrer positions, but also over a frequency bandwidth. This way we can get very close to a practically near-infinite amount of samples. Of course, collecting more samples means that the measurement will take longer – yet it is usually still a fraction of the time required in an AC for antenna efficiency measurements. This, combined with the ease of setup in the RC, is why I'm focusing on RC measurements. There are still numerous challenges to overcome, which makes my work on this topic a lot of fun. For the moment, my goal is to devise a way to take the effect of a smartphone's user into account in these measurements.

Figure 3: one of NIST's reverberation chambers

Boulder

The NIST campus I'm working on is located in Boulder, Colorado. This is a town of about 110,000 people, roughly located between Denver and the Rocky Mountains, and houses several Colorado University (CU) campuses. It is over loomed by the 'flatirons' – several quite impressive rock formations. Actually, some people working at NIST are lucky (or unlucky?) enough to have a stunning view of these mountains from their labs, meeting rooms or offices. They are quite wonderful to explore if you like hiking - and once you're adjusted to the altitude, a hike up Green Mountain provides quite spectacular views of Boulder (Figure 4) and the mountains (Figure 5). The town is quite widely set up, and houses many (bicycle and hiking) trails to easily get from A to B without facing the USA rush hour traffic. People are very friendly and open-minded, and Boulder has a wonderful historic downtown shopping mall with lovely little restaurants and bars. There's an abundance of micro-breweries around, which often have their own pub, but don't expect the depth of flavor you get in a good Belgian beer. In the summer period there are music and other festivals downtown nearly every weekend. In terms of facilities Boulder has everything you need, but probably not everything you'd like. You have to get to Denver for that, but there's a good bus connection between the two. This is a great place to explore some mountainous terrain, experience the USA in daily life, be a part of some of the best research teams of the world, and last but not least make some friends!

So, How About Time?

To come back to the initial question – could it be that time actually flows at a different rate here at NIST? Yes. Of course, the main reason for time seeming to flow differently to me is that it has been a very busy exciting and rewarding period. It is very interesting to work with people dedicated to improving metrology. It's an often neglected topic within electrical engineering, yet it is critical to nearly everything we do.

Yet, the altitude of Boulder is about 1650m above sea level. This not only influences the atmospheric pressure, making it harder to breathe, but also time. Gravitational time dilation – a concept originally posed by Einstein which follows from relativity – states that time runs faster when further removed from a gravitational source. This was actually demonstrated by NIST scientists in 2010 using very accurate clocks at a height difference of 33 cm (!). Of course, these time differences (on the order of nanoseconds over a lifetime) are not noticeable. Yet, by measuring accurately enough, they are still there. How's that for a measurement. ■

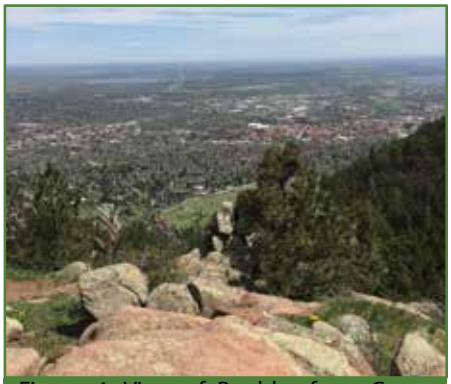


Figure 4: View of Boulder from Green Mountain


Figure 5: View of Rocky Mountains from Green Mountain

VIDI grant Pieter Harpe

By: Jan Vleeshouwers

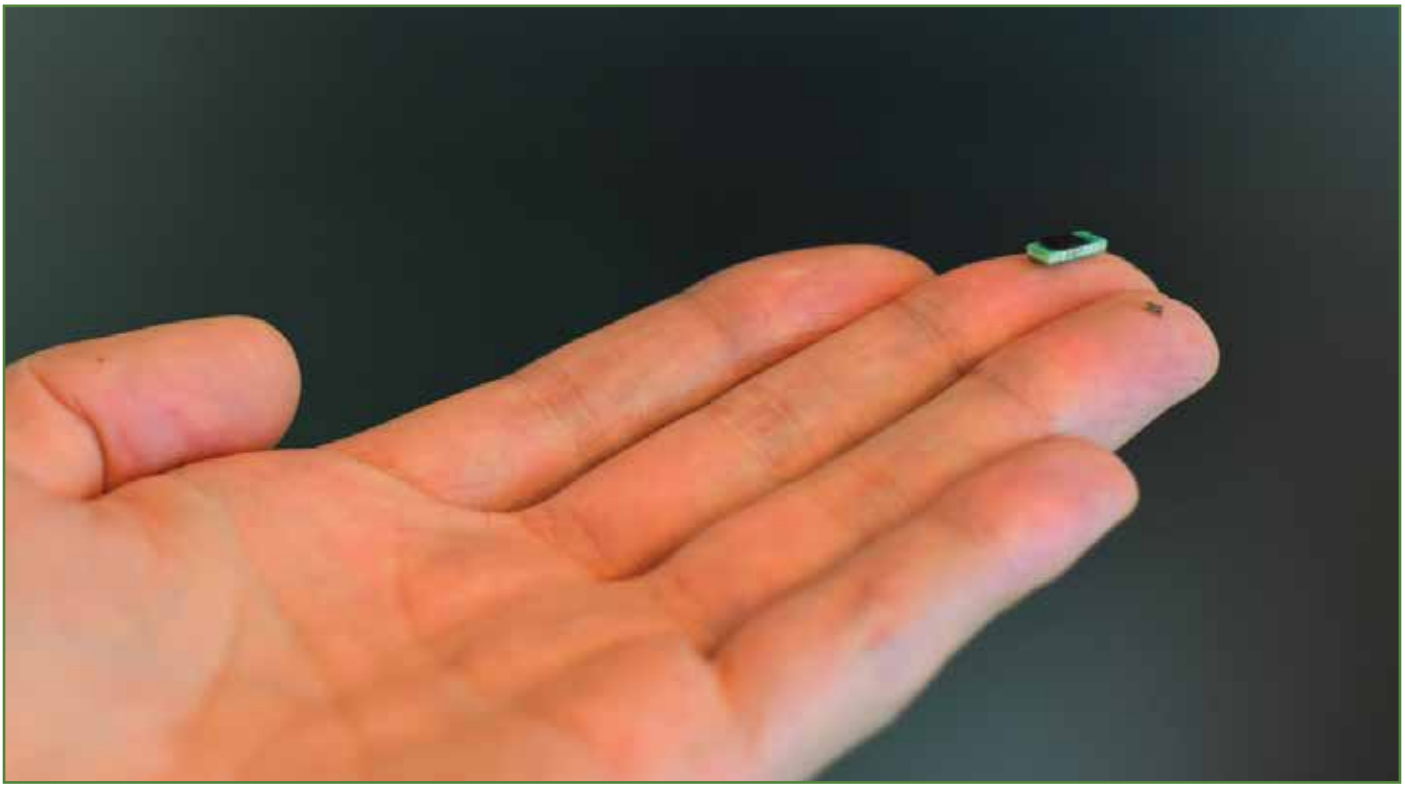
In June, Pieter Harpe received a VIDI grant from NWO, a personal grant to perform research which is primarily curiosity-driven but which may have a large impact on science and society. He works as an Associate Professor (UHD) in the Mixed-Signal Microelectronics group, on low-power electronics, often with application in the health area. The value of electronic circuits depends on a trade-off between functionality on the one hand, and the resources it needs on the other. More and more often, the resource use is becoming a crucial aspect, for instance in biomedical applications or internet-of-things. Such applications may pose strict limitations on how much power the circuitry can use, how easy it is to obtain the power, how much space the circuit requires, or on manufacturing and recycling aspects.

Pieter Harpe has always been fascinated by this side of electronics design. Instead of looking for the faster and the more powerful, he is primarily interested in creating desired functionality as unobtrusively and cheaply as possible. His VENI grant also addressed this issue. He created small and low-power configurable analog-to-digital converters, dissipating power in the order of nano-watts, while at the same time being widely applicable, so that mass fabrication and mass application becomes a realistic option. The picture below shows an example of a chip and a PCB made within this project. It contains a fully integrated circuit to measure, amplify and digitize physiological signals such as the electrocardiogram while consuming only 3nW.

His recently granted VIDI proposal will try to take resource efficiency a step further. Current attempts in achieving low resource use commonly start from given circuitry, which are then tweaked to perform with less power or space. Other researchers attempt to approach the problem from various far-fetched perspectives. Both lack the systematic character needed to bring much more designs to the level where we may qualify them as optimally resource efficient. So, Pieter will start with an attempt to formulate a systematic theoretical framework for designing resource efficient circuits. This framework will be sufficiently general to apply to a wide range of designs, and with a similarly wide range of resource limitations. But on the other hand, it will also be sufficiently specific to be applicable to concrete designs, of which he is planning to bring at least five to the prototype stage.

Pieter will spend about half of his time on this project, but he will be assisted by two PhD students, and he will have the faculty's facilities at his disposal for building designs based on his theory. He will also be assisted by a user's committee, in which various parties take part to provide feedback and support. In due time, he will also need master students for there will undoubtedly be all kinds of subtopics and sideway paths worth elaborating.

Of course, this is not the end of the road. Because if anything is resource-efficient, it is curiosity and creativity. The future will not only see very power-efficient circuits, but these will increasingly be stand-alone systems. They will provide for their own power, be it from sunlight, warmth, movement or chemicals, and they will also be more or less self-adapting, they will learn from their environment to behave optimal even if circumstances change. ■



The unknown face of Iraq

By: Sander Verdiessen

In the beginning of March 2017 I was sitting cramped in the back of a shared taxi in Iraq. Suddenly the driver started speeding up. At first I did not realize why, but after seeing a road sign it dawned on me. We were driving along the outskirts of Kirkuk. A city which was still partly under ISIS' control back then. I know what you must be thinking: 'Why would one travel to Iraq?'. Allow me to explain.

My journey started high up in the Zagros mountains at the border between Iraq and Iran after travelling in the latter. Leaving Iran was straightforward, but entering Iraq was the warmest of welcomes. All the border guards are smiling, friendly and they are all eager to hear where you are from and why you are visiting. One guard even asked my permission to add me on Facebook, although he never did. After a pleasant talk with the guard in charge I received a 30-day visa.

To clarify I visited the northern part of Iraq; Iraqi Kurdistan. This part is semi-autonomous with its own government and army. The region has struggled for independence for decades and the people were greatly oppressed during Saddam Hussein's reign. Remarkably the region is now one of the safest and most prosperous regions in Iraq. Their army, the Peshmerga, was the first to successfully fight against ISIS after the Iraqi army retreated. During this retreat they reportedly left behind a lot of their weaponry, which made ISIS significantly stronger. This bit of history is key to understanding the region.

After crossing the border I was not certain what lay ahead. If I was to trust the news I expected to see a big desert with hardly any vegetation. However, this was definitely not the case. After a scenic drive through the mountains I was met by lush green fields and a modern city called Erbil, where I spent most of my time in Iraq.

The city of Erbil is quite modern, but there are plenty of signs of the war against ISIS. Many construction sites are left abandoned, because many international corporations left the country when ISIS gained momentum. Despite the apparent economic turmoil people remain optimistic and have confidence in the future of the region. While in Erbil I met a group of students who showed me around and gave me great insights. All of them were studying and setting up their small businesses, showing the resourcefulness of the people in this region.

As the Mosul offensive was still raging during my visit there was a lot of military presence throughout my stay. Despite this I was reassured that the region is safe by everybody I met. I never felt unsafe throughout my visit.

Having explored Erbil and the surrounding areas I was invited to Sulaymaniyah by a hotel owner. I made my way to Sulaymaniyah, passing the city of Kirkuk, and got a very warm welcome. Surprisingly the hotel owner's cousin spoke fluent Dutch, because many people who sought refuge in Europe during the second Gulf war are now returning to Iraq. We spend the day walking around town meeting his childhood friends and family, discussing the history and future of Iraq and visiting some of the city's major sites.

The most impressive visit was that to a former prison during the reign of Saddam Hussein. Hundreds of Kurds were imprisoned and executed here. The writings on the wall were preserved behind some plexiglass and some were translated to English. One has stuck with me to this day. It read: 'I am a 15-year-old girl. The prison commander wrote down I am 18 years old, so that they can execute me tomorrow'. Next to this there are plaster statues of prisoners while they were being tortured. This left a lasting impression on me.

The main reason that I travel to places like Iraq is to challenge our believes of what a certain country is like. No matter how much war is going on there are always people living in these places with hopes and dreams very similar to our own. I hope this story has inspired you and convinced you to never judge a country and its people solely by what we see on the television.

This was one of the most insightful trips I have ever done. It clearly showed me that Iraq is not the same as it is portrayed by the international news media. I met many extremely friendly people who showed me that the best thing is to always stay optimistic and work for a better future. ■

High performance transceivers for optical interconnects in data centers

By: Sonja Knols-Jacobs

Our society is increasingly hungry for data. In the near future, data centers will have to transport hundreds of Gigabits of data per second within their networks. Since copper wires cannot cope with these gigantic data rates, researchers from the ECO group have developed photonic alternatives. PhD student Chenhui Li designed, produced and tested different cost-effective solutions to enable high bandwidth data transport at the lowest possible energy expense. Through his outstanding work, he has obtained the PhD title Cum Laude.

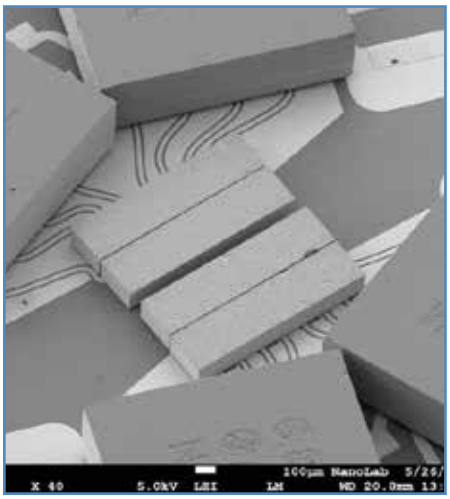
The PhD student came up with novel packaging concepts which enable powerful electro-optical transceivers that convert electrical signals used in data processing applications into an optical format used for high bandwidth transport, and vice versa. A transceiver consists of a transmitter unit, containing the laser driver and laser diode, and a receiver unit composed of a photodiode and data recovery circuits. Both of these units are combined in a package that establishes the electronic and optical connections to the outside world. Li developed new ways to package these transceivers in such a way that they consume much smaller footprint and thus enable considerable size reduction of the data server boards, yielding much higher data processing power in the same server volume.

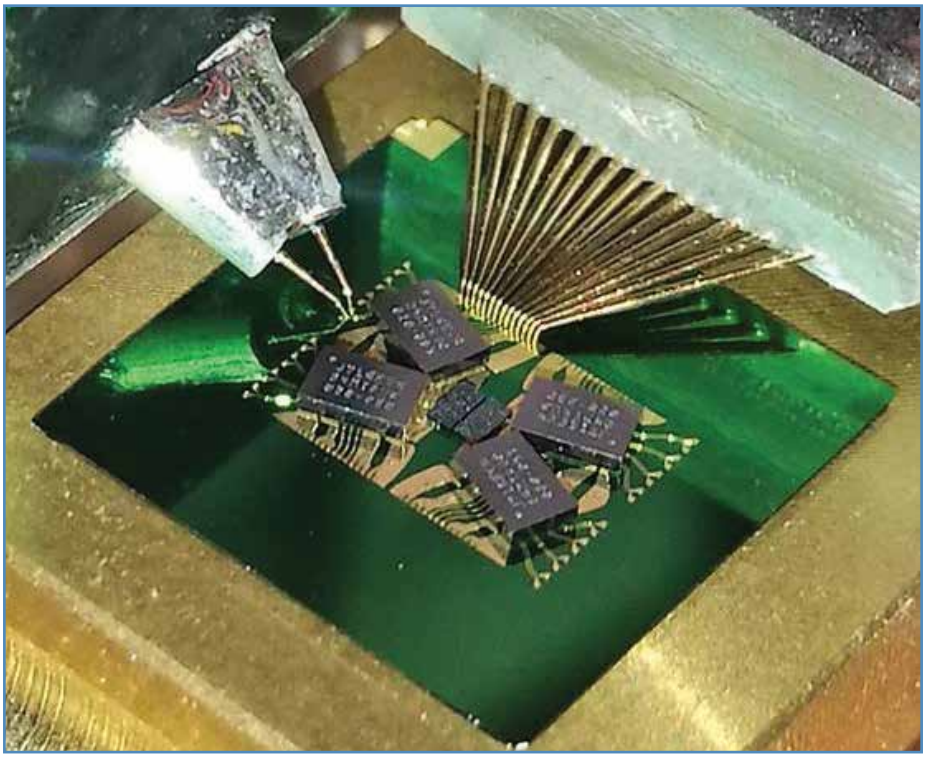
The main challenge was to develop a packaging solution that is small, relatively cheap and able to deal with large bandwidths, Li explains. 'We had to ensure the quality of both the electronic and optical connections, and develop solutions to disperse the heat that is generated in such a way that the transceiver can operate under optimal conditions.'

Silicon as multitasker

The PhD student proposed to make use of a silicon interposer: a silicon layer that enables both electronic connections and optical access, and at the same time acts as a heat sink. He developed a wet etching process to realize well-defined metal patterned areas in the silicon for positioning and light-to-chip coupling. With this process, he produced and tested three types of packaging.

In the first scheme he proposed, the optical and electronic components are placed side by side, embedded within the interposer. In the second scheme, the elements are also put inside the silicon, but this time on top of each other. Electrical information comes in on the top, and light is coupled out of the back via an array of lenses into twelve fiber channels. Li's most advanced scheme is based on this 3D-structure, but incorporates four optical components instead of one, leading to a smaller-sized chip (similar-sized module) that can handle four times as many optical channels, with specially designed two-dimensional optical access.





'We have developed a technology to package transceivers efficiently with higher channel counts and higher port- and bandwidth density, while taking up less space. We demonstrated that with these packaging schemes it is possible to realize ultra-compact receivers and transceivers that offer up to 10 gigabits per second per square millimeter bandwidth density,' Li concludes. 'Since we deliberately made use of commercially available chips, silicon that is widely used in CMOS technology, and existing technology for flip-chip bonding, our modules are close to being ready for production.' The PhD student has patented parts of the technology, and will stay in the ECO group as a postdoc to commercialize the platforms.

Chenhui Li defended his thesis entitled 'Silicon-Based Opto-Electronic Integration for High Bandwidth Density Optical Interconnects' on Wednesday June 27th at Eindhoven University of Technology. Promotoren prof. ir. A.M.J. Koonen and dr. O. Raz. He obtained the PhD degree Cum Laude. ■

Icons of EE: Claude Shannon

By: Matthijs van Oort

If we take a brief look at the history of mankind, we find that word of mouth has been the most used and easy way for people to communicate with each other. Nowadays however, much of the communication is done by means of something digital, whether it is sending a text via WhatsApp, surfing the internet or even just calling your granny by phone. And while digital communication is so big nowadays, there is no one who could understand a thing out of all these ones and zeros. Therefore, communication theory is very important for nowadays' society. And this is where Claude Shannon steps in, as being the founder of information theory.

Little Claude was born in the year 1916 in Petoskey in the state Michigan. He grew up in a descent family, with his father being a self-made business man and his mother being a language teacher. After finishing elementary, middle and high school, Shannon started getting interested in mechanics an electronics. He already started constructing his own circuits while still attending high school. One of his role models was Thomas Edison, who is famous for inventing the lightbulb.

In the year of 1932, Shannon entered the University of Michigan. He studied two bachelor programs at the same time, Electrical Engineering and Mathematics, which would help him a great deal in his future. After graduating from these two bachelors, Claude started his graduation work in the field of analog computing. Here he found out that by making a switching circuit, he could improve the telephone center relay systems which were active at that time. He even took this one step further by proving his circuits could fulfil all possible Boolean algebra problems. This new knowledge would become the fundamental building block for all digital computers. Eventually Shannon received a PhD degree at MIT in the year 1940.

After Claude received his degree, he started working for the Bell Labs. Because he joined Bell Labs during the time World War II was running through Europe, he spent most of his time on military concepts. He worked on different fields ranging from fire-control to cryptography. Eventually, at the end of the war, Shannon brought out a paper which included the smoothing of data, which describes the problem of separating a signal from interfering noise. Initially this was designed for fire-control systems, but it turned out this could be used for any kind of data system.

In 1948, the Bell Labs published an article about the work Shannon had done in the field of information theory, which is called 'A mathematical theory of communication'. In this paper, Claude describes what is the best way to encode information into a transmitted signal. He describes how he analyses the problem with help of the probability theory.

Next to only doing research and writing papers, Shannon made some practical implementations as well. For example, he built an electromagnetic mouse which could learn itself how to go through a labyrinth of 25 squares. When this mouse has passed through the labyrinth a couple of times, it is able to find his way out autonomously on any random spot. Therefore, this was one of the first artificial learning devices. Next to creating mice, Claude also worked on complex computer programs. He created a chess program which could solve a game of chess in 1949, and while it wasn't as good as it is nowadays, it was able to handle basic strategies.

After doing all this research at Bell Labs, Claude returned to the place where he became a PhD, the Massachusetts Institute of Technology. This time he became a teacher and therefore fulfilled his role to teach new students the lessons he has learned in his life as a researcher. Shannon eventually died in 2001 from the Alzheimer disease.

Overall, Shannon helped creating the world we live in comfortably today. Without his work, the digital world surrounding us would not exist (or at least in another way), and it would not have been possible to write this article. Therefore, we can be thankful for his work and dedication to information technology. ■

Internship in Texas

By: Sebastiaan Goossens

At some point in your master studies every student has to do an internship, preferably abroad. Some people already have a very good idea about where they want to do their internship long before it starts, while others just wait and see what is available when the time comes. Personally, I more or less fell in the second category. I was spending my time finishing all my courses so I didn't need to worry about them anymore. What I did decide already was that I wanted to do my graduation at the Electro-Optical Communications (ECO) group, and when I was contacted with an offer to do an internship in the United States of America, I didn't have to think twice. Who wouldn't take the opportunity to go to (almost) the other side of the world?

After an initial delay of three months, which I used to do all kinds of technical preparations, we were ready to start the visa application process. But, I quickly realized that getting into the USA is not straightforward at all. In total, I think it took me over a month and a half of filling in paperwork and performing all kinds of tests and background checks before I finally was able to apply for an internship visa, which then took another one or two weeks to process. In the end, I received my passport with visa with less than three weeks to spare before I had my flight, which was a bit too much of a close call for my taste. So already some piece of advice for anyone who is planning to do an internship in the USA: start as early as possible with your visa application.

The internship was performed at Fujitsu Laboratories of America, Inc. This company is the research and development section of Fujitsu Ltd, which is a multinational based in Japan with over 150,000 employees worldwide, and mainly focuses on information technology equipment and services. For me, this was an excellent opportunity to experience working in a multinational environment and do research in an area which is very relevant for my studies, which was researching certain techniques for optimizing optical-fiber communications.

Who wouldn't take the opportunity to go to (almost) the other side of the world?

My department within Fujitsu is located in Richardson, Texas, which is a suburb of Dallas city. With my internship starting on the 1st of March, I arrived on the 25th of February at Dallas/Fort-Worth airport after a total flight time of over twelve hours. I immediately noticed that everything in the USA, and especially in Texas, is enormous. The airport is one of the busiest and largest in the world (it occupies more space than Manhattan Island). Texas has plenty of open land and thus everything is built very widespread. Generally, a lot of the houses and buildings have similar constructions with a low amount of stories, compared to what we are used to in the Netherlands. The exception is the city center, which houses some enormous skyscrapers.

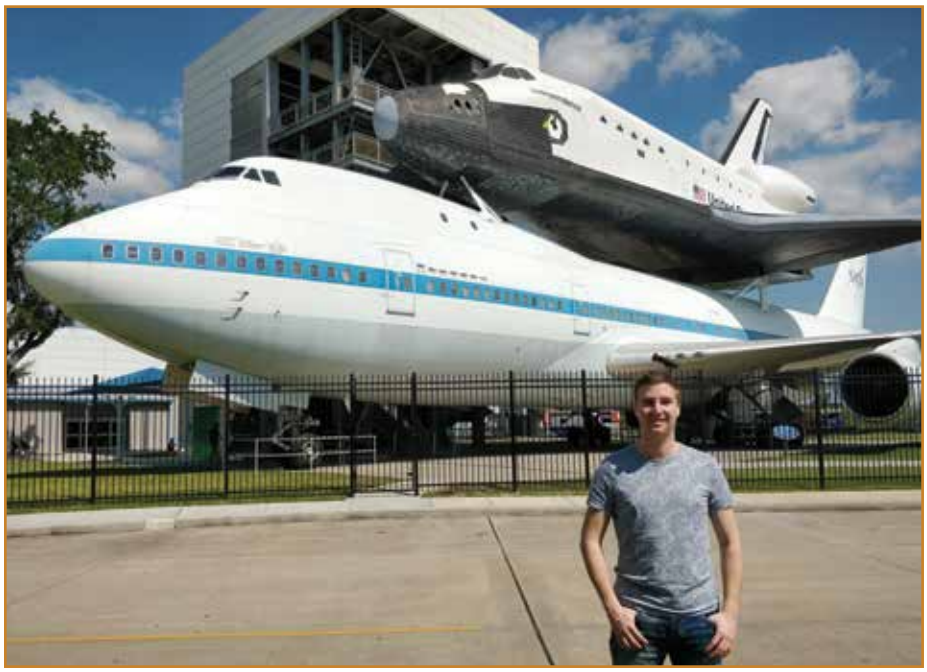
After taking an Uber from the airport to my apartment in Plano, which is another suburb of Dallas near Richardson, I began to realize how different transportation is in Texas compared to the Netherlands. Literally everywhere in the city you will find highways with an amount of lanes often not even countable on two hands. Dallas is so huge that it took over half an hour of driving at maximum speed on the highway to get to my apartment.

One of the first things I did when I arrived there was searching for a way to get a USA mobile phone number. The new European rules with free roaming are nice and all, but they don't hold for the USA, so this was a necessity to be reachable. I found a mobile store in a mall across the highway pretty close by. When I found out my apartment complex provided free of charge bicycles to be used by inhabitants, I of course used one of those, like a typical Dutchman. Actually, as far as I could tell, during my whole internship I was the only person who used the bikes, apparently with good reason. Infrastructure in Texas other than for cars is more or less non-existent. While trying to get to the mall, I had to cross multiple large roads with no facilities for pedestrians or bikers, travel over shady roads with no bicycle paths, and even finding a way to get to the other side of the highway was a disaster. So, what could have been two

minutes of driving by car took me over half an hour on bicycle. Because car insurance is extremely expensive for people under the age of 25 (I was 24), hiring or buying a car wasn't really a good option. It was literally cheaper to use Uber every day.

This brings me to my solution of how I got around during my stay in Dallas. As noted before, car and bicycle were not really an option, and public transport in Texas is close to non-existent, although in recent years things had improved a bit. I was pretty lucky and I found an apartment which was very near a bus/train station which had a direct bus connection to my internship company, and had a train line going to the city center. Apartments near this location were on the more expensive side of the spectrum, but in the end I saved a lot of money by being able to use public transport to move to certain areas. If I wanted to go anywhere else, like doing grocery shopping, I just used Uber, which actually worked very well.

So, I was all set to go for my three month internship at Fujitsu. I worked at a campus which housed over 1000 employees, mostly local Americans, but my department housed about ten employees, whom originated from all over the world. Next to this, the company has strong Japanese roots, which was clearly visible in the higher executive layers and in the way the company vision is expressed. It was really interesting to work in such an environment and speak to people of all these different cultures.



One of the things to note in Texas is of course the weather. Arriving there in February, it was a very acceptable 20 °C during the day, but during the last two months of my stay this turned into nonstop temperatures of over 30-35 °C for multiple weeks at a time with peaks of almost 40 °C. This made being outside a burden in itself sometimes, making air-conditioning a must-have. Even though I was in Texas during the official tornado season, I almost didn't have any rain or storms at all. I only had one official tornado warning, but luckily this did not develop into a full tornado, and when it rained, it was extreme: very hard and very much in a short time. Most of the time however, it was comparable to the heatwaves we had in the Netherlands this year, only even hotter still, which is apparently the norm over there.

Of course, while I was in the USA, I visited some interesting places in the neighborhood. One of the most notable attractions of all is in the city of Fort Worth, which houses a preserved cowboy village called The Stockyards. In here, cowboys still exercise traditions as they existed back in the days of the Wild West, with a weekly rodeo show, daily cattle drive and Billy Bob's Country & Western Nightclub being the main attractions. Next to this, the city of Dallas is famous for being the place where the murder on President John F. Kennedy took place, and offering tours and museums dedicated to this event. I also made a trip to Houston, where I visited the Houston Space Center.

After finishing my internship, I still had two weeks left before I had my flight back to The Netherlands. I took this opportunity to escape the burning heat, and made a small detour to the city of New York for a few days and visit all the standard things any tourist would go to.

In conclusion, my four months in the USA have been an awesome experience. I not only learned a lot in my own area of study, but also on a cultural level. I have met a lot of interesting people and I encountered numerous challenges I wouldn't have had if I didn't go abroad. Therefore, going abroad for your internship is something I can really recommend to everyone! ■

Puzzle

What is the answer to the question being asked?

110011101001000100110011100110011110110

101100101100110010011101101001111010111

001010010000101011101011010110010110011

010010001111101011111000101001001101001

011111111010111001001000101110010000100

111010011100111011101100110011100111011

000011001011000110101101100111010010011

111111010111100011010010011001111111110

101100001100101011001111111110101

Hint: The first words are: As this is

Objective / Rules

As EE and AT students love binary code, here is a binary code contest.

The contest consists of a binary code transmission where the spaces between the letters are missing and there is no punctuation.

Each letter of the alphabet was translated into its binary equivalent based on its position in the alphabet:

a=1, b=10, c=11, d=100, e=101, f=110, g=111, h=1000, i=1001, j=1010, k=1011, l=1100, m=1101, n=1110, o=1111, p=10000, q=10001, r=10010, s=10011, t=10100, u=10101, v=10110, w=10111, x=11000, y=11001, z=11010.

Solution: Whose desk is this?

The desk on page 9 belongs to Dusan Milosevic.

Winner previous puzzle

The winner of the previous puzzle is Elles Raaijmakers

These are the numbers 1, 2, 3, etc, as seen on a calculator, but the digits were then cut in half and the left half was then mirrored.

Puzzle solution June edition (Connecthor 42)

Elles with her prize

Where did it all begin?

By: Tom van Nunen

Sometimes I can't help but think: how did we get where we are now? And I don't mean that on an individual basis, or as a university, but rather as a species. When did we start becoming what we are now?

I guess it started more or less by accident, as lots of things in evolution start with random changes in DNA. Some apes became smarter than the rest and thought: hey, let's start cruising around in search for food, and maybe even follow that herd of animals. They also started using stones, sticks and bones as tools.

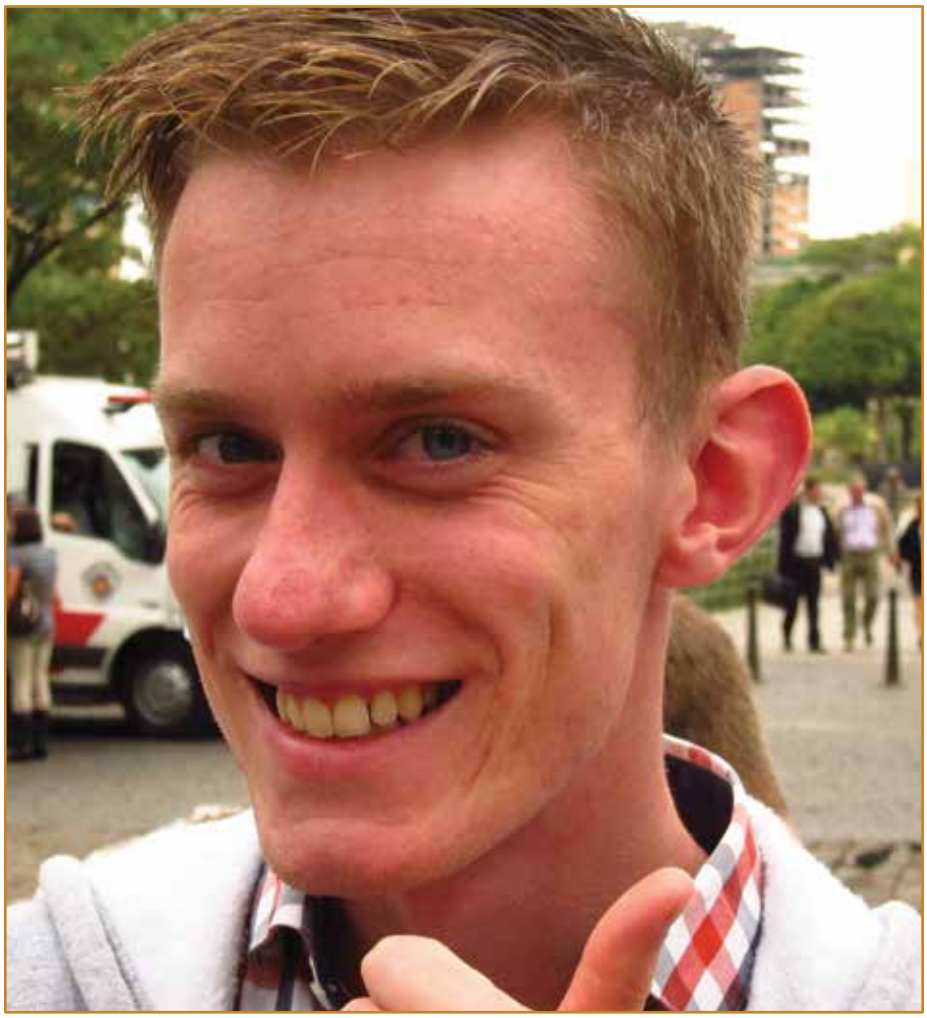
Over the time, they invented hunting equipment and canoes, and even thought that it would be a good idea to train wolves to aid them in the hunting process. After so many days, the group would have to pack all their primitive houses and travel to a new location, simply because they had eaten all the food in the neighborhood.

Can you imagine what their life would have looked like? I suppose they spent almost all the time they had on just making sure they had something to eat. Hunting, gathering, making fire, traveling to new areas.

How would these people react when they ran into another group of hunters and gatherers? Would they be happy to find new people of their kind? Would they join them? Would they be angry because this meant they had to share the same amount of food with more people? Would they start fights?

Then something very interesting happened: they found out that, instead of traveling around in search for food, they could just make large fields and grow all the food they desired. It didn't take them long to find out that they could also build fences to keep cattle, instead of hunting every day. My guess is that this started when they discovered that not only humans, but also animals like it a lot when they find a field full of crops, and they had to find a solution fast. They must have realized that a fence to keep animals out, could also be used to keep animals in.

Of course, I wasn't there to judge, but I think this is one of the most crucial steps in human history. From now on, gathering food took less effort and the supply was steadier. This meant that suddenly they had time to spend



on other activities. It also meant that they could get rid of their tents, and instead build decent houses out of stronger materials.

I'm guessing that they became curious and wanted to do useful things with the extra time they had now. They must have started exploring the possibilities of the world around them; cross-breeding plants, pottery, creating decent houses, but also a basic form of politics and division of labor in general. The motivation must have been to make life even easier and to prevent trouble.

The discovery of metals must have been another huge step in the right direction, enabling better tools and various other things.

Of course, this was only the bare beginning, and an uncountable number of inventions and events have happened between then and now, but still, this is where it started, this is where we started distinguishing our species from other animals. There are various species that use tools and/or make decent houses, there are even some primates that have entered the stone age, but still the distinction is clear.

To me, it's just fascinating to think about it. The path from being above-average apes to what we are now, from stone tools to the high-tech systems we produce now, from a handful of daily tasks for the whole village to the countless things that happen every day nowadays. It's just beautiful. ■