TU/e

connecthor 46

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June 2019

Career day | Rocket Launch | PhD research | WinThorsport | Mythology | **Internship** abroad

Connecthor

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You have just opened the Connecthor magazine, the June issue. Again we have managed to gather articles which, we hope, might catch your interest.

On the cover of this quarter's magazine you will see the REXUS 25 rocket being launched from the Esrange Space Center in Sweden on March 11th. Mark van Wijkvliet writes about the PR3 experiment. Perry van Schaijk writes about his PhD research on insensitive integrated laser. Alumnus Johan van Uden graduated in February 2014. Johan shares his life thus far after his graduation with you.

Jasper Sleumer did his internship abroad in Seattle, USA. He writes enthusiastically about his four-month experience fulfilling his American dream. e.t.s.v. Thor organized a Career Day this year for only Electrical Engineering and Automotive Technology students. The intent of this day was to organize a smaller, easier accessible and trimmed down version of the Career Expo from Wervingsdagen. Martyn van Dijke writes about this successful first event.

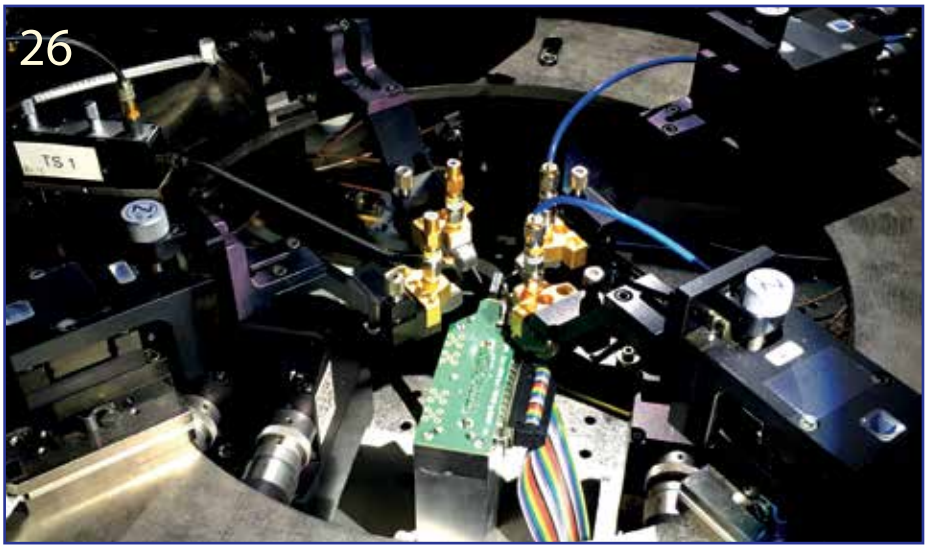
In consultation, we have decided to re-run Massimo Mischi's article from the March edition, since the coloring during the printing process didn't go well which caused the pictures to be poorly visible.

We hereby take the opportunity to say goodbye to a bunch of editorial-board members: Birgit van Huijgevoort, Fer Radstake, Lisa Teunissen, who have been long-time members, and Mariska van der Struijk and Marrit Jen Hong Li. Thank you for your hard work. You will all be missed.

For most of us, it's almost time for holiday, time to recharge, time to get back into shape for yet another busy and lively year. We wish you a wonderful summer holiday. Enjoy yourselves!

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. ■



Feedback insensitive integrated laser
Read more on Perry van Schaik his PhD research on integrated lasers page 23

Algeria like a local student.
Read all about the wonderful experience of sander in Alegria on page 25

Intership Abroad
Still wondering where to go for your intership? You can find a good example on page 18

Career after EE
Still wondering about what career you could take after EE? Read more about Johan van Uden his job on page 26.

How to deal with growth?

By: Ton Koonen

As a department, we have to prepare ourselves for growth. We are enjoying a healthy growth of the number of students opting for a career in Electrical Engineering. They choose for the TU/e to get a solid base for this career, and this brings a heavy education load. Industry, especially in our Brainport region, is anxiously looking for creative technical talent, and very much wants to recruit our graduates. E.g., ASML is looking for thousands of new hires this year… Moreover, the horizon of industry gets ever shorter, they need to introduce new products into the market ever faster, and hence have less time and resources available for mid- let alone long-term research. They are therefore eager to establish research cooperation programmes with us, which can bring them new ideas and as a valuable additional benefit also bring them into contact with young talented academic researchers who may opt for a career with them. Fortunately, our government has recognised these education and research needs. We were invited to share our ideas on how to strengthen the EE field in the Netherlands further, and to lay these ideas down in a proposal for funding in the framework of the so-called 'Sectorplannen Techniek'. This government funding is meant to strategically expand the scientific staff, with assistant professor, associate professor as well as full professor positions. At the TU/e side, the departments Electrical Engineering, Mechanical Engineering and Built Environment were invited to describe their ideas for the Sectorplannen Techniek.

Together with our EE colleagues at TU Delft and University of Twente we had a number of meetings to align each other's ideas about Electrical Engineering. We defined a limited number (no more than three was the target given) of focus areas in each university such that these areas complement each other, while building and extending strengths as well. For our EE department, this resulted in the focus areas Signal processing and imaging, Communication, and Cyber-physical systems. TU/e wants to profile itself as a high-tech systems university with strong links to industry, and as such, these areas match very well to the university's profile.

In the area Signal processing and imaging, we intend to expand our strengths in patient monitoring and image analysis (including data engineering and artificial intelligence) for applications in early medical diagnosis and personalized (elderly) healthcare. This will involve the development of systems with many sensors and the communication technologies to gather the data from them.

In the area Communication, we intend to further augment the research activities in integrated photonics and optical communication techniques, and in the wireless communication beyond 5G, with special attention for the symbiosis of these two domains. These activities are to address the booming needs in our increasingly networked society.

In the area Cyber-physical systems, research in complex hardware & software-based systems is to be strengthened, including activities in control theory, computing hardware and software, and the digital and analogue electronics facilitating all this. Application areas are high-tech systems such as

wafer steppers, high-resolution electro-mechanical actuators, electrical energy grids, etc.

For these three focus areas, after a careful inventory of the strategic long-term plans of our EE groups and their key future research directions, a number of positions have been defined in more detail. If the Sectorplannen will be approved, it is expected that more than two million euro per year for six years will be coming to us from these Sectorplannen funds. And that will imply that more than twelve new staff positions have to be filled.

Moreover, our TU/e Board in its Strategy 2030 plans has defined six so-called Cross-disciplinary Research Themes (CRTs), in order to stimulate research cooperation between various disciplines. Our EE department will be involved in several of those, which implies that another two million euro is expected to come to us for appointing PhD students and additional laboratory equipment. These CRT funds will further add to the strengths to be built up by the Sectorplannen.

So we are getting into a kind of 'luxury problem'… There will be significant amounts of money available, which is of course very good at one hand, but on the other hand it is quite a challenge to find and recruit the talented people to do all these extra efforts. So that holds for staff positions, but also for PhD and Postdoc positions. And all that needs to happen in a timeframe wherein also industry is recruiting heavily… Obviously, working in industry is quite different from working in academia, each world has its particular attractions. But given the fact mentioned before that industry has ever less time and resources to do (applied) research, these worlds are more and more coming together. Research programmes set up and run together with industrial partners allow young academicians to enjoy both worlds, and make a well-balanced choice for one or the other. To help mastering the recruitment challenge, our university has opened specific positions for recruiters, who will actively scan and address the job market, and assist in identifying and selecting candidates; already three recruiters have been appointed. Also, advertisements for the openings have been launched. You are invited to a look at the website, https://www.tue.nl/en/our-university/departments/electrical-engineering/department/working-at-electrical-engineering/. Please spread the word, and do not hesitate to trigger (potentially) interested candidates to visit the website and to reflect on these openings. Your support to master this luxury problem in getting more people on board, and thus to secure a great future for our department, is highly appreciated! ■

Graduates January and April 2019

Louis Daniël van Harten
Robbert-Jan de Jager
Tom Hendricus Gerardus Franciscus Bakkes
Petrus Wilhelmus Maria van den Boom
Joshua Riet Mobach
Michelle Catharina Adriana van Grinsven
Sjors van Riel

Congratulations!

Bram Witteman
Stefan Eijsvogel
Vivek Narayanan Sekhar
Koen Jeukendrup
Yilun Yu
Misha Bekker
Pascal Den Boef
Athina Ilioudi
Stijn Adrianus Wilhelmus van der Linden

Congratulations!

Bas Jacob Groenen
Sander Hendrikus Petrus Sebregts
Shashank Singh
Thom Thomas Wilhelmus Maria Christina Overhof
John Van Truong
Coen Peter Joseph Beurskens

Congratulations!

ASSOCIATION

From the President

By: Dana de Vreede

During my board year I have learned a lot of new things, but one of the most subtle and most unexpected things I have gained, is the growing appreciation for numbers. It started out with the concept of time, something which is going too fast at one moment and does not seem to pass the next moment. During this year, I have gotten used to waking up at 07:16 when I am to be the first one in the Boardroom that day. You may ask yourself, why this odd time?

As long as I can remember, I have had the tendency to set my alarm at either 1, 2, 16, 37, 47 or 53 minutes past the hour. My conclusion was that I just don't like waking up at round hours. Why exactly I am drawn to those numbers I have never truly figured out, but I have accepted it anyway.

I have always liked playing with numbers, either in my head or on paper. In elementary school I was challenged with sudoku puzzles when I finished the tasks set for the week. I still enjoy solving logical puzzles such as sudoku, tectonic and hitori, which is why almost everywhere I go I have a puzzle booklet with me to make sure I can pass time faster when necessary. In secondary school my fascination with numbers still existed. I liked linking numbers to each other in any way possible, even if it seemed to be the weirdest connection possible.

About four years ago I finally decided what my favorite number would be, the number 4999. The number itself can be split in 49 en 99, which can be split into 7*7 and 11*9 and the last can be split into 11*(3*3). For you this might seem like just a random set of numbers, but I have always liked 3, 7, 11, 49 and 99, so finding out this combination made me especially excited about this number. What made 4999 even better, is the fact that it is also a twin prime number, a prime number two more or two less than another prime number. In this case 4999 is a twin prime with 5001, which is again just 1 off of the round number.

I have noticed that in life, and especially during busy periods such as a board year, it is important to enjoy the little things in your everyday life. For instance, every morning when I ride my bike to the university and pass by the bicycle counter, I check how many people were there before me. It's a number that differs a lot during the week. I have noticed that Monday and Friday mornings seem to be less popular than the other days of the week.

Whatever it is that delivers these little bits of happiness for you, make sure you hold on to it. Whether it is skating in your free time, coloring in a beautiful picture during a (little bit) boring meeting, enthusiastically reacting to every new good or bad idea or whatever. Make sure that, however busy you might be and whatever you have to do, you take time to enjoy what you do. When you take the time to enjoy what you're doing, the time passing by so fast does not seem like such big a deal anymore.

Veel gedonder!
Dana de Vreede
President of Thor ■

Human intelligence in biomedical diagnostics

By: Massimo Mischi

This article is reprinted from Connecthor 45

Biomedical diagnostics makes extensive use of imaging and monitoring technology. Accurate diagnostics are vital for better patient outcome and reduced healthcare costs as it facilitates timely and less invasive treatment. Biosignal analysis plays a major role in improving biomedical diagnostics. In contrast to recent trends, where artificial intelligence (AI) is employed as a black box tool for biosignal analysis, I would like to put human intelligence in the spotlight. Driven by clinical need, biosignal analysis techniques are developed that include understanding and accurate modeling of the full measurement chain: pathophysiological sources, sensing physics, and signal acquisition. Emerging AI tools can then contribute to enhance our understanding and improve our models. Based on these models, personalized diagnosis can be achieved, paving the way for patient-centered medicine.

Healthcare challenge

Today we are facing an epochal challenge because of the exploding demand and cost for the healthcare system caused by our greying society (30% over 65 by 2060 in Europe) and related increase in chronic and age-related diseases. This cannot be paralleled by an adequate increase in the financial and professional volume available for caregiving. In this situation, how can our society still guarantee high-quality care and assistance?

Biomedical diagnostics

I firmly believe that the answer lies in technological innovation aimed at transforming the healthcare continuum by reverting the order of the conventional pathways for caregiving. In particular, biomedical diagnostics plays a fundamental role in this process. Timely diagnosis is essential for effective prevention of disease progression and patient deterioration, and for limiting the disease to levels that can be treated either at home or by minimally-invasive intervention in the hospital.

Already the etymology of the term, diagnosis, suggests a strong link with the human drive to learn, which is central in our academic world. From ancient Greek, "dia" meaning "apart" and "gignoskein" meaning "to learn". As a whole, diagnosis means to discern and distinguish between different conditions, for instance between benign and malignant tissue. It is therefore the result of a learning process, referred to as diagnostics, which aims at understanding our (patho) physiology to detect and evaluate the onset and development of diseases.

Modeling the full measurement-chain

Physiology and pathophysiology, although already complex and not fully understood, represent only the first step of the measurement chain providing medical doctors with the inputs to make their diagnosis, such as biomedical signals and images. Correct interpretation of these inputs requires understanding of the full measurement chain (Figure 1), from the (patho)physiological sources, to the physics underlying the sensing process, up to the electronics conditioning the measured signals and/or forming the displayed images.

Based on our understanding of the full measurement chain, parametric mathematical models can be created that describe the measured (patho)physiological processes also accounting for the adopted measurement process. Modelling and parameter estimation lead to the generation of quantitative representations of the physiological parameters of interest. Quantitative rather than qualitative representations facilitate the clinical interpretation and diagnosis, enabling objective evaluations that are more accurate and reproducible.

Besides providing quantitative information, model-based analysis of biomedical signals also allows adjusting the model parameters to account for specific patient conditions. This is a fundamental step towards enabling patient-specific medicine, starting with a diagnosis that is personalized and tailored to specific conditions. Moreover, understanding

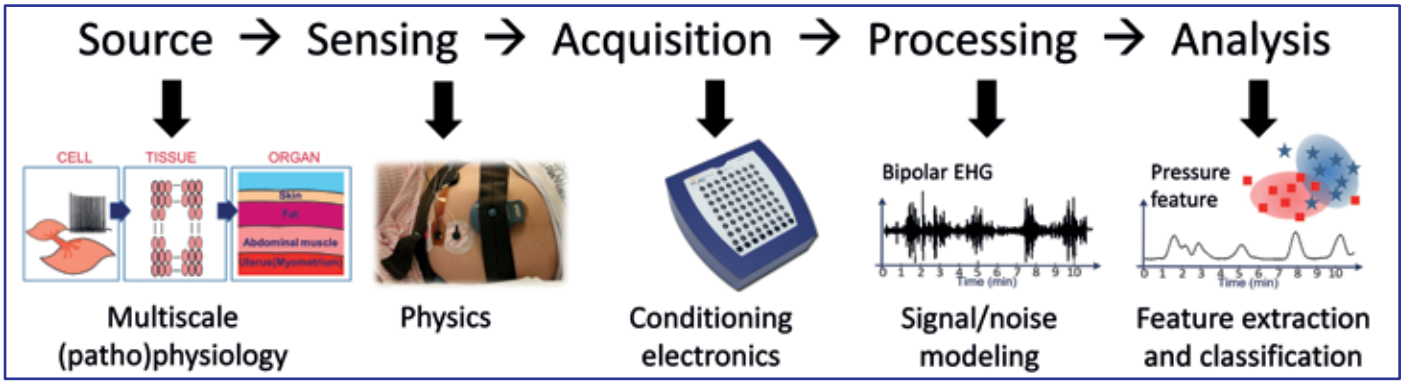


Figure 1: Representative example of measurement chain for the analysis of the electrical activity of the uterus, referred to as electrohysterogram (EHG) during pregnancy.

and modelling the full measurement chain also permits improving the adopted measurement instrumentation and protocol. Improved diagnosis then results from a multidisciplinary effort aiming at optimizing all aspects in the measurement chain.

Probabilistic framework

Because of the trend towards multimodal, ambulatory acquisitions, the acquired signals may be severely affected by multiple, time-varying noise sources and artifacts, limiting the performance and applicability of deterministic signal analysis, and often resulting in misinterpretation and unreliable quantification. In order to cope with this problem, probabilistic frameworks can be developed where a-priori knowledge of the physiological sources and measurement chain is integrated with a probabilistic characterization of the parameter space, also including measurement uncertainty.

Within such a probabilistic framework, machine learning techniques have gained a prominent role for classification and diagnosis based on a number of features extracted from the acquired biomedical signals. In line with the model-based approach, the use of machine learning techniques can provide valuable support with the selection of the key features for interpreting and modeling the underlying physical and (patho)physiological processes.

Artificial intelligence

Somewhat different from the long-lasting efforts of many scientists to develop models describing the human (patho)physiology, today increasing attention is directed towards the use of AI, enabled by ever increasing computing power and the availability of large datasets for training convolutional neural networks. This is "deep learning", often used as a "black box" tool for making diagnostic choices based on complex models that are learned by the network but unknown to the humans. Although the results are often astonishing, they are not immediately generalizable and may be affected by unknown dependencies on the training dataset. Moreover, diagnostic failures cannot be readily explained.

The role of deep learning

Instead of seeking a "shortcut" to find easy solutions overcoming the complexity of biomedical diagnostics, AI can be considered as an opportunity to achieve better understanding of the (patho)physiological processes regulating our function and diseases. This can be achieved through latent-space and deep-layer visualization. So called "transparent" deep-learning approaches can be designed with the potential to propagate back and gain additional knowledge about the underlying physics and physiology. This way, the learning process can be used to enrich our knowledge, yielding reliable diagnostic solutions that are based on domain knowledge and improved understanding of the physics and physiology behind our biomedical measurements. In return, improved modeling can provide us with the ability to generate synthetic data that are good representations of the reality, enabling the use of deep learning also in domains where only limited data is available. This win-win situation may indeed result from reestablishing the value and role of human intelligence in biomedical diagnostics.

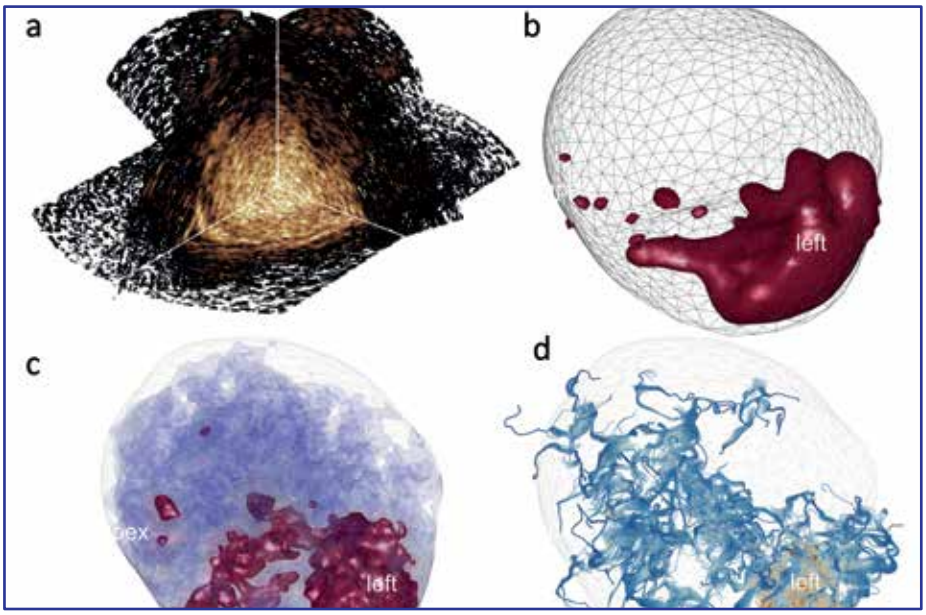


Figure 2: (a) 3D dynamic contrast-enhanced ultrasound imaging of the prostate with corresponding registered histology (b) and estimated dispersion (c) and tractographic (d) maps. All maps evidence the tumor area (red color) in agreement with the histological ground truth.

Application domains

Aiming at a large societal impact, we focus on those dysfunctions, diseases, and critical conditions that are widespread, and where timely and accurate diagnosis is crucial. Primary examples of this type are cardiovascular dysfunctions, cancer, and pregnancy, requiring different diagnostic solutions that are suitable for either high-end medical imaging (e.g., tissue and microvascular characterization) or unobtrusive, ambulatory monitoring (e.g., monitoring of pregnancy and atrial fibrillation).

Imaging

Noninvasive diagnostic imaging has a major impact on the healthcare continuum, enabling screening and minimally-invasive intervention through timely diagnosis. Being widely accessible, cost-effective, and perfectly suited to perioperative use, ultrasound imaging is an important research area that we address throughout the full measurement chain, by innovative interpretations of the measured signals as well as by innovative use of the acquisition technology. In this application area, quantification is an essential yet lacking option that we are constantly reinforcing through innovative research findings. Ultimately, accurate and reliable imaging is expected to become suitable for image-guided minimally-invasive intervention. Figure 2 shows an example of quantitative imaging of prostate-cancer angiogenesis using ultrasound contrast agents.

Monitoring

Multimodal unobtrusive measurements combining e.g. electrocardiography, photoplethysmography, and accelerometry, provide the inputs required for reliable model-based system identification through accurate estimation of physiological parameters with high diagnostic value. Figure 3 shows a setup for electrophysiological monitoring of pregnancy. Our research efforts are directed at providing technological solutions to offload the diagnostic burden in the hospital while enabling early and accurate prediction of patient deterioration at home. Acquisition redundancy can be exploited to boost the estimation robustness. Emerging acquisition technologies, based e.g. on large arrays of contactless sensors, are providing important opportunities for long-term monitoring. ►

Impact

Relevant solutions for biomedical diagnostics that can make an impact on our society, should be driven by clinical need, based on domain knowledge, and suitable for implementation and clinical translation. This is facilitated by the establishment of a multidisciplinary research team combining academic, clinical, and industrial expertise. In particular, close collaboration and regular interaction with clinicians represents a unique opportunity to generate ideas and develop diagnostic solutions that tackle relevant problems, providing valuable support for improving clinical workflow and healthcare sustainability.

The value of a triangle

In fact, I believe that technological innovation making a societal impact builds on a fundamental triangle combining academia, clinic, and industry. In this way, we develop solutions that address both clinical needs and industrial interest. This is required for the clinical translation of our results, supported by industrial implementations that facilitate their clinical validation and uptake. To this end, building on a unique ecosystem made of flourishing companies and research-oriented, regional hospitals, the Eindhoven area is shaping towards a more structured and efficient approach to research and innovation. The most representative example is the e/MTIC (Eindhoven MedTech Innovation Center), a synergic research program involving TU/e, Philips, and hospitals in the Eindhoven region.

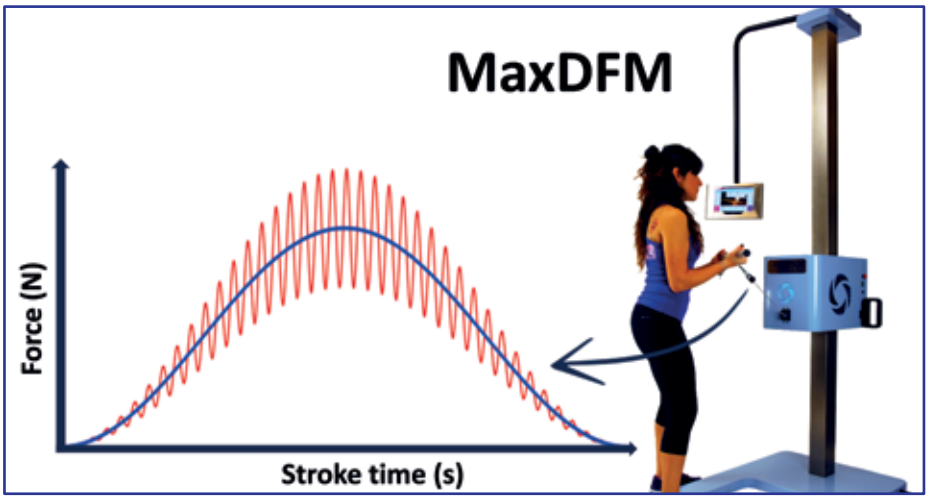


Figure 4: Maximized dynamic force modulation (MaxDFM) system for neuromuscular conditioning applying a dynamic load to the muscles consisting of a slow-varying force modulated at higher frequency.

Spin-off ventures

Clinical translation and uptake indeed requires implementations that are suitable for clinical validation and use, and can be easily integrated in a clinical workflow. Larger companies often lack the flexibility required to support this process. More and more, small spin-off companies are formed that have the freedom and drive to push the implementation and promotion of new technology. This process creates unique opportunities for innovative technological solutions to make a real impact on society and healthcare. I have had the possibility to lay the basis for two spin-off companies in the area of neuromuscular rehabilitation (HiPerMotion, Figure 4) and prostate-cancer diagnosis by ultrasound (CUDI, Figure 2). This experience provides a unique opportunity to enrich our view on research with different perspectives, accounting also for societal need, market size, and route-to-market strategies based on proper knowledge of the main stakeholders. To make real impact, our research should already account, in its early phase, for the full socio-economic context, moving towards technological solutions that are suitable to raise industrial and clinical attention.

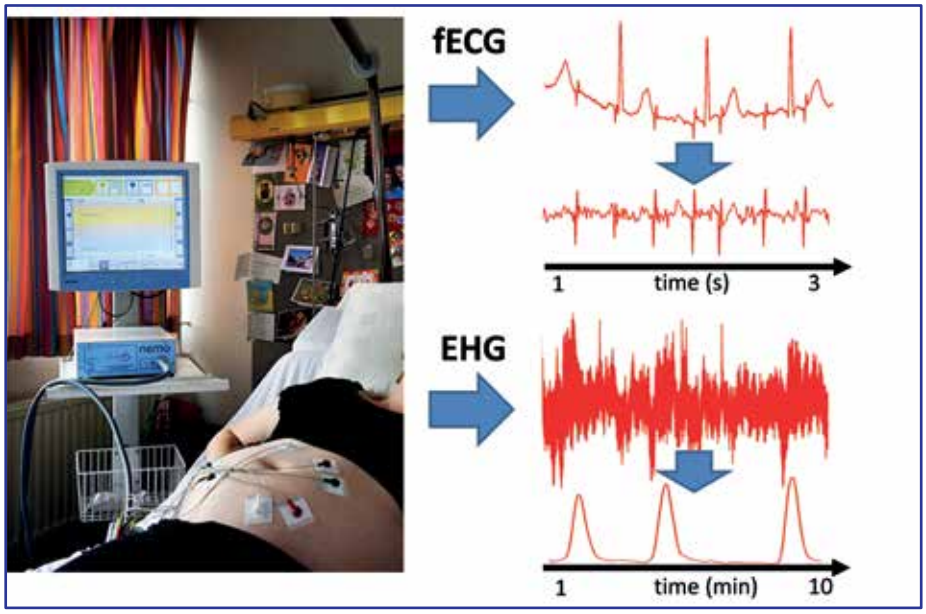


Figure 3: Electrophysiological pregnancy monitoring by measurement and analysis of the fetal electrocardiogram (fECG) and the electrohysterogram (EHG), reflecting the activity of the fetal heart and the uterus, respectively. After model-based de-noising, the fetal heart rate (above) and the intrauterine pressure (below) are estimated.

Conclusion

The term "human" has multiple connotations. The drive behind our research efforts and achievements is human, based on our natural inclination towards curiosity. AI intelligence provides extraordinary means to learn from the large amount of data that we now have available, providing an additional contribution to human knowledge and understanding. In fact, I firmly believe that effective and reliable healthcare improvements can only be achieved through understanding human (patho)physiology and the full measurement chain employed to acquire biomedical signals and data.

Restoring human rather than machine learning to the spotlight is especially valuable for our students. Curiosity and creativity is the basis of innovation and are prominent when we are young. That is why our students and young researchers have immense potential to be innovators and to face the modern challenges in healthcare. They should stay open, curious, and creative, like a child. After all, I believe that inventive ideas occur in that very moment when, with all our knowledge, we are children again. ■

Introducing...

Hello Eindhoven! My name is Ariyan Bighashdel and I have just started a PhD at the VCA group in the department of Electrical Engineering. In all of my life, I was struggling to find the answer to the most controversial question: which one is more important: intelligence or working hard? I am here because I have beaten intelligence with hard working, several times. In 2013, I graduated with a BSc degree in Aerospace Engineering, from a university in Iran. After graduation, I set off on an "odyssey" and spent a whole year on studying. In 2014, I took the Iran national entrance-exam for postgraduate studies and ranked 10th among thousands of participants. In 2015, I joined the Sharif University of Technology, which is the most prestigious university in Iran, and started a research position on Flapping Aerial Vehicles. After three vibrant years, I decided to leave Aerospace field and enter into the exciting field of computer vision. I went to great lengths to prove that I am worth investing in. Finally, I have made it! Now I am here and it is like a dream that comes true. More determined than ever, I am more than ready to start this new journey. Looking forward to meeting new colleagues at the TU/e!

Hello everyone! My name is Prem Sundaramoorthy. I am basically an engineer who time-shares between the roles of a researcher, teacher and entrepreneur.

As of January this year, I have started as a post-doctoral researcher at TU Eindhoven. I will be supporting system-level studies for the OLFAR (Orbiting Low Frequency Antennas for Radio astronomy) project. I did my bachelors in Telecommunication Engineering in India and then worked as a scientist with the Aeronautical Development Establishment, responsible for system integration and automated test equipment development for Unmanned Air Vehicles. In 2005, I enrolled for the MSc program at the Aerospace Engineering department of TU Delft and received my MSc degree in 2007, specializing in Astrodynamics and Satellite Systems. Between 2008 and 2012, through an employment as a PhD candidate at TU Delft, I was pursuing research in the area of miniature spacecraft design and distributed space systems. For the last six years, I worked as a lecturer and researcher at the Space Systems Engineering group at the department of Aerospace Engineering at TU Delft. Here, I developed, coordinated and conducted various courses and projects at the graduate and undergraduate level. I have also been involved in the in-house satellite projects Delfi-c3 and Delfi-n3xt at various stages. Between 2012 and 2017, I have also been actively involved in entrepreneurial activities and I co-founded two tech companies in Delft.

My research interests include systems engineering for small satellites, distributed space systems and space mission design. I am passionate about education and I like to explore how technology can be used to enhance learning. I also like travelling, seeing new places and meeting new people.

Hello everyone! My name is Alessia Senes and since December 2018 I work as a Research Manager in the Electromechanics and Power Electronics group (EPE) and in the Centre for Electrical Energy Technology and Systems Eindhoven (CEETSe).

I come from the beautiful island of Sardinia (Italy), where I studied Electronics Engineering. In the past nine years, I worked as a researcher (in Konarka, Austria, and then at Holst Centre) in the field of Organic Electronics, for large-area and light-weight printable electronic devices, such as OLEDs and solar cells. In the end of 2012, I decided to start a PhD in parallel with my work at Holst Centre. Completing my PhD while working as a researcher and having a baby was a big challenge!

After finishing my PhD, I decided to stay in the field of research, but to move my focus from the details to the big picture.

In my new role I support the researchers with finding new collaborations, starting new projects, writing project proposals and managing granted projects. I find this very exciting as I enjoy working in research, meeting new people and bringing people together, creating new opportunities.

I love spending my free time with Jan-Laurens and Valentino (my husband and son), walking or cycling in the nature, going to the sea (better if in Sardinia!) and meeting friends.

Looking forward to meeting new colleagues at the TU/e!

Hello to you! My name is Petra Aspers, and since December 2018 I have started at the secretariat of the ESA Team AP and EE. I am supporting Ruben Trieling, Henk Swagten and Sjoerd Hulshof and also the rest of the team.

I did my study in Tourism & Recreation in Tilburg. After that, I worked at a travel agency for a few years. I traveled across Europe, met a lot of interesting people, and enjoyed the surroundings during these short work visits.

While working at a compound feed company, I started at Hogeschool Schoevers in Eindhoven.

In the evenings I followed courses for Management Assistant. That brought me to this university in December 2007.

For 10 years I have worked for the Control Systems Technology group at the department of Mechanical Engineering.

But I am very happy to be at Flux now! ;-)

Pie for bad luck

This edition's pie for bad luck was presented to the employees of the Spar, who had to throw out all their cooled products because the heavy wind had caused a short circuit in the cooling equiptment on the roof of Flux.

The balance between research and application

By: TNO

Jorrit Goos is System Integrator in the Integrated Vehicle Safety department of the TNO Traffic & Transport unit in Helmond. He loves the opportunity he gets at TNO to go through the entire process from concept development to practical application.

"Our department is located on the automotive campus in Helmond, where various companies are working on the very latest developments in the automotive field. The focus of my department is to ensure that traffic on public roads is as safe as possible. To this end, we develop robust and reliable solutions for the vehicle itself, but also increasingly between the vehicles themselves and with the road environment. The safety systems in cars have moved on from ABS and cruise control to autonomous emergency braking, the highway pilot and the self-driving car, aspects we are working on now. We process the cooperation between car and environment into systems that we collectively call cooperative automated driving. The other day we did a test in Noord-Holland with seven Prius cars driving in a column to improve the flow. They communicated with each other and with smart traffic lights. The next step is to enable them react to road works. We also develop systems for unmanned freight transport in distribution centres and port areas. Like moving containers in the port of Rotterdam.

team University Racing Eindhoven, when it became clear to me that I wanted to continue in dynamics. For my graduation internship I chose TNO. The subject – the intelligent car tyre – fascinated me a lot as did the fact that TNO lies between university and industry. The internship went well: nice colleagues, good supervision, pleasant working atmosphere. Apparently that feeling was mutual, because my supervisors asked me to come and work at TNO. Immediately after my internship I started working here.

BALANCE BETWEEN RESEARCH AND APPLICATION

"After three years I can say that I still like the balance between research and application. One moment you go deep into the development of new concepts, the next you see them being applied in a test setup. Going through the whole process makes it interesting. I am also pleased to have TNO as an employer. You are very free to organise your hours and to decide what you want to do. Every year you set technical goals and personal targets. For example in the training you want to follow. Or the career path you want to take. TNO has

in contact with government agencies, such as the National Road Authorities, because at some point we need exemptions to be able to test our test vehicles on public roads. I have been a work package manager for a month, which involves more management and monitoring progress. That's a challenge, but it's one I'm really enjoying. I also hope to have more contact with customers in the future. Maybe I'd like to go on into management but for a few more years I'd like to continue doing the work for which I studied."

Working on the very latest developments in the automotive field

FROM INTERNSHIP TO WORK

"As a system integrator, I develop vehicle software. How do you make sure that a car stays in its lane? How can you assist it in finding the route to a car park and then park safely? It tends to be developing algorithms that calculate the action needed for specific situations so that the vehicle does what you want it to do, within set requirements. I studied mechanical engineering in Eindhoven, mastering in Dynamics & Control. I took a gap year to be on the board of the student racing

the Talent Centre for this purpose: a digital platform with a wide range of e-learning modules, training courses and development programmes."

ON INTO MANAGEMENT?

"My working day is a success if I can work with a group and have made progress at the end of the day. The days on the test track are also great fun. I am now being given more and more responsibilities. Besides my normal work I am now active as a recruiter in hiring students and supervising interns. I am also

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TNO innovation for life

WinThorsport 2019

By: Lucia Kalkman

During the carnival holiday, the SnowCo organized their yearly skiing trip. A group of seventeen people went to Saint Sorlin in the French Alps. We were staying in an apartment close to the ski slope, so every morning we just had to walk for five minutes to start skiing (or snowboarding of course).

The skiing trip started on Friday, at nine o'clock in the evening we gathered in Flux. All the food and beer was already packed in the van and as soon as we had packed the personal baggage as well in the three cars and the van (luckily it all just fitted), we could start driving. The trip went all right and in the morning we all arrived. After having breakfast together, the people without their own equipment went to rent it. We couldn't enter the apartment till the afternoon, so the guys who had an extra skiing day changed in the cars and got going. The rest of the group was either hiking in the snow or sleeping in the car. In the afternoon some of the guys with an extra skiing day wanted to get some sleep so some others could get on the slope.

The next morning, everyone got onto their skis or snowboard to get going again. The groups, based on skill level, were quickly formed, and some of the more experienced skiers and snowboarders were teaching the beginners.

From 15:00-16:30h, people arrived at the apartments again. After changing clothes and having a shower, everyone gathered in the bigger apartment. It was time for some beers, games and food. The cooking always took place in the bigger apartment, where eleven people were sleeping at night. After the dishes were done, everyone hung around for a couple of hours before going to the only bar, La Grotte du Yeti.

The daily schedule of the rest of the week was exactly the same, waking up early, getting on the slope, ski or snowboard for an entire day, coming back to have dinner, drinking and going to the yeti bar. The only thing added to that schedule from the second day on was the swimming pool and sauna. Because it was the carnival holiday, some people also brought their carnival suits and went onto the slopes in the most beautiful outfits.

On the last day, just before departure, we remembered that we didn't make a group picture with the entire group yet. So the only picture with all of us in it was made five minutes before leaving. Unfortunately, the trip back didn't go as good as the outbound. The van broke down and the five people in it had to wait for an entire day before travelling back by train. After having been in a cab, five trains and a metro, they arrived at station Eindhoven, where the WinThorsport gang was waiting for them with beer and the song 'Potentie', which was the end of WinThorsport 2019. A very exhausting, but also awesome week! I am already looking forward to WinThorsport 2020. ■

Feedback insensitive integrated laser

By: Perry van Schaijk

Semiconductor lasers emit light with a very well-defined frequency or color. Linewidths of less than 1 MHz are common, while the operating frequency is typically well over 100 THz. This makes these lasers ideal light sources for a wide range of applications, including tele- and data communication, the diagnosis and treatment of a wide range of diseases, and numerous sensors, such as distributed thermometers, strain sensors and sensors for accurate determination of the position of an object.

In all of these applications, the laser is connected to additional circuitry that further processes the light. These circuits typically reflect a fraction of the laser light back into the laser itself. The problem that has faced lasers since their invention is that minute fractions of reflected light can already affect the laser light to such an extent that it becomes unusable for many applications. It was found for DFB lasers (a popular type of laser) for instance that a reflection of less than -60 dB was sufficient to make the laser hop between two frequencies. However, by changing the optical phase of the feedback light, the same feedback strength could also be used to make the laser more stable. Since the wavelength of the light from these lasers is typically 1.5 µm, this means that minor changes in the circuitry outside the laser result in unacceptable changes in the output of the laser. Such feedback is therefore considered undesirable. It is typically avoided by placing a strong optical isolator at the output of the laser. This device allows light to pass through in one direction, but not in the other.It therefore effectively prevents the feedback problem.

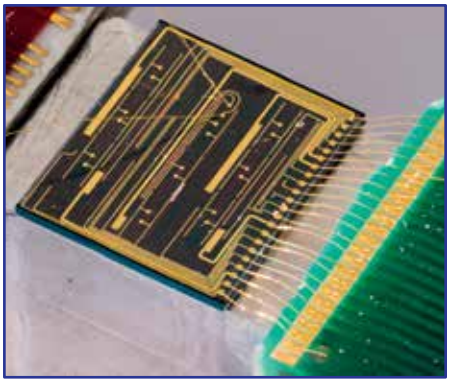


Figure 1: Photograph of a photonic integrated circuit. The circuit is connected to two printed circuits boards (red and green) to facilitate electrical connections to the circuit.

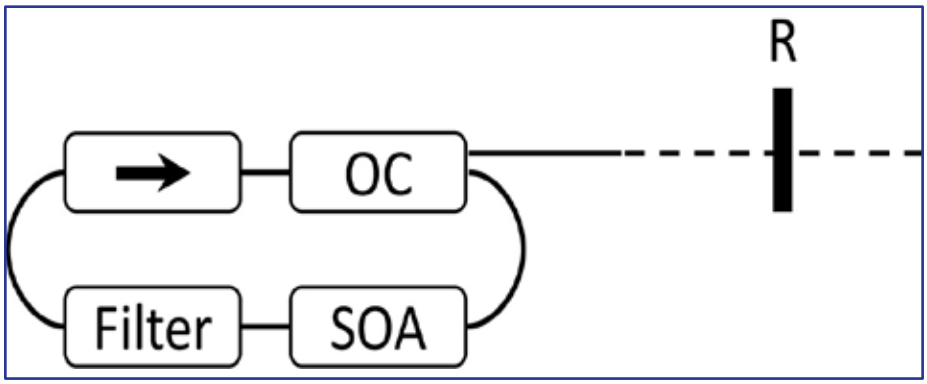


Figure 2: Schematic representation of the ring laser cavity with isolator. The cavity includes an amplifier (SOA), spectral filter (Filter), weak optical isolator (arrow) and an output coupler (OC). The external reflector is indicated by R.

The applications for which lasers are being used are becoming more and more demanding. The number of components that are required in the circuitry that is connected to the laser has therefore also seen a steady increase over recent years. The traditional methods of connecting these components using freespace- or fiber-optics do not allow such scaling to be cost-effective. Such configurations are also bulky and typically consume a relatively large amount of power.

Another method of combining the optical components is using photonic integration. In such platforms, all the optics are grown on a substrate. This is comparable to the way electronic integrated circuits are fabricated and it provides similar advantages to optical circuits. Devices such as phase modulators, amplifiers and polarization converters can be connected to form more complex circuits, similar to the way resistors, capacitors and coils form the basis for electronic integration.

One of the devices that is missing in these platforms is a strong optical isolator. The materials that are typically used for such isolators are not compatible with clean room processes. Much work has been put into the improvement of such integrated isolators, but this did not yet result in an isolator that is able to fully suppress the effects that the external feedback has on the laser. For this reason, my project has focused on achieving feedback insensitivity using alternate methods.

We first studied various laser geometries. This has resulted in the proposal for a novel laser geometry. In essence, our laser consists of a ring cavity with a weak optical isolator inside the laser cavity. The isolator is used to force the laser to lase in the clockwise direction while suppressing the light that is propagating in the counter clockwise direction. As such, the isolator does not need to completely suppress the feedback light and 10 dB isolation already provides complete insensitivity to the feedback. Compared to the 60 dB suppression

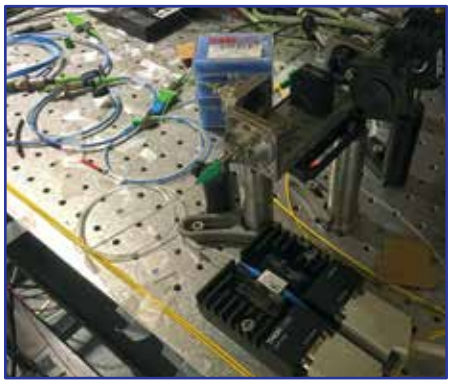


Figure 3: Photograph of the fiber based laser. At the bottom is the amplifier. This component is connected using optical fiber to the free space section at the top. This section includes a tunable optical isolator. To the left is part of the feedback circuit.

that was needed for a DFB laser, this is an improvement of five orders of magnitude!

We studied our proposed laser using a set of differential equations. Such a model is relatively simple and can therefore only provide a rough estimate of the real performance of the laser. More complete studies using 3D modeling of the laser (FDTD simulation) require too much computation time for the size of the structures that we use. Another advantage of a rate equation model is that it often yields analytical expressions for important laser properties, which allows to more easily see trends in the behavior of the laser.

In order to demonstrate the practical viability of the concept, we built a ring laser with intracavity isolator from fiber-based components. Using this setup we were able to demonstrate that our model and experiment agree well, even though the model explicitly assumes a single mode laser while the fiber-based laser is multi-mode.

The next step was to implement the laser on a photonic integrated circuit. This required an integrated version of an optical isolator. Even though strong optical isolators are not available in photonic integrated platforms, a variety of weak isolators have been reported in literature.

We selected one that could be implemented in our technology platform without major modifications. This isolator consists of two phase modulators and a spectral filter. The phase modulators are each driven by RF sources at the same frequency, but with a phase offset. The phase modulators are separated by a section of waveguide that introduces a time delay between the time that light passes through each modulator due to the finite propagation speed of the light. By carefully matching the phase difference to the physical spacing, a situation can be reached where the two phase modulators either add to or cancel each others effects, depending on the propagation direction of the light. Narrow laser light, such as from a single mode laser, is therefore not affected when traveling through the two modulators in the forward direction, while it is converted to other frequencies in the backward direction. By attenuating these other frequencies using a spectral filter, a directional attenuation and thus isolation is obtained.

Like with all physical models, this model for the isolator is only an approximation of the actual device. We therefore characterized this device in much more detail than was done before and determined the limitations of the device. In this way, we were able to find a trade-off between modulation amplitude, physical distance and the modulation frequency. Also, we found that the performance of the isolator in our platform was limited by a combination of non-linearity and residual amplitude modulation of the phase modulators in our platform. Performance was however sufficient to continue integration

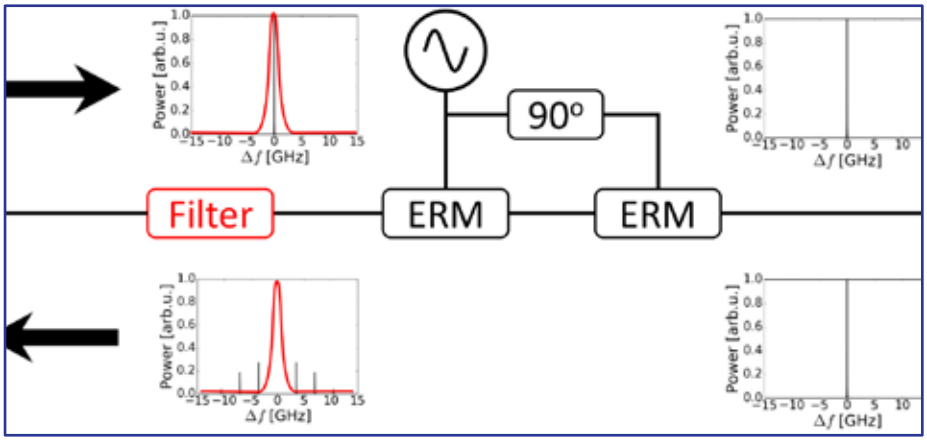


Figure 4: Schematic representation of the integrated isolator consisting of a spectral filter and two electro-refractive modulators (ERMs). The modulators are driven by an RF signal and are separated by a specific length of waveguide. The graphs show the input- and output spectra of the light traveling in both directions. As is shown, light is unaffected when travelling from left to right, but it is attenuated by the filter when travelling from right to left..

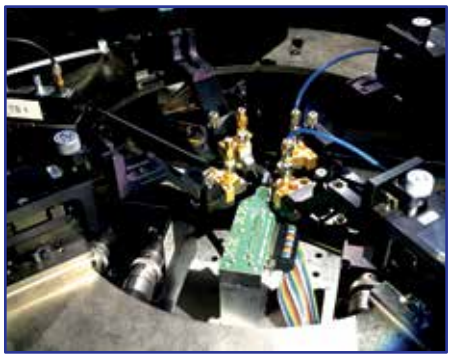


Figure 5: Photograph of the setup used for characterizing the integrated laser. The chip is the black square in the middle of the picture. DC signals are supplied by the green PCB at the bottom and RF signals are applied using the gold-colored probes. Finally, light is coupled out of the chip using lensed optical fibers that are fixed to the piezo-controlled stages which are located below the probes and to the left and right of the chip.

of the component in a laser cavity. We therefore designed a ring laser with the intracavity isolator in order to prove that the concept works. A couple of months later, the device was fabricated by SMART Photonics and we could start its characterization. As is common in laboratory experiments, this laser did not behave exactly as expected and we spent quite some time finding a good operating point. Ultimately, we were able to show that the laser performance was limited by reflections inside the laser cavity that were stronger than we anticipated. The race for a feedback insensitive integrated laser is therefore still ongoing.

Reflecting on the project, I think we proposed and investigated an interesting new concept for a feedback insensitive laser. The cavity of our fabricated lasers has grown to be extremely complex over time, mostly due to the type of isolator that we chose. Integration of a less complicated isolator will however require a significant effort in the clean room and was outside the scope of the project.

Given the interesting uses of isolators in general, I am quite sure that some day such isolators will be available in our platform. Combining such isolators with our concept for a feedback insensitive laser would then yield an interesting road to a small, feedback-insensitive laser. ■

Wafer-scale CMOS-based X-ray detectors

By: Teledyne DALSA

Teledyne DALSA is an international leader in high-performance digital imaging and semiconductors with approximately 1000 employees worldwide. Established in 1980 and acquired by Teledyne Technologies in 2011, Teledyne DALSA designs, develops, manufactures, and markets digital imaging products and solutions, in addition to providing semiconductor products and services. Teledyne DALSA has R&D Facilities in Canada (Waterloo, Montreal & Bromont), USA (Milpitas) and the Netherlands (Enschede & Eindhoven). At our location in Eindhoven we research, design and produce CMOS-based dynamic X-ray detectors for advanced medical, dental and NDT (industrial) applications.

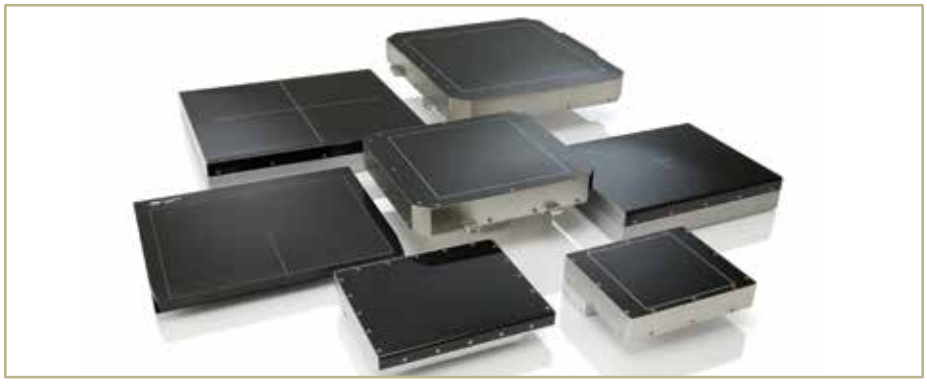
Teledyne DALSA builds upon many years of expertise in the Eindhoven area. Since the beginnings of the 70s, CCD detectors were researched and developed within Philips Natlab. These activities were acquired by the Canadian company DALSA in 2002. In 2011 DALSA became part of Teledyne, which has expanded the imaging activities ever since. In 2018 the revenue of Teledyne Technologies was 2.9 billion dollar, with the digital imaging responsible for 31%.

CMOS-based X-ray detectors

For years, the installed digital X-ray imaging systems were either CCD-based image intensified cameras with complex optics or compact flat panel detectors that used amorphous silicon (a-Si) technology in conjunction with conversion media like CsI (indirect conversion) or a-Se (direct conversion). Image intensified solutions suffer from poor optical collection efficiency, low resolution, poor image geometry and inconvenient form factors. Amorphous silicon-based flat panel detectors overcome many of these obstacles, but suffer from high noise floor, image lag and low read-out speed, and are limited to large pixel pitches. Both solutions lead to unacceptable performance compromises in low-dose and high-speed applications.

An emerging technology, flat X-ray detectors use high-quality mono-crystalline complementary metal oxide semiconductor (CMOS) pixel technology and deliver on the promise to combine excellent low-dose image quality at high resolution with the compact flat detector form factor as demanded by today's healthcare practitioners.

Our CMOS X-ray detectors are composed of wafer-scale image sensors and an optical stack to convert X-ray photons to visible light photons detectable by the sensor (indirect detection). Large area panels are constructed by butting together different sensors with high precision. The CMOS wafers are processed in a standard CMOS imaging process.



The main advantages of CMOS X-ray detectors are:

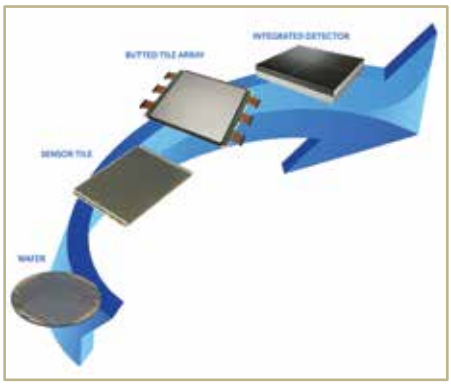
- High image quality and low dose
- High speed imaging
- High resolution
- Innovative design
- Long lifetime
- Stable operation & easy integration in customers systems

Detector Assembly

At Teledyne DALSA, a CMOS wafer is designed with a pixel size between 20 to 200µm, forming an imaging array of several Megapixels. After processing, the wafers are cut in dies, with sizes ranging from 3x2cm2 to a maximum die size of 13x13cm2 (single wafer die). These dies are mounted on a carrier and wirebonded to a tile PCB, forming a sensor tile. On top of this tile a scintillator is mounted, either CsI of Gadox. The largest detectors consist of a 3x2 array of sensor tiles, forming a butted tile array. The distance between the individual tiles (the butting gap) is only 1 pixel wide. Finally, the assembly is built into an integrated detector, with the housing, electronics and cover.

Teledyne DALSA Eindhoven

We are located at the High Tech Campus Eindhoven, the smartest km^2 in Europe with more than 185 companies and institutes, and 12.000 researchers. Teledyne DALSA has a very international, and highly skilled workforce. We are always looking for new technical talent, and we have opportunities for master assignments and internships. Visit our website www.teledynedalsa.com ■



TELEDYNE DALSA
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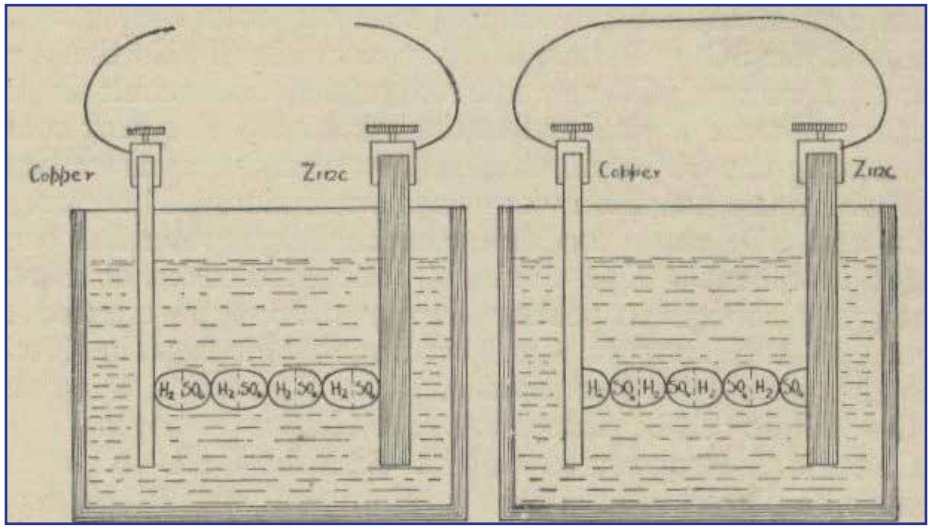
Icons of EE: Georg Simon Ohm

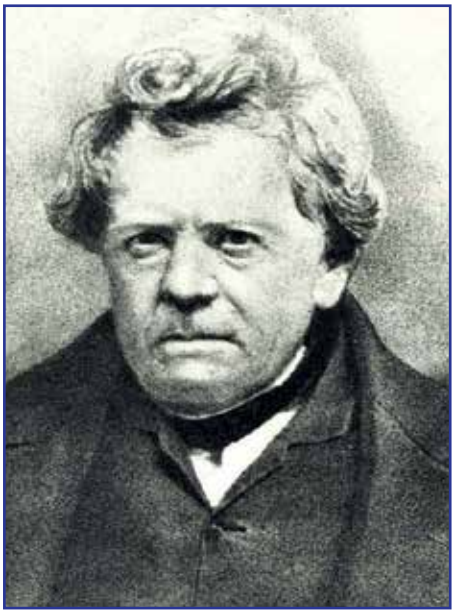
By: Matthijs van Oort

Not every time a great inventor or scientist discovers something new, it gets recognized by the big-mass. For example, a large portion of the world's scientists kept believing that the earth was flat, though research proved that it should have the shape of a sphere. The same holds for the belief that the earth stood in the middle of the universe. The same holds for the Electrical Engineer discussed in this article: Georg Ohm. Though every engineer sees his theories as basic knowledge, it took quiet a while to get accepted by other scientists.



Georg Simon Ohm was born in the year 1789 in Erlangen, Germany, as the son of a locksmith. While his parents did not really have anything of an education, his father was respected for his knowledge. He taught everything he could to his two sons, Georg and the younger Martin, until their mother died when Georg was ten. He then went to the Erlangen Gymnasium, where they tried to teach Georg in the area of science, but Georg did not really listen to this because of the background with his father.

Because his father got concerned about this, he sent his son to Switzerland to continue his career there. Eventually, Georg ended up being a math teacher for a few years. Then in 1809, his interest in science returned, Georg quit his job as a math teacher and started as a private tutor. Because of his work as a private tutor, he had more free time to teach himself the work of Euler, Laplace and Lacroix. Eventually he returned to Erlangen in 1811, in order to receive his doctorate in the same year at the University of Erlangen.



After working for nearly two years at the same university, Georg quit because he could no longer live on his salary. He took a step back, and started working as a math teacher at a school in Bambert. Georg was not happy with this job, but earned enough to survive. Next to his teaching, he started working on a book on geometry and the math behind this. After finishing it in 1817, he sent it to King Wilhelm III, who was impressed by the quality of Georg's book and offered him a position at the Jesuit Gymnasium of Cologne.

At this school, he had the freedom to work on his own physics projects, next to teaching physics. Because his father taught him some practical skills as a locksmith, Ohm knew how to build his own setups and started experimenting with the newly discovered electrochemical cell (which has been invented by Alessandro Volta).

During these experiments, Georg discovered that there was a close relation between the electric current through a metal and the potential difference he put over it. Due to his discovery, he started writing his first academic publication called 'The Galvanic Circuit Investigated Mathematically', which would later be called Ohm's Law.

The school did not appreciate this publication and even fired Georg for doing these experiments, therefore his work was not known for quite some time. After this he was unemployed for nearly six years, after which he started working again as a teacher at the Polytechnic School of Nuremberg. Eventually, Ohm tried to do a new publication on Molecular Physics, but found out that his discoveries were already done by a Swedish colleague, so he cancelled his own publication.

Nowadays, it looks normal that the earth has the shape of a sphere and that it is not even close to being the center of the universe. It is good to keep in mind that at the time it got discovered, it was so mind-blowing that most people just could not accept it. New ideas often get resistance, but after a while people will accept it as the new standard. While Ohm did not get enough credit for his work during his life. Nowadays, his law is being taught to students in Electrical Engineering already during the first weeks of college. And while he did not have a very exiting and a rather tough career, we could not proceed doing the stuff we enjoy without his law. ■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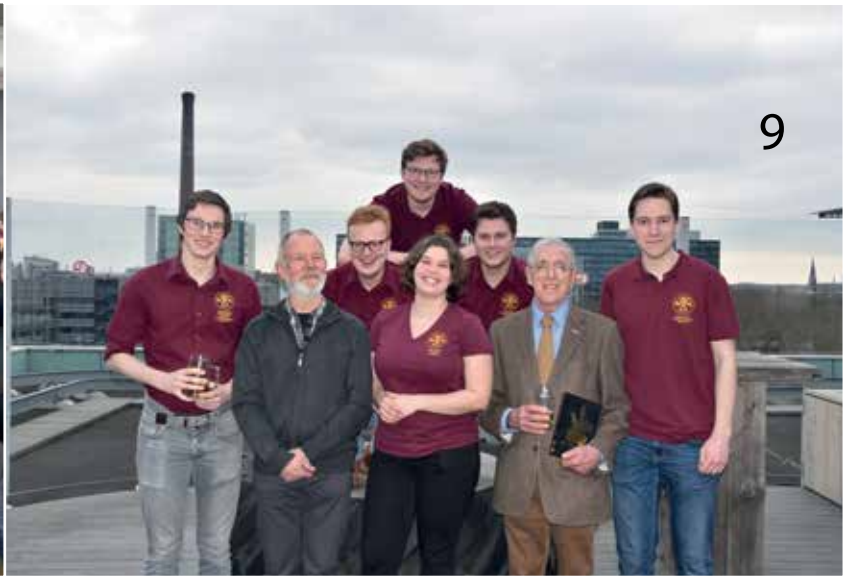

1. ACCI X-FacThor
2. SkelthorCo Dynamo demontage
3. Lunch lecture Cisco
4. Ivaldi Party
5. & 12. Ivaldi Open House day
6. ACCI boardgames
7. Carnaval party
8. Lunch lecture Prodrive
9. Honorary members drink
10. Mobi Bash workshop
11. ACCI Bingo
13 . Semi-annual GGM
14. La Chouffe party

Mythology

By: Fer Radstake

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

To find out where the Vikings originated, we have to go back to ca. 3000 BCE. In those times, northern Europe was populated by the Funnelbeaker culture, which we know from the dolmens they left us, such as the *hunebedden* in Drenthe. But all was to change, when on the steppes around the black sea a new people emerged. These Proto-Indo-Europeans, as we call them, quickly became the dominant culture of the region. Helped by their mastery of the horse, they soon conquered much of our continent, from the British Isles to northern India. They eventually merged with the peoples they subjugated, dividing into various Western European cultures: the Romans, Greeks, Celts/Gauls and Slavs, and in southern Scandinavia the Germanics.

As time passed and many of the other Indo-European civilisations reached their apex, the Germanic culture remained a rural one. Where the Romans and Greeks massed together in huge cities and developed a cultural elite, the Germanics remained mostly a warrior-based culture. Warring and raiding were commonplace, and the greatest dishonour a man could face was to flee in battle. Although some tribes tried to gain wealth by farming and trade, others are said to have relied on raiding, extortion and conquest to a large extent, and all certainly were capable fighters.

The Germanics first appear in history in 113 BCE, when the originally Danish Cimbri and Teutones invaded the lands of the Taurisci, a Celtic ally of Rome. The Romans persuaded the invaders to retreat from the Tauriscan territory, but then dishonoured their agreement and ambushed the withdrawing armies near Noreia in the eastern Alps. This plan backfired however, when the Cimbri and Teutones won the battle and were now in open war with the Romans. These tribes won some more victories against Rome – including famously slaughtering some 80,000 legionaries in the Battle of Arausio – before being finally defeated in 101 BCE after a long and costly war.

At the time when the Romans expanded north towards the Alps and Gaul, the Germanics moved south. When the two cultures met, a series of bloody conflicts erupted, until finally in 21 CE the Rhine was established as the northern border of the Roman Empire. The two civilisations lived alongside each other relatively peacefully, until in the 4th century a combination of failing Roman policies and the pressure of the Huns to the east led to a mass invasion of Germanic tribes. The West Roman Empire finally collapsed in 476, when it was divided into a number of, mostly Germanic, successor states. Even though the Germanics had left Scandinavia half a millennium earlier, their languages were still largely mutually intelligible, and they very much shared a common culture. In their essence, tribes such as the Franks, Saxons and Frisians that the Dutch population descends from, or the Goths and Langobards that ruled Rome, didn't differ much from their Scandinavian relatives. Indeed, much like the Vikings would later do, the Goths raided the coast of Anatolia in the late 250s, the Heruls Frisia in 287 and Spain in 455 and 460 and the Saxons Britain in the 4th century.

Much of the culture of the non-Scandinavian Germanics was to change over the next centuries however. As these conquerors merged with the Romanised population of their new kingdoms, they slowly lost their cultural identity. Before long, they converted to Christianity and lived in cities under the firm rule of a God-appointed king. As the centuries progressed and the Romanisation of the Germanics reached its final stages, the church slowly gained in wealth and power while western Europe was relatively peaceful under a series of strong kings. Fortifications were rare outside ▶

Although by 1066 the Normans had lost much of their Viking culture, their ships can be seen to be still of the Scandinavian model (including dragon figurehead) on this scene of the Bayeux Tapestry.

of disputed borderlands, and whenever wars did occur, monasteries and churches were generally spared from plunder.

Meanwhile, Scandinavian society was changing as well. As power became increasingly centralised, struggles for kingship became more frequent and intense. A raid on a wealthy foreign place was a sure-fire way to raise money to support one's claim to power, and many would-be leaders started raiding to gain wealth and reputation, goals that attracted many of the poor as well. Scandinavian trade with Western Europe meant that the locations of undefended towns and monasteries were well known, and the early Vikings were quick to pick these out. The Viking age had started.

The Viking age is said to have begun in 793, when an attack on the Northumbrian monastery of Lindisfarne shook the whole Christian world. The shock didn't come so much from the fact that the Vikings existed – they had been trading with England for many years, and occasional raids had occurred – but that God had allowed such an attack to take place. If somewhere as holy as Lindisfarne wasn't safe, nowhere was.

In these first phases, the main strength of the Vikings was their adaptiveness and mobility. When civil war among the Franks weakened their coastal defences in the 840s, the Vikings were quick to take advantage. When in the 860s Frankish resistance became effective again, the Vikings moved to England. Attacks were swift and relatively small, rarely numbering more than 20 ships (a crew consisted of around 40-50 soldiers) and rarely moving far inland before returning. Before their victims could muster an army and march to battle, the invaders would be long gone along with all the valuables.

As time went on, both internal and external circumstances forced the Vikings to change tactics. Under pressure from the costly raids, the Western European countries started building walls around coastal towns and monasteries and garrisoning them with soldiers. Many of the places that were still left defenceless had by now already been plundered time and again, leaving little of worth to Viking raids. This caused the Scandinavians to probe ever deeper into enemy territory to the still wealthy and lightly defended areas around rivers, leading to such attacks as the 845 CE siege of Paris (bought off by 2500 kg of gold and silver) or the 861 CE raid into the Mediterranean. Such attacks into the heart of enemy territory put the invaders at high risk. This required larger armies, so the fleet size increased to many hundreds of longships: another siege of Paris 40 years later is said to have numbered between 300 and 700 ships. The longer distance and occasional siege warfare had by now made it necessary to overwinter. Because of the Viking naval superiority, the obvious choice was to occupy islands; several semi-permanent resupply bases were established along the European coast (including Walcheren in the Netherlands), while many of the larger Viking armies built temporary camps on river islands.

The final phase of the Viking age was characterised by conquest and settlement. A worsening climate ruined harvest after harvest while a series of harsh kings went after their political opponents with cruel vigour. This forced many Scandinavians to leave their homeland behind and seek a new life elsewhere. In 841 Dublin was conquered, in the 840s northern and western Scotland and in the 860s much of eastern England, while as part of a peace deal Normandy was given to the Viking king Hrólfr in 911. As the Vikings settled, they lost their main asset of mobility however, so more effective resistance often meant the Viking kingdoms soon lost their independence to the native kings.

Meanwhile, Christianisation and Romanisation had reached Scandinavia. Royal power became absolute and hereditary, and the rulers could depend on taxes and tolls for their income. The incentive for would-be kings to start raiding disappeared, and the Viking age slowly faded away. Harald Hardrada, a Norwegian king and one of the last "true" Vikings, died in 1066 while trying to conquer England. The English army couldn't enjoy their victory for long however, as only two weeks later they were decisively defeated by an invading Norman army, the descendants of those who had accompanied king Hrólf in 911. With this last conquest, the Viking age had finally come to an end. ■

The Nydam boat from the early 4th century (here in an 1865 sketch by Danish archaeologist Conrad Engelhardt) already shows much of the characteristics of Viking longships..

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Walhalla Lustrum

By: Meeuwis van den Hoek

This year het Walhalla turns 45 years old and that needs to be celebrated. A whole week of activities for everyone who wants to join. We started the week with an opening stunt, followed by a weekend for all the (old) members of het Tappersgilde. We tested everyone's knowledge during our pubquiz and beer tasting, and we visited brewery 'het Anker' to give people more information about the brewing process. Last but not least, we closed the celebration week with a massive party to celebrate the birthday of our beloved bar. ■

NTS' knowhow of propulsion and print systems

By: NTS

System architect Mike Curvers (47) develops propulsion and printing systems at NTS. Twenty years ago, he started at a predecessor of NTS. He saw his professional field change: mechanical machines became mechatronic, motion control continued to become more important and the demand for printing flexible, customised series continued to grow.

Mike was already interested in technology at a very early age. During his study he found electronics especially appealing. In practice he discovered that he was mainly fascinated by engines and propulsion That is why Mike chose to start at Te Strake, one of NTS' predecessors.

"That was twenty years ago," Mike says: "and now I still work here. In that time a lot has changed, the company has professionalised a great deal. Although we were already a forerunner back then when it came to our machines for textile printing for instance. That was a very innovative product."

Understanding exactly what happens

"Back then, those machines were entirely mechanical. At a later moment in time they became mechatronic: a combination between electronics, software and mechanics. The textile printer is an example of an extensive project that I have worked on. It is a system printer, motion control in this case is very complex, the ink needs to end up in the exact right position. I want to be able to understand what happens exactly and I want to see that it works."

Best project ever: printer of 800 kilos with high precision printheads

"The best project I have ever worked on is a very large printer for Agfa. It is a large industrial printer with a print system that weighs 800 kilos and has 64 printheads that need to move with an accuracy of 10 micrometre. We were mainly responsible for the motion control and electronics. That was really, very nice. It was even patented."

"Agfa has a sound knowledge of inkjet but does not have enough expertise of this type of motion control. We have developed the printer together with three parties. A lot of the testing took place in Germany. That was a very nice period, the collaboration was very good. During daytime we worked hard and, in the evenings, we went out to dinner and explored the environment. It was challenging, educational and fun."

Inkjet offers great flexibility

"The advantage of inkjet over offset is that it offers you great flexibility. It is extremely suited for printing small series or limited editions. You can also apply special effects, like printing layers, fast marketing campaigns where you print relief on packaging, printing a wooden pattern on boards, printing panels and so on. It offers you a wide range of possibilities."

Ever smaller series

"The wish to be able to be flexible and print small customised series is something you hear a lot in the market. You don't see a lot of large series anymore. Certainly not in Dutch industry. It is all about small series and large flexibility. Products generally have a continuously shorter lifespan. Think of potato chips, in the past you could choose between a natural or sweet pepper flavour, now you continuously have new flavours. These new products repeatedly require new packaging."

Knowledge NTS has of propulsion and print systems is unique in Europe

"What NTS does in the field of propulsion and print systems and the experience we have in this field is unique in Europe. Not a single other company has the expertise that we have in the combination of motion control, electronics, software and mechatronics. We do not sell products of our own. Our services consist of helping our customers design and develop customised print systems and parts of these systems in order to manufacture them in series." ■

Algeria like a local student

By: Sander Verdiesen

Awestruck, I am looking at the greatest structure I have ever seen. The Djamaa el Djazaïr mosque has a footprint of 20,000 square meters and features a minaret of 260 meters high. This makes it the largest in Africa and the third largest in the world. I ask my Algerian friend how much it costs. "2 billion US dollars" he answers. As I let this enormous figure sink in, he adds, "imagine the number of hospitals we could have built". This was one of many times during my trip that I noticed how deeply discontent people are with their government. Two months later the largest protests in history erupted in Algeria.

At the end of December 2018 I started out my trip through Algeria in the capital Algiers. Some local students took care of me during my time there. They showed me around the city center which looked very similar to Paris, because Algeria used to be a French colony. I encountered the famous North African hospitality throughout the city. Random people invited me to have tea with them or to show me the local mosque. The coolest (and most dangerous) part of my time in Algiers was spending a day at the back of a moped. Algerian roads are in very good condition, but the traffic is crazy since hardly anyone obeys the rules.

During a late night discussion with an Algerian about his discontent about the government I got to know another piece of the puzzle. In the 1990s Algeria was plagued by widespread terrorism. For many years Algeria was a dangerous country and bloodshed was common. Only after the current president, Abdelaziz Bouteflika, took power, the situation improved. People remember these dangerous times all too well and are afraid to rise up against the ruling elite. "We don't want to end up like Libya" he said.

The second city I visited was Constantine. This city is built around a canyon and offers some truly amazing views. You can cross some of the squeaky bridges or take a trip to one of the many Roman ruins scattered around the city. I spent most of my time here with a group of university students who taught me a lot about everyday life in Algeria.

Here I got to know how the government has managed to keep its population silent for so long. This has to do with making people think Algeria is doing great. Firstly, the government made sure that fuel and education are really cheap. By doing so people are no longer able to complain about their basic necessities. Secondly, it is difficult for foreign investors to invest in Algerian businesses, because the government will take half of any foreign investment. This diminishes the exposure of Algerians to foreigners, which makes it easier to influence their opinions through state-owned media outlets.

The last city I visited was Annaba. This coastal city is one of Algeria's top tourist destinations, because of its beaches and many hotels. I stayed with a very progressive couple, who introduced me to their family. Annaba is surrounded by hills and cliffs, which offer some amazing views.

As we were driving through the city's surrounding areas, we drove past an area full of large mansions and villas. My host explained that these are owned by the elite and their families. Outsiders are not allowed in and from stories he knows that life there is great. He told me that they have the best food and they do not have to worry about anything. This goes to show to what extent the wealth of the country is concentrated in a very small part of the population.

I spent a little over a week in Algeria and I met many friendly, hospitable and interesting people. Two months after I left, the greatest protests ever broke out in the country. I stayed in touch with many of the people I met and all of them were protesting. At the time of writing this column the president has been ousted, but the protesters want to see many more reforms. I sincerely hope that when this article is printed, the situation in Algeria has not deteriorated towards a similar fate as Libya. ■

Career after EE

By: Johan van Uden

It is the 27th of February 2014. Today I will receive my Master's Diploma after spending quite some time at the TU/e. I'm a bit more nervous than I should be, but that is because I'm also going to propose to my girlfriend during the ceremony. My life after EE has already started, as I just started working in my first job a couple of months ago. "Where do you see yourself in five to ten years from now" was one of three questions I got when doing my job interview. And this is a question that is quite hard to answer, as a lot can happen in ten years. But for this article I was asked to do exactly the opposite, describe what happened over the course of the last five to ten years, after I left EE and the TU/e.

I think there are still two things in my life, apart from my family and friends that are still in my life since I left EE. The love of my life (who actually was my girlfriend back then, and is my wife today – luckily she said yes) and my very first car (which actually was my daily driver back then, and now sits a lot of time in my garage). But apart from that, a lot of aspects changed. For starters, we have moved a couple of times. Three times to be precise, and currently while writing this article, I'm still unpacking boxes from the last move. I went from a student room, to moving in a small apartment together with my girlfriend, to a house in the city center of Eindhoven. Since we have become parents of a beautiful daughter Lisa with the second underway, we decided to trade the city of Eindhoven for the more spacious village of Heeze (back to my roots as I was born there many years ago).

For some more background, I started at EE in 2004 (the Automotive bachelor didn't even exist back then) and became active in all parts of the student life. I joined Thor and was active in six committees, spent quite some time in Het Walhalla and was an active member of University Racing Eindhoven (URE). So, back in 2011 when I finished my bachelor end project at URE, I decided to do my master Automotive Technology and traded the well-known E-hoog building for W-laag. During my graduation project I laid the foundation for my professional life, because I was able to combine two things for which I share a great passion since I was a little kid: technology and motorsports. I got involved with a couple of other students, all from different faculties, and together we started InMotion.

On the 30th of May 2012 we officially kicked-off the InMotion project, which at that time existed of around ten different master graduation assignments all linked together by one futuristic race car. My graduation research inside the team revolved around model-based development of vehicle software for our car. But in the meanwhile we were also setting up the entire project, doing sponsor meetings, and arranging everything else that is needed to start-up a company and/or student team. At the time we all graduated, we decided the project would be best continued as a student team and we also had the task of finding new enthusiastic students to continue the work, while we all searched for our first jobs. I am still very much involved in the InMotion team today, so that's another constant that remained over the years, however the role inside the team changes from year to year. This makes it very dynamic and keeps it really interesting to stay involved. ▶

It was just before my graduation that I started talking with ICT Group (ICT) and I actually wasn't very interested due to the vague name at first. But when I looked further into what they did, I found out that there was a lot more to it than just ICT. So, this lead me to their automotive software unit, where I started out as Software Engineer. Within automotive, Software Engineer meant almost automatically embedded software in C at that time (and still, for the larger part). However, I became specifically interested in ICT's project around Model-Based software development. This was a perfect match to what I had been doing during my graduation project.

The match even got better when the first working prototypes of our platform needed a technology demonstrator, and at the same time InMotion needed ECU's and software to run the full electric formula racecar. At that point I presented the case together with my colleague to the management of ICT, and as they also saw the win-win situation, they decided that ICT would become a sponsor of InMotion. How about making turning your hobby into a profession! That this collaboration was indeed a big success became even more evident after breaking three lap records together.

This success proved that the platform I had been working on with some of my colleagues was ready to become a commercial success as well. Since we developed the project within ICT with a small team, and product development was at that time something new in an organization which did 80% secondment, I got a chance to do everything you would do in a start-up within the luxury of a large organization. With a small team we did marketing, branding, development, and commercialization. This really relied as much on the soft skills as on the technical part. At that point my interest and focus also changed more towards everything in the project that was not purely technical development.

After some very good discussions within ICT it became clear that I was ready to move on from the engineering, more towards a consultancy role. And that is why I still love what I do every day. In this role I got a lot more responsibilities and variety. In this role I get to visit potential customers together with a sales consultant to discuss technical issues and make an estimate of the time required to develop a solution. For this I can use my network and domain knowledge gained during my studies. Furthermore I look inside the organization to talk with different specialists about specific technical challenges. Presenting for the board, customers, at a conference or for a group of students is also part of the job. The nice thing about all of these tasks, is that this is more about communicating with people than just about technology itself. In this way I have the luxury to talk about the subject that has my interest and meet new and exciting people while doing this. Sure that the "Connie en Olga" (non-technical skills) have helped me greatly in this part of my job.

So, looking back at the start of my life after EE, a lot has changed and my life today does not look at all like it did while I was studying. However, I think that all the changes were very positive and some of the major ones wouldn't have been possible without the things learned during my study years. ■

Career day

By: Martyn van Dijke

This year I wanted to do something different, something unique, something that has not been done before in Flux: organizing a Career Day for only Electrical Engineering and Automotive Technology students. The intent of this day was to organize a smaller, easier accessible and trimmed down version of the Career Expo from Wervingsdagen. While the Wervingsdagen offers an awesome and large event, it's hard for students to find time to go to the Career Expo outside of lecture hours and to talk to the really interesting Electrical Engineering companies. The idea behind the Thor Career Day is to bridge this gap and provide a fun alternative for the Career Expo.

Who participated?

Since the intent of the day was to provide a large scope of companies unknown to EE and AT, I have done my best to arrange an as diverse as possible line-up of companies. Laying a good focus on Automotive Technologies companies, in table 1 you can see the companies and one student team (InMotion) that attended the Career Day.

With this line-up of companies, a large part of the studies is covered, from power quality to RF amplifier design and from RF to Control Systems and from Control Systems to manufacturing automotive components. With these companies, all students could talk to a company of their interest, which they wanted to know more about. For instance, what it's like to work there in the near future and what's the company all about.

Students in conversation with Royal IHC.

Company	EE or AT
HyTEPS	EE
Schneider Electric	EE & AT
Denso	AT
Ampleon	EE
Royal IHC	EE & AT
Alliander	EE
InMotion	EE & AT

Table 1 : Listing the companies and their expertise

How did it go?

On the 14th of February, it was time to make it happen and see if my plan for the Career Day was any good. In general, the day went really well with about 100-150 students from the department of Electrical Engineering dropping by, grabbing some provided free lunch and talking to the companies they were interested in. Overall, the companies and I where happy with the turnout and the interest from all the students!

With such a large event, there are always some small and some unforeseen problems that need to be fixed. The most notable problem of the day was that the provided free lunch did not come with napkins to hold the sandwich to not make a mess. But luckily the Spar in Flux sells plastic plates, so after buying all of their plastic plates, this issue was quickly resolved.

Martyn van Dijke

Commissioner of Public Relations of e.t.s.v. Thor ■

Students being explained the inner working of HyTEPS products.

REXUS 25 rocket launch

By: Mark van Wijtvliet

On the 11th of March this year the REXUS 25 rocket carrying the PR3 experiment was launched from Esrange Space Center in Sweden, 150 km north of the Arctic Circle. The experiment, built by students from both TU/e and Radboud University, performed two experiments during the flight that reached 82.4 kilometers of altitude. The rocket, and launch, are sponsored by the Swedish, German, and European space agencies and is part of the REXUS program. This program launches two sounding rockets every year. Student teams from universities can submit project proposals and, when selected, fly their experiment on one of the rockets. PR3 is the first Dutch team to pass the selection.

Rocket localization

The first goal of the PR experiment is to localize the rocket during flight. Although the rocket has GPS on board, GPS becomes very inaccurate under high accelerations. For the REXUS rocket, the initial accelerations are quite high (over 20g) and lead to large location inaccuracies. To overcome this, the goal was to test localization using radio-interferometry. This method is based on measuring the phase differences of a signal transmitted by the rocket. The PR3 section of the rocket payload has three antennas mounted to the outside of the rocket. Each antenna is connected to a transmitter and transmits a distinct carrier frequency. These frequencies are received by six ground stations that are placed all around the launch site. The phases measured by the ground stations are sent to a central computer that computes the location of the rocket during flight. Phases are measured at 1KHz and the accuracy is expected to be around 10cm.

Radiation measurement

Electronics in spacecraft are sensitive to cosmic radiation. This radiation can cause temporary or permanent faults, which can lead to all kind of problems (even loss of the spacecraft itself). To provide insight in the current 'health' and expected lifetime of the spacecraft, information about radiation is important. This allows faults to be correlated with, for example, solar activity. Unfortunately, radiation sensors are typically quite large. This means that miniature satellites such as CubeSats (approximately 10x10x10cm) cannot use these sensors. The second goal of the PR3 payload is to show that standard CMOS and CCD cameras (like the ones you can find in a smart-phone) can be used to detect radiation. To do so, the cameras are blocked from visible light and tuned to be very sensitive. When a particle hits the pixel-array of the camera, one or more pixels light up. By detecting these pixels, thes particles can be counted. These sensors are typically very small (less than 1x1 cm) and easily available.

The launch

One day before the launch, all ground stations were placed around the launch site and tested. The rocket payload was integrated with the rocket systems and tested together with the other experiments. After several tests, during which everything went according to plan, the decision to launch was made by the organization. The rocket launch was very successful, all systems operated as expected and the rocket returned safely to earth. The PR3 team is currently analyzing data. However, the first indications for both experiments are that they have been quite successful.

A video of our time (and the launch) can be found at: https://youtu.be/WY7nHtl4u0o ■

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Fulfilling the American Dream

By: Jasper Sleumer

One of the many streets in Downtown Seattle.

It has been a truthfully wonderful experience in the USA during my four-month stay for my internship. I stayed in Seattle, Washington, known for its first Starbucks location, the Space Needle and some of you might recognize it from the Grey's Anatomy series. Everyone has a particular idea about the stereotypical Americans, including me. Well, I can tell you, if you stay longer than a two-week trip in the US, your view on the Americans will change! I've learned a lot about the American culture, I've seen a lot, did a lot of activities and, of course, the internship itself made me learn a lot as well.

If you have the opportunity to go abroad (internship, graduation project, etc.), grab that chance and go for it! It might come along with a long road from finding an internship project up until you set foot in the country itself, but it is all worth it.

Inside of the University of Washington's marvelous libraries.

The process of only getting the visa to enter the US took me three months. Since high school onwards, I always wanted to stay for a longer period in the US, hence this internship provided me the possibility to do so. Finally, on October 3rd, I set foot in Seattle, let's get this exciting period started! Within the first week, you are being confirmed that all stereotypes you have about America are true. There are numerous fast-food restaurants, Starbucks is on every corner of the street, the houses look like those in Home Alone, sport is a huge thing, Americans can exaggerate a lot, racism is still a big thing among the Americans, they have big cars, and distance-wise going from A to B is very far. America is simply very big in every aspect.

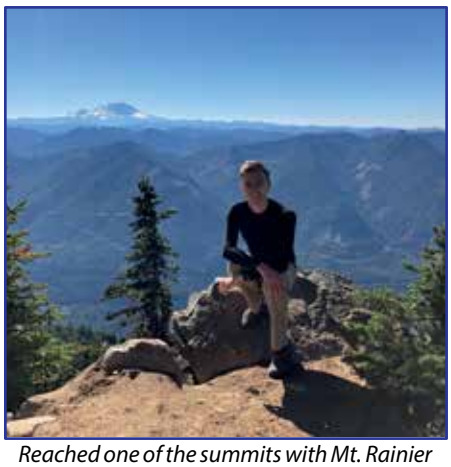
Internship project

The internship was at the University of Washington (UW) which has a truly amazing campus! It was established in 1861, so there are still some very old-like buildings, including one of the libraries. When you walk across this huge campus, you will also find cute gray squirrels between the large number of trees, large squares, and students that wear these famous college/university hoodies which are in the UW colors: gold and purple.

The Neurosurgery department from the UW Medical Center and Ultrasound laboratory works closely on a study which uses ultrasound techniques to detect the severity of a spinal cord injury. The use of ultrasound to image the spinal cord is worldwide very new, so it was still in an experimental stage. My project was on 3D rendering and registration of the ultrasound images that were acquired from an injured rat's spinal cord. I also had the opportunity to attend one of the surgeries where they injured the rat's spinal cord (in the name of science, of course) which was very interesting to see.

Homestay

One aspect of preparing before starting your internship experience is finding a home to stay. This can be quite a challenging task when you are still in the Netherlands, since you cannot quickly visit the apartment or room. There are quite some scams online so you want to check if it is all legit before you settle arrangements. To play safe I rented a room in a house via AirBnB for the first month. Once you're there, I had the opportunity to search and check for a ▶



Reached one of the summits with Mt. Rainier in the background.

Result after carving pumpkins for Halloween.

new place to stay since you can quickly visit the apartment/room of interest. In the first house I got to know great people from South Africa, France, Japan, Cuba and a local American. Together we watched movies, made sushi, played beer pong and carved pumpkins during Halloween. For the remaining three months I chose another AirBnB home which was occupied by less people so you had the feeling of being there with 'family', especially since we were accompanied by two very friendly (but naughty) dogs! We celebrated the holiday season together, including Thanksgiving, had a lot of Sunday morning American breakfasts (pancakes, eggs, bacon, baked potatoes, fruit, etc.) together, had some great and memorable drinks and supper

Right before the Football players show up

together, hiked in the Cascades (more on that later) and we visited the Zoo. They all made the stay in Seattle awesome and I learned a lot from these people as well, including cryptocurrency (the host was obsessed with this topics) and about the American culture.

Nature

Seattle is situated between Olympic National Park and the North Cascades, which are truly amazing mountains. After only an hour drive you're in the middle of the mountains that are more than 2km high. In the first month I met an American guy via one of my roommates who was into hiking. He was training to tackle the big Mount Rainier, a magnificent snowy volcano that can be seen from a lot of places in Seattle and surroundings. Together with him and later with another roommate, we set out for a couple of hikes in these beautiful mountains. In the Netherlands you first need to drive for more than five hours to get into the Alps to get these kind of views and experiences, so every hike was amazing (but

College football in action. Go Huskies!

challenging sometimes). The views you get on the summits were very memorable, as you don't see those every day. This is also one of the things I miss now that I'm back in the flat Netherlands again.

Activities

Next to your internship 8am-to-5pm job, there are a lot of things you can do. Therefore I visited downtown Seattle a lot of times, where you had Pike Place Market, a nice waterfront, lots of restaurants, shops, malls and of course there was a Starbucks on almost every corner of the streets. A little further from downtown there were some nice museums as well which I can recommend you to go

to if you're in Seattle. One of them was the Museum of Flight which had a lot of incredible and astonishing airplanes standing or hanging from the roof. They even had the Blackbird, the Concorde and the Airforce One (the presidential airplane) exposed. If you're an Apple fanboy, you should really visit the Living Museum: Computer + Labs museum since you have the chance to see and

Thanksgiving dinner. The dogs were so jealous!

to experience the complete lineup of Apple computers, from the working (!!) Apple I up until the Apple iMacs. Sports is the Americans number one

On top of another snowy summit.

activity (i.e., doing it or watching it while drinking beer in sports bars) and its number one sport is American Football. The University has its own college football stadium where The Huskies played every two to three weeks. I attended two of these games with UW student friends and these were amazing! Next to the hamburgers, the Americans, and buildings, also the sports games are so huge in terms of entertainment! A professional soccer match in the Netherlands is nothing compared to this kind of caliber. Before the game, we had some pre-drinking games on Greek-row (that's where all the fraternities and sororities are) so I experienced the true student life that you see in the movies as well. The first American football game I

attended started at noon so we started partying at 10am already. The day was such an experience! I also had the luck

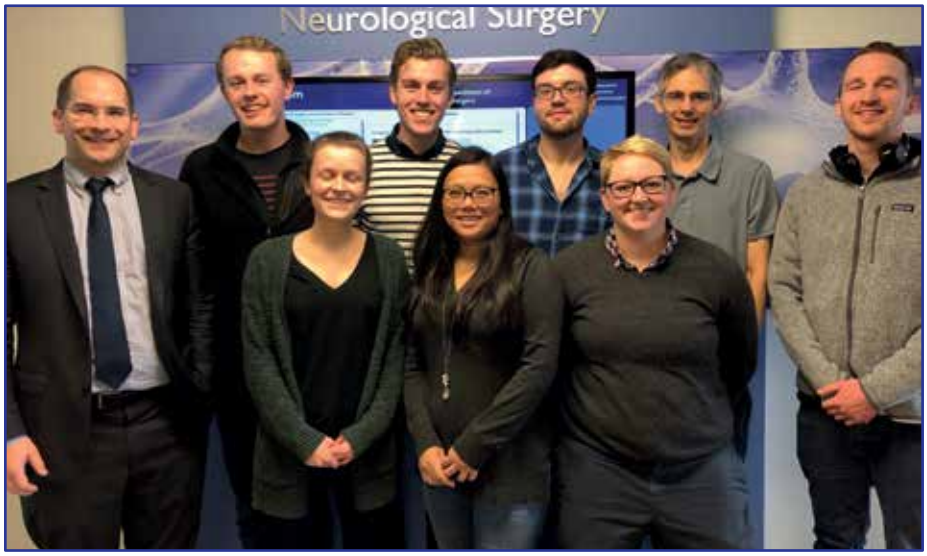
My girlfriend and I got the chance to meet Dubs and Harry, the UW's mascots!

to watch the Super Bowl game, the biggest American sporting game of the year, with my roommates before I had to head home again a week later. There are many more activities I have done, such as attending a Halloween party, going on a weekend trip to San Francisco, running a Christmas race, walking through candy cane lane, checking out the craziness of Black Friday and visiting Vancouver, Canada with my girlfriend who visited me during Sinterklaas, and even more. It's just too much to write in two pages.

Final words

I can recommend everyone to go abroad during your studies. It makes you aware of a new culture and how things are handled in another country, and you learn a lot about things you never had to worry about before. For example, even though America has a western culture as we do, they are still very different in their standards and values. You also get to do and see a lot of things in detail you probably don't get to do and see here in your own country (or when you're on a holiday) which is incredibly interesting, awesome and valuable for your life experience. Although America is a great nation, I'm glad to live in The Netherlands but I'll definitely go back for traveling in the future!

Currently, I am sprinting toward my graduation by doing my graduation project at Philips until the summer. I often look back at four amazing, great, interesting and lovely months that no one can take away from me again. If you have any questions about my internship or how I fixed all the administration, you can always contact me. And if you are curious about what else I did more, I'd refer you to my blog I made during the internship (https://www.polarsteps.com/JasperSleumer/944918-internship-usa). ■



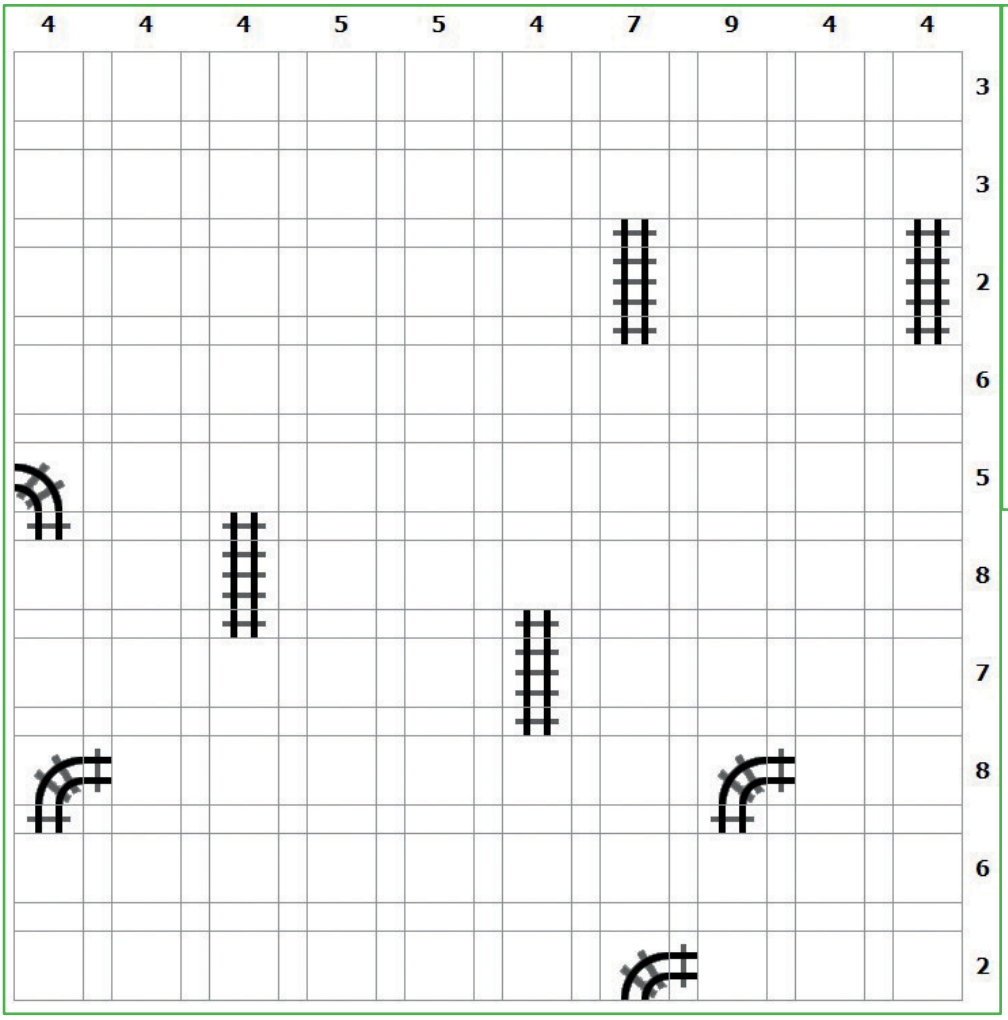
The internship project team

Weekend trip to San Francisco

Korean BBQ with colleagues

One of the beautiful spots of the campus

Puzzle



Rules

- Find the route of the track.
- There is only one start and one end to the track.
- The track doesn't cross itself.
- The numbers across the top and down the side tell you how many track pieces are in the respective row or column

Please send your solution to connecthor@thor.edu before the 26th of July.

Previous puzzle

The previous puzzle in Connecthor 45 was about sacks of flour that had to be moved. Congratulations to Martijn de Kok for solving this puzzle!

Answer: The way to arrange the sacks of flour is as follows: 2, 78, 156, 39, 4. Here each pair when multiplied by its single neighbour makes the number in the middle, and only five of the sacks need be moved.

There are just three other ways in which they might have been arranged (4, 39, 156, 78, 2; or 3, 58, 174, 29, 6; or 6, 29, 174, 58, 3), but they all require the moving of seven sacks.

More Stuff

By: Tom van Nunen

When I look in the mail, I notice dozens of catalogues full of stuff that I need to have. When I scroll through my social media feeds, I get bombarded with ads about all the stuff I am currently missing in my life. When I start a game on my phone, I even see an ad for an app that lets me organize all the ads, such that 'I don't miss anything'. I must be missing loads of stuff. Where did it go wrong in my life?

Some people regard stuff as a symbol for their success; lots of expensive stuff represent a successful person. Those people love to display their stuff, and make sure everybody around them notices. But does this really make these people happy?

I'm told there is also a generation that is all about sharing: sharing space, sharing transportation, sharing tools, sharing experiences. Away from the materialist mindset.

There are also people that can't buy or do anything they want, they really have to choose what they find the most important, and accept that they can't have the rest. Remarkably, they seem to choose expensive phones and brand shoes quite often.

On the other side of the spectrum, opposite from expensive stuff and experiences we value, is cheap stuff we don't need. Stuff that makes you wonder why it even exists. For example, my mom recently bought several small plastic things that prevent the string of a tea bag from falling into the cup. Another urgent problem solved.

We live in the age of AliExpress and eBay, online platforms that let us buy Chinese stuff for very low prices. These prices often become an excuse for buying something: it's only 2 euros, what could possibly go wrong? When something is broken on arrival, just ask for a refund, and when you don't like the product, just put it in a drawer or throw it away. After all, it's just 2 euros you wasted, and the shipping is for free.

Let's be honest: how much of this stuff do you have lying around your house? Products that only cost a little and you haven't used in years? And when you add the price of all those things, what other cool things could you have done with that money? Many times 2 euros can still be significant.

Let's be clear: I'm no saint. I also have this kind of stuff lying around. Some of it I use regularly, some of it 'could be useful someday', bought online for a few bucks. But if I wouldn't have had them, would I have missed them? Would I be less happy? Would my life be worth less? I doubt it.

It makes me wonder: what if we wouldn't buy all this stuff we don't need? What if we asked ourselves 'why do I need this', instead of 'why not?' The money saved per person might be small, but what about the reduction in environmental impact, caused by production, packaging, and transportation? This could in fact be quite substantial.

Usually, the parcels mention that their value is only a few euros, below a certain threshold, so no import duties must be paid. I recently discovered that there are plans to lower this threshold, which effectively means that import duties must be paid by default for all parcels.

I'm sure many people become angry when they hear about those plans. But is it really that bad? Maybe people will think twice now before buying something that they might not need, and that is shipped here from the other side of the world. Maybe they realize their money is better spent on something else. ■

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