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TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

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IN OUR TEAM

Rock Your Baby

Symposium on **DC Grids**

Engineering Knowledge and Practice

The Eindhoven **Hendrik Casimir Institute**

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

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The Connecthor editorial board, from left to right: Sanne, Jan, Pauline, Jos, and Jurgen.

Already three months in the new year and all restrictions of the past two years seem to be over with. We are finally at a point that we are back at Flux without having to wear a mouth nose mask. And that we can interact with colleagues and students like we use to. And if all that isn't enough the new season has started with some well needed sunshine.

This new edition contains many articles. Varying from introducing the new AI&ES master, the first-year design course "Rock Your Baby" to Whose desk are these? But also, about the birth of a new Institute at TU/e. Martijn Heck, scientific director of the new Eindhoven Hendrik Casimir Institute wrote an article on page 11.

Rabia Syeda wrote an article about her PhD topic "a sparse array topology approach to millimeter-wave radar systems" on pages 18, 19 and 20.

DSD Waldur organized a symposium last year on DC Grids. Menno Spitteler's and Mandy Heppe's article about the event can be found on pages 14 and 15.

Again we would like to draw attention to the fact that the Connecthor editorial team is severely understaffed. We could use some extra hands. Whether you are a student or a staff member, your help is more than welcome. Please join our team. If you need information about the workload or if you have other questions about joining our team, do not hesitate to contact (one of) us. We are more than happy to answer your questions.

The Connecthor editorial board,

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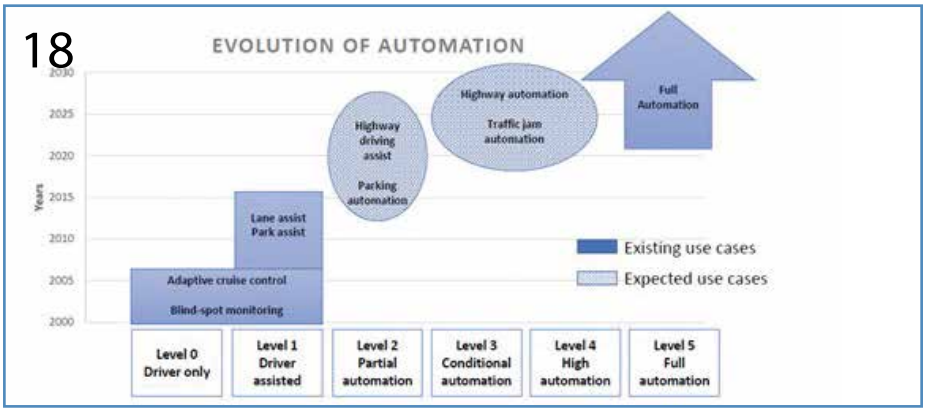
(Jan, Jos, Jurgen, Pauline and Sanne)

Symposium on DC Grids
Master association Waldur organized a symposium on DC Grids. Read all about the event itself and what it takes to organize on pages 14 and 15!.



A sparse array topology approach to millimeter-wave radar systems; is it a vantage point?
Rabia Syeda tells everything about her PhD on the sparse array topology approach for millimeter-wave radar systems on pages 18 to 20..

Eindhoven Hendrik Casimir Institute
Martijn Heck introduces us to the newly founded Eindhoven Hendrik Casimir Institute on page 11.

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Board issues

By: Bart Smolders

Due to the Corona restrictions, we again have been forced to organize an online version of our traditional new year's reception. Normally, I would prepare a short speech summarizing the high- and lowlights of 2021 and the plans for 2022. This year, we used the "flipped classroom" concept and invited the group chairs to present their plans for 2022. The nine group presentations confirmed the richness and diversity of our department, with topics ranging from electromechanics, medical imaging towards communication and sensing.

Still, I would like to share a couple of very relevant agenda items for 2022 with you. In 2019 we managed to organize a structural financial impulse (Sectorplannen) for the three Electrical Engineering departments in the Netherlands. As a result, we could hire 14 new scientific staff members in our department including additional start-up packages and investments in our labs. All groups have benefited from this and the first results are already visible. Last year, we had a record number of PhD vacancies and submitted VENI/VIDI/VICI proposals. Other good news is that we currently are preparing a follow-up of the previous plans, known as "Sectorplannen 2.0". The idea is to extend our fundamental research to explore new research areas at the crossovers of existing disciplines. The crossovers could be found within Electrical Engineering but might also be connected to existing research domains of other departments. Next to these sector plans, there are several major opportunities for our department to acquire new funding. A nice example is the growth fund (Groeifonds) for which we already participate in a couple of proposals. Make sure that your group is also connected to new initiatives! Note that our centers can also help you to connect to new proposals.

Regarding education, we have several items on our to-do list for 2022. First of all, we are very pleased that our new master program 'Artificial Intelligence & Engineering Systems' (AI&ES) has been registered in the official educational program of the Netherlands and will start in September 2022. AI&ES is a joint program between seven departments coordinated by the Electrical Engineering department. It is a unique interdisciplinary engineering program for students from a broad range of bachelor programs with the aim to understand, study, develop and research new systems at the interface between artificial intelligence and advanced engineering systems. Next to this new master, we are working on a major redesign of our bachelor program, which should start in September 2023. The new bachelor will allow for more mandatory EE courses and will fix a couple of issues of our current bachelor program.

Please do not hesitate to contact me personally if you have a question or suggestion on one of these topics of our to-do list.

Bart Smolders, a.b.smolders@tue.nl

From the President

By: Mart Philipsen

In my last edition of 'From the President', I talked about changes and how this year would also be one where we'd be likely to see changes to our lives. In the time between receiving the previous Connecthor and writing this, we've been through noticeable changes already. Just before the Christmas holiday, a lockdown was announced, forcing us to work from home again.

For us as the Board, this gave us some extra struggles, as suddenly we had to prepare for an online GMM, which was planned on the Monday and Tuesday of that first week in lockdown. As we had never organized an online GMM ourselves. It resulted in talking to predecessors and making sure all preparations were in order over the weekend. Fortunately, we could still enter Flux to get all our suits and, of course, my hammer Mjölnir.

Working from home meant that the usual chaos that we experience while working in the Board room decreased significantly. Suddenly, I was back in my room alone, with social interactions being reduced to meetings and talking to some members on our Discord server. This did give me time to finish some tasks I wanted to finish before the holidays, but it was not how I imagined finishing the year.

Being able to work a bit more efficiently also gave me the chance to pick up some hobbies again. I found myself picking up my bass guitars more frequently that week, something I hadn't been able to do as much as I wanted to in the past few months. When I had a few minutes between meetings, I would pick up my instrument and play it. Whether it would just be playing some random notes or practicing a specific song, it gave me some rest and made me be able to work more efficiently afterwards.

On Thursday that week, I found myself with no meetings or specific tasks to finish that day. I did have a list of things to do before the end of the year. Not wanting to have to do these tasks between Christmas and new year's, I thought back to the past week and how taking little breaks helped me keep my focus. This reminded me of the 'Pomodoro technique', a technique where you set a timer for 25 minutes and work during this time, and then take a break for 5 minutes. In the morning, I picked a song I wanted to learn that day and got to work. Taking many short breaks at a set time felt forced and weird at first, but as the day proceeded, I noticed that, whereas my focus normally would fade throughout the day, I actually got a lot done and felt like I was just as focused at the end of the day as I was at the beginning. Not only did I get more done that day, but I also got to finally really exercise my bass playing again. In the past few weeks, I have noticed I'm playing it a lot more often, even now that I'm working in the Board room full time again. One thing that did not stick, is my use of the Pomodoro technique. I did try for a day, but I quickly noticed that there is too much chaos in the Board room for such a structured technique and such breaks do not lend themselves well to the everlasting stream of people going in and out of the Board room.

The efficiency is something I do miss, but I still prefer working at the university over my room, as I enjoy the interaction with members and the spontaneity that comes with it too much. That is why it is also great that we can see each other in Flux and Het Walhalla again.

Veel gedonder!

Mart Philipsen
President of e.t.s.v. Thor ■

Introducing...

Hi everyone! My name is Bernat Molero, and I recently joined the Photonic Integration (PhI) group at TU/e to work at the PICOSTAR (Photonic Integrated COherence Scrambler Through phased ARrays) project as a PhD candidate.

Some of you may have already met me. For the ones that didn't, I come from Barcelona (Spain), where I studied my bachelor in Physics and my bachelor in Mathematics in the Autonomous University of Barcelona (UAB), as well as my MSc in the Barcelona Institute of Science and Technology (BIST). I have been working in different institutions and companies, such as ICFO and Quside Technologies. It was there where I fell in love with Photonic Integrated Circuits and that's why I am now here to do my PhD.

Well, a part from all these aspects of formal presentation, the thing I want you to keep is that I am a really social guy who is really passionate about what I do. My interests range from sports, travelling and (some) computer games, to entrepreneurship, reading and self-growth.

In brief that's who I am, I hope we meet each other soon in TU/e!

My name is Janneke Cohen, I am 21 years old and I was born and raised in the neighborhood of Eindhoven.

After graduating from my bachelor education of International Business in July 2021, I applied for a vacancy position at the TU/e. Currently, I work for the departments of Applied Physics and Electrical Engineering and assist in the fields of Central Student Administration and Internationalization. I am very proud of the city Eindhoven, it is a place very close to my heart. Therefore, I utmost enjoy my work, since I welcome and assist students that study at our university and come to Eindhoven.

To pleasantly help students, assist them in their international experiences and prepare the graduation procedures of our students, has resulted into my passion. Both the teams of Applied Physics and Electrical Engineering are a joy to work with and have been really supportive throughout my new months of being an employee. In my spare time, I enjoy travelling, visiting new places and learning new languages. Next to this, I love spending time with my family and friends while enjoying good food.

Hi everyone, my name is Frederique de Raat and from the 1st of December, I have joined the Signal Processing Systems group as a PhD student. My thesis is part of the ACACIA project (Advancing Cancer Care and Cardiac Care through interpretable AI) and will focus on the validation and implementation of an AI clinical predictive tool for optimizing post-operative cardiac care for patients prone to hemodynamic deterioration. During my master thesis at the Catharina hospital, in cooperation with Philips research, I focused on the validation of handheld echocardiography for stroke volume and left ventricle ejection fraction quantification in comparison to standardized echocardiography. My fascination and enthusiasm about advanced critical care grew even more during that period, which eventually resulted in the desire to do a PhD in this field of research. Since physical and mental health go hand-in-hand, I love doing sports in my spare time. Heading towards the summer, I always try to participate in several triathlons but since this summer I like playing beach volleyball as well. I like to cook, listen to music and play the piano, but it's never as enjoyable if not shared with family and friends. I am looking forward to this PhD endeavor and will hopefully create new valuable collaborations. Please don't hesitate to reach out if you have any questions.

Hello everyone! My name is Hande Bayazit and I recently joined the Electromechanics and Power Electronics (EPE) Group at TU/e as a PhD student. My research interests include analysis, modeling and condition monitoring of electrical machines. During my PhD, I will be dealing with building digital twins for traction machines. These will enable us to predict the lifetimes, optimal operation regions and failure probabilities of the machines that are used mainly in automotive applications.

I was born and raised in Ankara, the capital city of Turkey. (Yes, surprisingly, it's not Istanbul.) I got both my bachelor's and master's degrees from Electrical and Electronics Engineering of Middle East Technical University (METU), Ankara, where I also worked as a teaching assistant for 2.5 years. In the senior year of my undergraduate and my master's studies, I specialized in electrical machines, specifically on fault tolerant multiphase topologies.

METU has a pretty large campus (approximately half as large as the whole city of Eindhoven), most of which is forest. Having spent quite some time there, I already feel at home in the beautiful nature of the Netherlands. I like cycling and exploring new places, practicing yoga, cooking, and spending time with my cat in my spare time. I look forward to meeting new friends in TU/e!

Hi everyone! My name is Tristan Stevens, born and raised in the Netherlands and just started my PhD at the SPS Biomedical Diagnostics group. This summer, I finished my masters at the TU/e with my thesis titled: "Accelerated Intravascular Ultrasound Imaging using Deep Reinforcement Learning". I have a true passion for fundamental deep learning techniques, applied in the field of signal processing. Currently, I am very proud to be able to focus this passion towards research in the field of medical ultrasound.

Before I dived into the realm of signal processing, I started my interest for Electrical Engineering more from the hard-core electronics angle. Specifically eying automotive and clean mobility, which culminated in my previous job at Lightyear (Dutch solar car company). I hope to be able to combine my knowledge from both these domains during my research here at the TU/e.

Research is fun and all, but you have got to live a balanced life. I love to play music, and my sports of choice is basketball (both playing and watching). Recently, I started getting into the game of chess and co-founded the chess association (Noesis) here at the university. Hope to meet all of you soon!

Hello! My name is Priscilla Allwin and I'm from Chennai, India. I started my PhD in the Electronic Systems (ES) group at TU/e in November 2021. I received my bachelor's degree in Electronics and Communications Engineering from Anna University, Chennai and my master's degree in Electrical Engineering from Wright State University, USA. I worked on the design of low power and area efficient data path components during my masters research and really enjoyed the experience of learning something new every day.

I aspire to become a research scientist in the future and TU/e is the best place to work on cutting-edge technologies and to also improve my research skills. In the ES group I will be working on developing circuit level innovations to reduce the dynamic power consumption in components that are involved in computation and data movement operations inside the processing hardware for 5G communication systems.

Besides research, I enjoy travelling and exploring new places, I look forward to exploring what Netherlands has to offer as soon as the lockdown situation gets better. I also love cooking and experimenting new dishes and making new friends. I am excited to meet more colleagues at TU/e in this new year! ▶

Introducing...

This is Sarvin Moradi from Iran. I have just started my job as a PhD candidate in January 2022, and now I am a member of the Control Systems group in the department of Electrical Engineering. My research will be focused on the physics-informed learning framework, where the classic physics laws are embedded in the state-of-the-art machine learning tools! It is a novel framework that can be used in almost every physical system. So hopefully we can extend it to various fields.

I have finished my bachelor's and master's degrees at the beloved University of Tehran, and I am really excited to follow my journey at the TUe. I am obsessed with art and music and enjoy discovering other cultures, so if you hear about any art event please send me an invitation!

Hello, everyone! My name is Carlos Jose Gonzalez Rojas and I am from Colombia. In November, I joined the Control Systems group as a PhD candidate and I will be working on the topic of digital twinning for food printing in the PRINTYOURFOOD project.

I earned a bachelor's degree in mechanical engineering from the Industrial University of Santander (UIS) in Colombia and a master's degree from the State University of Campinas (UNICAMP) in Brazil. As part of my master thesis, I explored the use of physics-informed neural networks for inverse problems, and during the last year, I participated in projects in the area of model order reduction for fluid flow using machine learning techniques.

I am a sports fan, and I also enjoy watching series and playing board games. I am glad to be part of the TU/e and hope to make the most out of it. ■

Introducing... the AI&ES master

Great news for all students interested in Artifical Intelligence and technology! As from September 1, 2022, TU/e will offer a new master's program that is for everyone who wants to learn about new systems at the interface between AI and advanced engineering. The Dutch-Flemish Accreditation Organization (NVAO) recently approved the accreditation of the program.

The Artificial Intelligence & Engineering Systems (AI&ES) master is intended for students interested in studying and researching AI methods and engineering techniques, with the aim of developing new products in a wide range of applications, such as robotics, smart cities, manufacturing, health and mobility.

Registration is open now! ■

Record number of students Rocking Their Baby

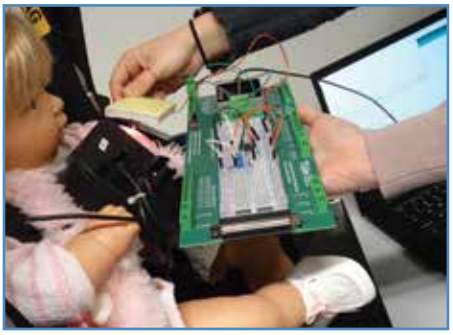
By: Jan Vleeshouwers

The first-year design course 'Rock Your Baby' was offered to a record number of 157 students this year. "That only works with the help of very many people and with the willingness of the department to invest in the course infrastructure", says Anne Roc'h, who shares the role of responsible teacher of the course with Michel van Eerd. Building and maintaining these setups has been the work of Michel and his team; next to the technical support, there were also ten staff members involved in coaching the teams. "This year, we were able to use half a floor in Traverse, which meant that all groups were working near to each other, and we had six babies instead of four last year, so there were less groups which had to share a single setup."

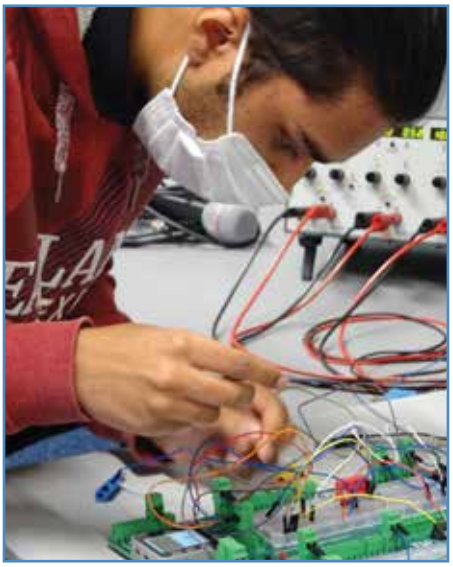
"Having this compact location works very well for creating a sense of community." This, Anne says, is one of the less obvious but quite important goals of the RYB-course. The course is running for almost ten years now. It is a nice introduction to the Care and Cure track in the EE bachelor program, but it has grown to be much more. It is an anchoring point for students, a kind of a 'rite of passage' most EE and many AU students go through in the course of their studies. The master students tutoring the groups all took the course when they were first-year students themselves, which for them highlights the development and growth they went through since.

Perhaps even more important than the community aspect that RYB provides, is being immersed in designing a real engineering system. Designing is core to almost every engineering activity. It takes time to master and cannot be learnt by the book, so a first encounter never comes too soon. It has to be followed by several more efforts before one becomes confident with the process, becomes a natural active member of a design team and becomes aware of her or his talents and weaknesses in it. Anne also sees that RYB's electronic circuit and programming aspects allow students to start finding out what engineering topics they like more and which less. Students really like making something, and it is heart-warming to see the enthusiasm of a student who finds the photo diode and exclaims that "now everything will work out fine!".

After seven years of teaching the course, Anne still enjoys seeing students develop and progress. It is not actually teaching, she says, but she rather supports the learning. It is all about letting students find out for themselves. When students look back, they regularly see the initial vacuum as the hardest part of the course. But it must be there; it is no use to just provide answers when a group is stuck. The questions that arise from being stuck make students discover their own creativity and their power to solve difficulties, even if it is through trying and failing a number of times. This is a fascinating balance which is different for all groups and students. Next year, probably for even more students than this year, and hopefully without the COVID restrictions. ■



The testing of a subsystem.



Preparing the circuit for the tests.

A group of proud students next to a baby-setup.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Eindhoven Hendrik Casimir Institute

By: Martijn Heck, scientific director EHCI

The new academic year also meant the birth of a new institute at the TU/e: the Eindhoven Hendrik Casimir Institute, or EHCI for short. Institutes are bringing together the research from multiple complementary departments to create synergy and to start new research lines. EHCI builds on the well-known photonics activities, many of which you are probably already aware of at our department, and we combine those with our TU/e activities in quantum technology. Why? Because we think photonics and quantum technology are two of the main technology pillars that will drive a sustainable information society, now and in the future.

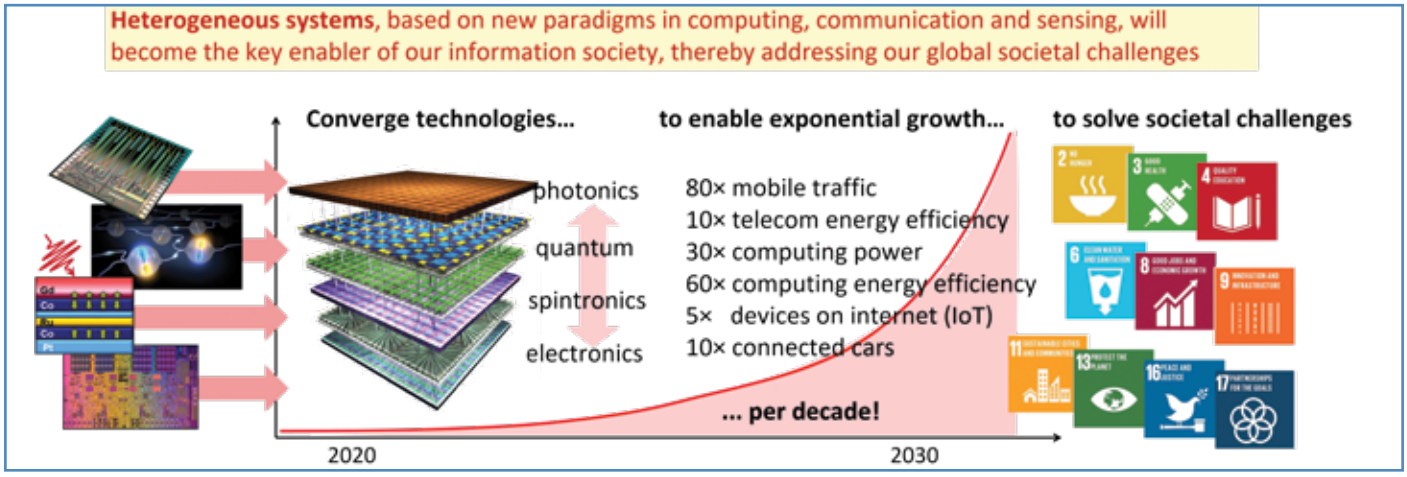
Our information society is built on so-called exponential technologies: technologies that explode in usage, performance, and/or complexity, for example. Think about Moore's Law and the internet bandwidth, as examples. EHCI will focus on such technologies for computing, communication, and sensing. Can we realize alternative types of computers that will outperform our existing ones, for example, using neuromorphic or quantum computing? How can we scale our internet, in such a way that we can grow it by ten times over the next decade, but also make it ten times more energy-efficient and secure? And how do we get sensors everywhere, from sensing single molecules on a chip, to remote sensing of dangerous goods, using various sensing modalities?

EHCI will focus on synergy to explore new research lines. We will actively stimulate groups to work together and to come up with creative and impactful ideas, to keep Eindhoven on top of the global technology rankings. It is important to note that photonics and quantum technology do not exist in a technology vacuum. In fact, actively pursuing synergy with "good old" electronics, but also novel technologies like spintronics, is very high on our agenda. After all, as we all know here at EE: although maybe an "old" technology, silicon transistors still rule the digital landscape and will not be replaced by photonic integration and quantum technology. Rather, such technologies will merge, into so-called heterogeneous systems and circuits. With our NanoLab facility, EHCI can become one of the major global players in this field.

Although we focus on fundamental and ground-breaking research, the interaction with applied technology is absolutely key. In fact, that is one of the main reasons we named our institute after Hendrik Casimir. As a former professor and director of the Philips NatLab, he was a proponent of the science-technology spiral: science strengthens technology, but the demands from technology will also pose new research questions and drive fundamental science.

Artistic impression of our future interconnected world

What does this mean to you? We now have our team up and running and we are starting to invest in the first truly collaborative research challenges. Furthermore, we have set up teams to address specific sub-topics, and we are starting to build the community. In the future, expect to see a lot of exciting talks, discussions, workshops and some symposia. If you are interested and want to know more, please visit us in FLUX 0.155 and follow us on social media: linkedin.com/company/tue-ehci. Wieteke, Marija, Gijs, Esther and Elvira will be there to bring you up to date. ■



Exponential technologies will drive our future sustainable information society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TU/e

1 - 3 & 11. Active Members Activity

4 & 8. Carnival Party

5 - 6. Monthly Lunch

7 & 12. Announcement of Prince Carnival

9 - 10. ACCI Pubquiz

Symposium on DC Grids

By: Menno Spitteler & Mandy Heppe

On December 1st 2021, the symposium on DC Grids was organized by DSD WALDUR, the master association for high power applications (EES & EPE). Speakers from TU/e but also RWTH Aachen and KU Leuven were presenting on the development of Low- and Medium voltage DC grids as seen from different abstraction levels : Component level: AC-DC links, system level: LVDC systems & MV Grids and finally regulations & standardization. Around 45 students were present and had many interesting questions and discussions.

Lunch

A very tasty lunch was served before the presentations. One of the main ingredients was "quantity" which students always like. Rumor has it that some even had sandwiches for breakfast the next morning…

Presentations

From KU Leuven, professor Johan Driesen was present. He is associated to the Energy Ville research initiative between VITO, imec, UHasselt and KU Leuven in Belgium. At Energy Ville they have a fully functioning Low Voltage DC grid on which they research DC applications in residential setting. His talk also featured many lessons from history to put current development into perspective. As many know, in the beginning of electricity grids, a great rivalry between Edison (DC) and Tesla (AC) took place. Tesla won because of the ease of transforming AC voltages, something which was difficult to do with DC until the rise of Power Electronics. Switching back to DC now can be seen as logical as generation (PV & Wind), storage (Hydrogen, batteries) and loads (computers, frequency drives) are all DC again.

dr. Tiago Castelo de Oliveira giving a presentation on the future of power links for smart grids

Two staff members of our own department also held a talk: dr. Tiago Castelo de Oliveira (EES) presented his research on flexible MVDC links. Power flow can be managed more easily in DC. Adding DC links to the AC grid can give the distribution grid operators more flexibility. Using hybrid links, capable of both AC and DC has major benefits when emergencies due to faults elsewhere occur.

Committee member Bram serving lunch for the participants

Professor Sjef Cobben (EES) discussed some of the ongoing discussions within the international standardization organizations on DC grids and applications. As well as Power Quality phenomena in DC systems. Electromagnetic compatibility is still something to take into account in all frequency ranges. He also discussed protection and safety of the systems, batteries and PV will always have some potential whilst inverters switch of rapidly when detecting abnormalities.

The final speaker of the day was Msc. Julian Saat from the Institute for High Voltage Equipment and Grids, Digitalization and Energy Economics (IAEW) at RWTH Aachen, Germany. RWTH Aachen is involved in the process of actually constructing a Medium Voltage DC Grid: The Flexible Electrical Networks (FEN) Research Campus, a collaboration between different industries and research departments. The grid will be 5kV bipolar (+/-2.5kV) capable of transporting 6.2MW between 3 buildings.

prof.dr.ir. Johan Driesen from KU Leuven about the use of AC sockets in the future

Julian also told us about his PhD research into the spatial planning of DC distribution grids by means of different algorithms and the implications of several topologies on redundancy, utilization and cost. He also showed a case study by adding a DC link to an AC grid to increase the control of power flow.

Organizing a symposium

Preparations of the symposium started in February 2021 this meant that we had plenty of time which was very nice since the committee existed of only 3 members. As much things as possible were organized and made far in advance such as the posters, banners and proceedings booklet.

However, 4 days before the event we got a call from the printing office. "we cannot deliver the goodiebags… That was a very stressful moment, luckily they offered an alternative which arrived 1 day before the symposium.

Also, doing groceries looked like a middle school math exercise. "Menno bought 55 bananas. Mandy carried 25, how many did Menno carry?" Luckily, at Lidl everything comes in boxes already.

The organizing committee, f.l.t.r.: Menno Spitteler, Bram Groenen, and Mandy Heppe

Lessons learned from organizing a symposium.

Organizing an event always comes with unforeseen challenges, here is a quick list of our main learning points.

1. Start early with the promotion
2. Speak to different professors if they know interesting institutions which are active in the field. They often even have contact persons!
3. Make promotion at related courses (in our case Electrical Power Systems from prof. dr. ing. Pemen)
4. Make a 'draaiboek' for multiple days before the event: who is going to prepare what.
5. 20L of coffee is a bit much for 50 attendees
6. Keep the boards of Waldur & Thor up to date, they will provide solutions for problems you did not know you had.
7. Coffee stir sticks are difficult to find, most grocery stores don't sell them.

Co-Co-Rona

Ow-no, I did not want to mention the pandemic… but again, as with so many events in the last few months we also had major uncertainty if the symposium would be allowed to take place. Luckily we envisioned this right from the start of the preparations and decided very early on to only allow TU/e staff & students making it a strictly educational activity. In the end we had to cancel the network drink which was unfortunate but understandable. Maybe Waldur will organize a network drink when it is possible again ;)

All in all, I think it was a very successful event with interesting talks and a very relaxed atmosphere. I would like to thank the speakers, my fellow committee members Mandy Heppe & Bram Groenen, the Sponsors TenneT & HyTEPS and of course the board of DSD Waldur.

Do you want to organize a symposium or another career oriented event? Contact board@waldur.nl! ■

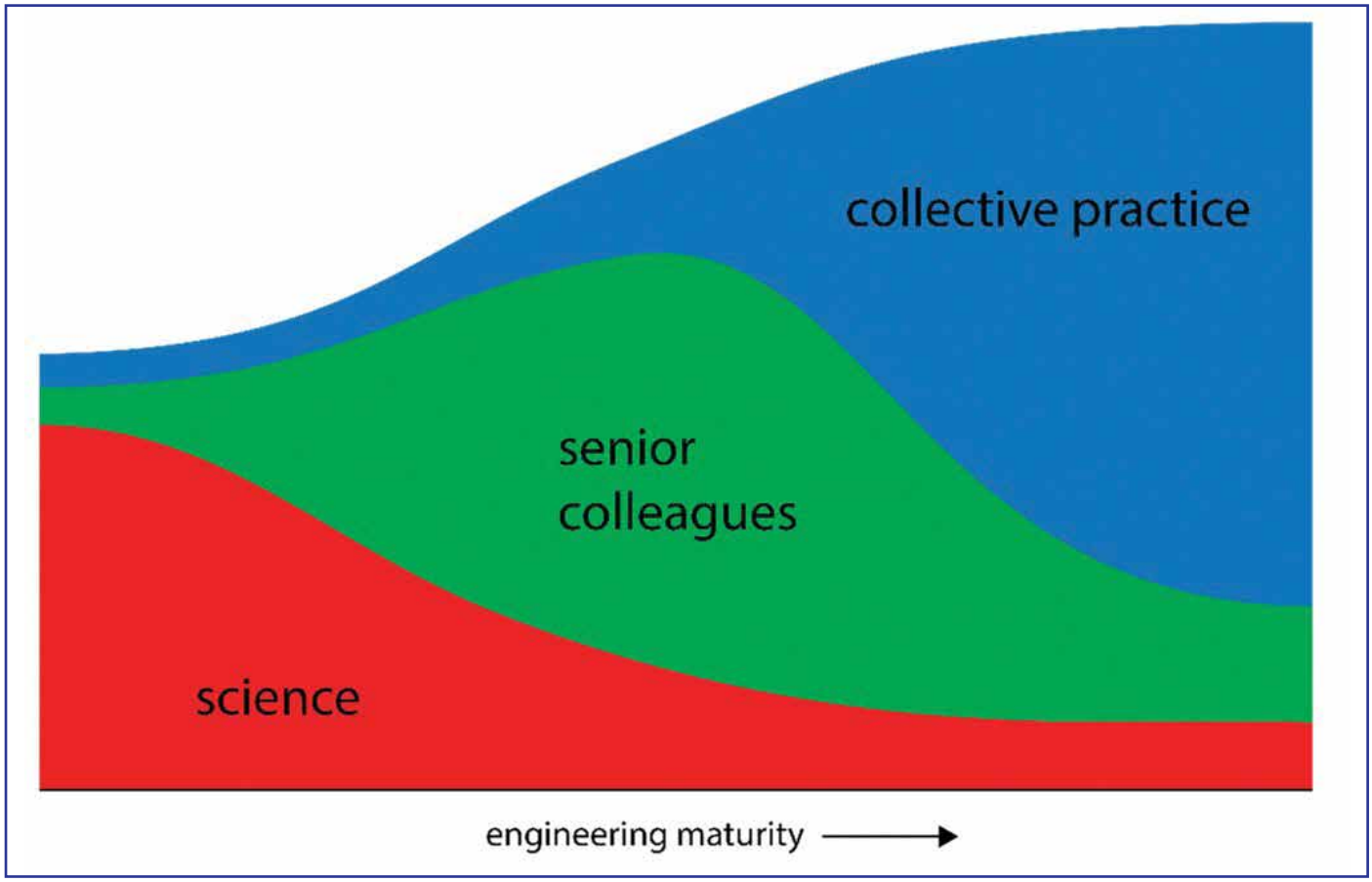
Engineering Knowledge and Practice

By: Jan Vleeshouwers

The idea was to follow up on the question of engineering knowledge and its recognition [1] by interviewing a couple of experts on our university on their views on how to proceed. How to highlight and teach knowledge which evades description and has a high dose of intuition? To prepare these interviews, I read 'Engineering Practice in a Global Context' (EPGC), a collection of essays [2] on the daily practice of engineers at work, hoping to find some general thoughts on the knowledge engineers actually use in their jobs. I'll conclude with the questions the book brought me, but the book provides a wealth of insights which I cannot resist sharing. The essays paint a picture of the different ways in which a developing engineering career relates to knowledge.

EPGC picks up the career of the exemplary engineer after high school. Although there are probably interesting developments before that moment, the focus of EPGC is on engineering education and training, so for now, skip childhood. Engineering students start with exploring codified knowledge. They are expected to become fluent in technical subjects as well as social subjects [3], but what humanity (or science) has already discovered, is overwhelming. You would never be able to grasp even a fraction of the relevant knowledge if you would have to find out through your own experience. By sheer necessity, engineering students have to turn to what others have found out and written down previously, because only this path will provide a sufficiently complete map of knowledge highways, albeit a weak and sketchy one.

The most crucial aspect that studied textbook knowledge misses, is the complementary action [4]. EPGC is painstakingly clear about that – in fact, it says, engineering knowledge does not exist outside of engineering practice. Practice is to knowledge what branches are to leaves. Come to think about it, both students and teachers often know this intuitively. But it is difficult to create practice contexts in a formal education setting: they must be serious and lifelike, and at the same time permissive to errors and allow to step back and learn from them. Our student teams may well be as close as you can get.



The action, the practicing of knowledge, both technical and social, is what defines engineers. EPGC stresses that, and supports it with evidence from observing engineers at work. While the brittle frame of the knowledge highway map is being constructed in the will-be engineer's mind, practice already starts to seep in: through group work, whether or not study-related, through jobs, internships and small research projects. But as EPGC shows, it really takes off only after graduation. Most engineers feel they become engineers in their first jobs, when being submerged in problem solving in complex technical and social contexts. In this 'learning-on-the-job', experienced colleagues provide the finely spaced, often tacit knowledge and the feedback needed to grow. By contrast, engineers indicate they hardly use the originally studied science subjects. They do keep using, however, the way of analytical thinking that came with the studying [5].

I'm not sure how to interpret this apparent uselessness of scientific knowledge. In the case of mathematics, EPGC relates disuse to one's original attitude towards studying the subject, and notes that math may be perceived of minor importance because it is always part of the 'bigger picture' that engineers are after. Also, math use is a small problem compared to communicating math results.

EPCG concludes that mathematics taught to engineers should stay close to engineering practice, including "mathematics discussions and subjective analysis". Still the authority of engineers comes from a thorough understanding of the laws of nature: without this understanding, no technical solution will fly. And finally the capacity to master physics and mathematics (and to be able to persevere in it) may be indicative of how good an engineer someone may once be.

After having actually become an engineer through close interaction with experienced colleagues and real engineering problems, EPGC signals a second transition, with again a new attitude toward knowledge. In this new phase, engineers generate new knowledge, triggered by cooperation in diverse (multi-disciplinary) teams. The diversity brings together a variety of knowledge perspectives, which need to be reconciled in order to solve a problem, design an artifact, create a device that works for people. The net result is new knowledge, which depending on its importance remains inside the team members' heads, trickles down to company protocols, or is further codified in standards, publications or books.

To conclude my summary of EPGC, the graph below paints the picture, showing the relevance of various kinds of knowledge, social as well as technical, in the course of an exemplary engineering career. (EPGC also notes engineers are more receptive to images than to text; so see the image on the previous page.)

So what questions arise from all this with regard to engineering knowledge?

To begin with, the essays do not picture engineering as a technical occupation, but as evidently mixed: 60% social, 40% technical. In fact, it is the connectedness between social and technical that defines engineering work: engineers try to match human imagination (inarticulate wishes, needs) to nature's possibilities, and they have to tweak both to make a match happen. This requires a firm grip on the regularities of nature and on the ways that these may be exploited. It also requires social acuity, to ground expectations but also to function in the inevitable multidisciplinary team which may make dreams come true. So if we call ourselves a technical university, aren't we ignoring half our mission?

Next, the essays confirm that knowledge is much more than what has been codified in books, drawings and recordings. Engineering knowledge needs practice and engineering colleagues to be spread, and engineers also create new knowledge, mainly of the tacit, uncodified type. The amount is impossible to quantify but probably huge. So the character of engineers is not one of knowledge sinks, absorbing the outcomes of science, but they are also sources, perhaps even primarily. The uncodified character of the knowledge circulating among engineers requires them to be excellent in exchanging it, a social activity pur sang. By consequence, shouldn't our engineering university also blend teaching and learning into one: exchanging?

Finally, engineers use and create knowledge in their engineering activities. That's a bit of a no-brainer, but it is important to see engineering knowledge not as something that gets poured into practice from the outside, but as something inseparable from the practical context. Engineering knowledge just doesn't exist outside practice. (Or at least: it is not meaningful to consider knowledge in isolation.) Scientific theories are abstractions from practice, from real world phenomena. Mathematics are extreme abstractions, which considerably stress the ties with practice. But still they are tied. Shouldn't our engineering university root our exchanging (teaching and learning) activities in real world engineering practice?

Three nice questions, but they share a premise that can also be questioned: should our university's practice (research and education) resemble engineering practice at all?

I hope you are just as curious about answers as I am.

[1] *J.M. Vleeshouwers, 'Can you make a resistor?' Connecthor December 2021, vol. 14, no. 4, pp. 10-11, Dec. 2021*

[2] *Engineering Practice in a Global Context: Understanding the Technical and the Social. Editors: Bill Williams, José Figueiredo, and James Trevelyan, 2014.*

[3] *EPGC, Chapter 3: engineering work is 40% technical and 60% social.*

[4] *EPGC finds support in the work of John Dewey (Chapter 1) and could also have mentioned Karl Popper.*

[5] *EPGC Chapter 11 focuses on mathematics. I assume that can be generalized.*

A sparse array topology approach to millimeter-wave radar systems; is it a vantage point?

By: Rabia Syeda

Radar imaging systems have become increasingly popular to capture a camera-like image and can be used for a wide range of commercial applications, such as security, health monitoring, and autonomous driving. mm-Wave Radar systems offer the ability to have a better performance under various weather conditions as compared to their alternatives, such as laser and optical systems. In order to replace or complement a camera-based system in these applications, the radar imaging systems have to meet stringent requirements such as a large bandwidth to realize a high range resolution, and a large electrical aperture to obtain a high angular resolution while keeping the size and cost to a minimum. Primarily these radar systems employ phased-array radar technology which results in large, complex, and expensive systems. Recently, the concept of Multiple-Input-Multiple-Output (MIMO) radar technology is being used as an extension of conventional phased array radars. MIMO radar offers several advantages including an increased angular resolution and reduced cost and energy consumption. In this PhD work, the challenges of designing and evaluating MIMO radars for millimeter-wave imaging radar systems were investigated and analyzed, that are briefly presented in this article.

In today's demand-driven era, technology primarily thrives based on the desires and requirements of consumers and so is the case with the automotive industry. The demand for safety, comfort and sustainability is rapidly growing for the car industry and hence the need for autonomous driving is thriving. Although in the past year, the corona pandemic has stalled the driver-less cars vision, but as the world is now slowly coming out of the corona pandemic and society goes back to the 'so-called' normal, the travel and commute to-and-from work will also resume en masse. Moreover, the demand for autonomous delivery vans and taxi robots has also been made obvious and essential during stay-at-home times. Therefore, the demand for automobiles that go beyond their current potential, provide a mobile living space while commuting to-and-from work or travel to-and-from a holiday destination and become more safe is going to sky rocket in the near future. Also, traffic density reduction and efficient fuel consumption are among the challenges of today's ever-growing mobile world. Autonomous driving has a potential to contribute to resolving these challenges.

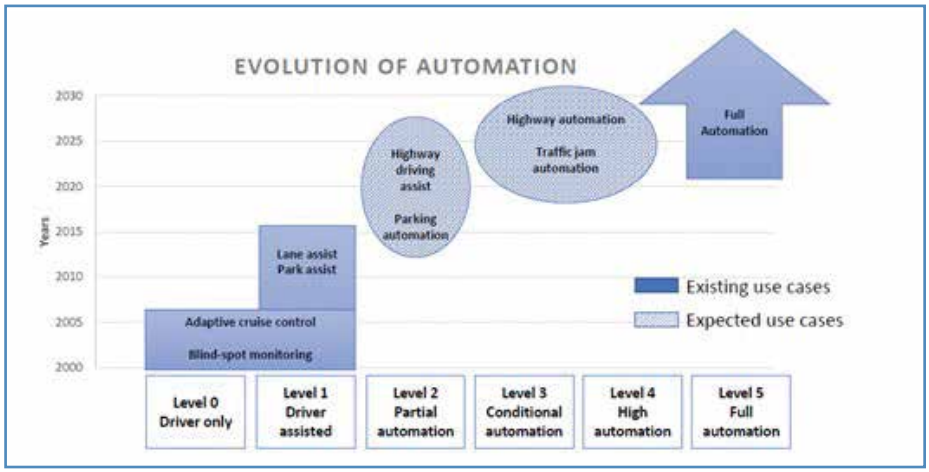


Figure 1: The evolution of five levels of automation versus the years with the use cases that already exist in the market (blue shade) and use cases that are expected (pattern shade).

The idea of a car that drives itself was instituted as early as the 1950s, but at that time its realization felt far-fetched. However, with the rapid breakthroughs in technology and fast urbanization of mega cities, the vision of autonomous driving has come a long way. Over the past two decades, the road towards self-driving cars has evolved significantly and the path has been segregated into five levels of automation, as shown in Fig. 1. In the early 2000s, the adaptation of safety features in high-end cars became mainstream with the introduction of adaptive cruise control and blind spot detection where the driver is mainly in control of the vehicle (level 0 and 1). Only recently, car manufacturers, like Audi and BMW, have been offering a partial automation (level 2) that mainly involves remote parking and highway auto pilot mode.

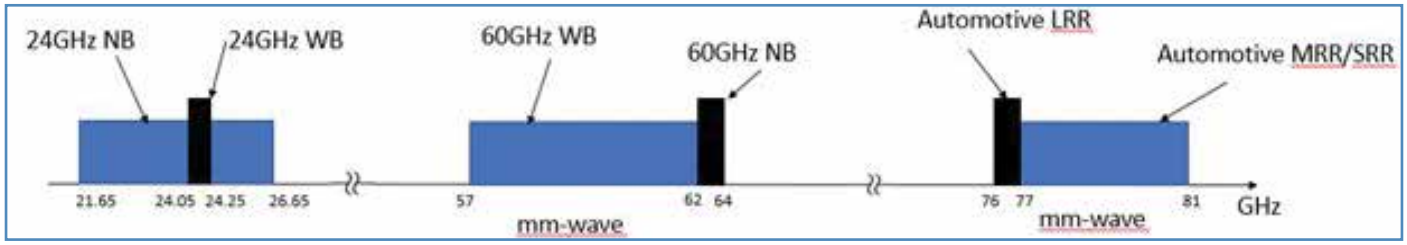


Figure 2: mm-wave bands for radar systems

However, these use cases are still not very mature and mainstream. The automotive industry is now in the process of promising the availability of full highway automation and automation during traffic-jams (level 3 and 4), while some manufacturers, like Tesla, have announced to offer a fully autonomous vehicle (level 5) by the end of the year 2021 . However, whether the engineering capabilities and legal framework will allow this is still questionable. Needless to say is that our future nevertheless holds self-driving cars that will make commuting safe, comfortable and sustainable.

In order for a vehicle to be fully automated, it needs to monitor its surrounding, for which there are a number of sensors placed in the cocoon of the car. The traditional sensors include LIDAR, stereo cameras, infrared cameras, ultrasound sensors and radar sensors. All these sensors have particular capabilities and functions that allow 360 degrees coverage around the car. These sensors are technologically advanced but radar in particular has been gaining a lot of attention by car manufacturers, ever since the technological breakthroughs in semiconductor (silicon-based) Radio Frequency (RF) circuits in the mm-wave frequency band are providing low-cost, low-power, and small size solutions. Some functionalities of radar are unique to it and give it precedence over other sensors, such as its ability to create a complete 4D image (range, azimuth,

elevation and velocity) and its operation under all weather conditions. Thus, the next step in automotive sensing is a radar imaging system in the mm-wave range.

mm-Wave radar imaging systems

Radar imaging systems are a strong candidate when it comes to many 3D environment scanning applications, such as automotive, security and medicine. In the automotive industry, they are used in short-range radar (SRR), medium-range radar (MRR) and long-range radar (LRR). The two categories of radar imaging systems are: microwave imaging and mm-wave imaging. Microwave radar imaging systems operate in the range from 300 MHz to 30 GHz (1 meter to 1 centimeter wavelength) e.g. ultra-wide band (UWB) near-_eld imaging radars and 24 GHz radars. On the other hand, mm-wave imaging systems operate in the frequency range from 30 GHz to 300 GHz

(10 millimeter to 1 millimeter wavelength). The most popular among these systems are the 60 GHz and 77 GHz radar systems.

For SRR and MRR, the 24 GHz radar had been used predominantly but due to the introduction of this band in 5G-NR, this frequency is expected to become obsolete for automotive applications. The 60 GHz and 77 GHz bands are therefore becoming more suitable for SRR and MRR, in addition to LRR (r.f. Fig2). The mm-wave range is most suitable for radar imaging applications because of its potential for high resolution, which is desirable for target recognition and separation. Therefore, a great deal of focus in the radar community is being put forward to address the challenges that arise when improving the resolution of an imaging system. Radar modules are aimed to have an improved performance through a large bandwidth in order to provide a high range and velocity resolution. The relation of the range and velocity resolution between

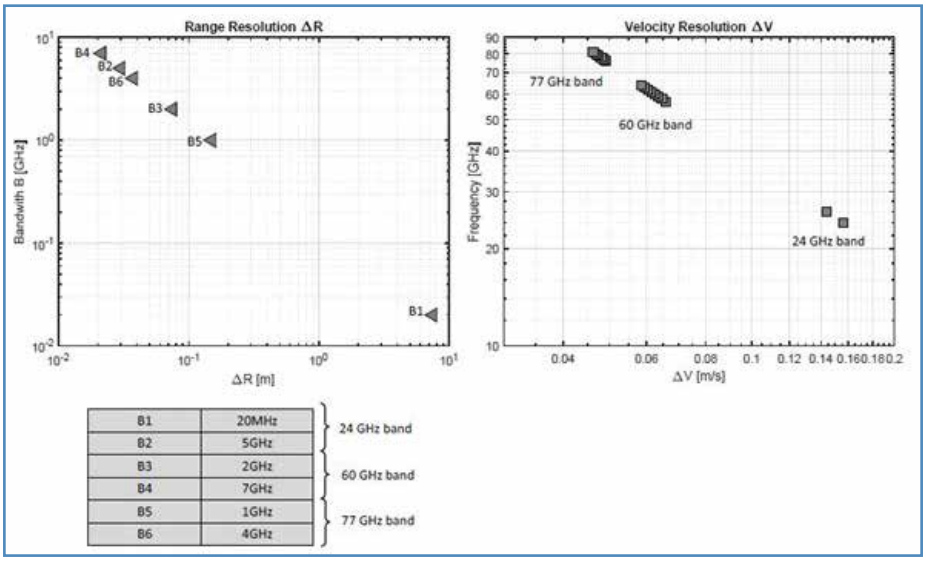


Figure 3: The relation of the range and velocity resolution at microwave and mm-wave frequencies.

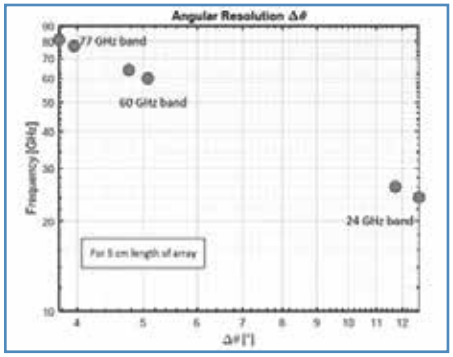


Figure 4: The relation of the angular resolution at microwave and mm-wave operating frequencies, where the length of the array is the same for all ranges.

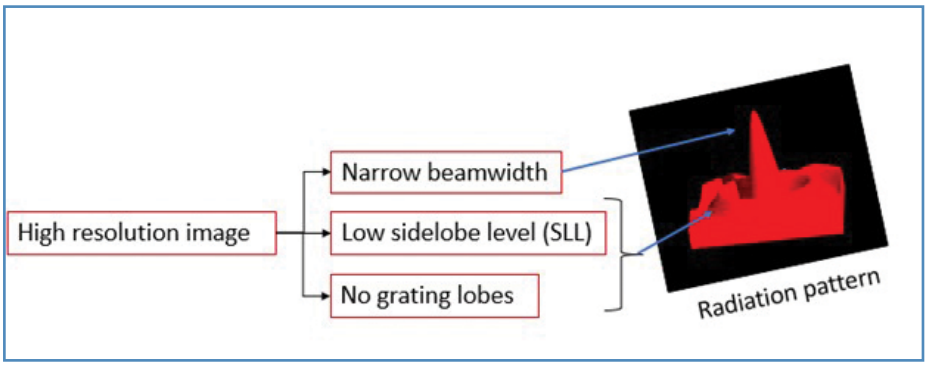


Figure 5: Image resolution and beamwidth relation.

the microwave and mm-wave frequency ranges is shown in Fig. 3. The mm-wave band has a great potential to have higher range and velocity resolution as compared to the microwave band. Next, radar modules are largely employing the concepts of phased arrays and MIMO radars to improve the angular resolution, which also depends on the frequency as shown in Fig. 4.

From Fig. 3 and Fig. 4, it is clear that the mm-wave band is the best choice for a high-resolution radar system. However, the mm-wave frequencies bring in challenges and obstacles that need great attention while realizing a radar imaging system at these frequencies.

But it's not just frequency, the state of the art technology for this purpose that is being used in radar imaging systems is a concept called MIMO radars, which as the name suggests is multiple input multiple output system which allows to develop a very high resolution image. High resolution image of a radar system means that the environment scanned by the radar is well perceived, is distinguishable and no unnecessary or unwanted objects are falsely detected. These characteristics in antenna terms translates into three parameters of the radiation patterns of the radar systems, aarrow beam width, low Sidelobe levels (SLL) and no grating lobes. On a fundamental and basic level, it means that the radiation patten needs to have a pencil beam for high resolution and the SLL is low with no extra peaks (r.f. Fig 5).

Main research question: is it possible to break the limit of angular resolution in conventional MIMO radars through a sparse topology?

With this question, my PhD research journey with the goal to improve the imaging of MIMO radar systems started . The first research activity started with the availability of single-chip radars, which led to the research on feasibility of 60GHz MIMO radars. During this activity, an array of FMCW radar chips in a MIMO setting was developed designed and evaluated, and the main outcomes of this research were that the Sparse array configuration provides better resolution and that the synchronization between the radar chips in a MIMO radar system is very much susceptible to RF interference. The first outcome of this research activity then set the path for the rest of the PhD journey, the focus was shifted to sparse array analysis. The sparse array is required to be developed with the motivation to reduce the number of elements which ultimately reduces the number of electronics being used, hence the low maintenance and low cost for radar systems. Applying the sparsity to array systems showed that the sparsity is the solution for reduced cost and reduced maintenance of single array systems and half elements with the same performance in terms of effective aperture and noise temperature can be achieved. It was the most crucial analysis in this study because, since the radar systems are two-way systems, the next question was , then why not apply sparsity to both transmit and receive systems of a radar separately and this led to the third activity, that was the synthesis of sparse virtual array.

Optimization techniques for virtual array synthesis

In order to automate sparsity in design process, I developed a Two-step synthesis procedure, which can be used to separately synthesis transmit and receive array to achieve an optimal configuration of the virtual array synthesis, that was method one but since in MIMO radar transmit and receive array are related to each other, it is even better to synthesize one depending on the other and this was method II. These methods resulted in the improvement of ≈3° beamwidth and ≈7dB improved SLL (see Fig 6).

In order to validate these results a measurement strategy for recreating virtual array pattern and emulating TDM MIMO mode using a two-port VNA instead of building an entire radar platform was also developed in this thesis and the experiments were performed.

The research activities in this thesis showed that certainly using a sparse topology in mm-wave radars systems in a vantage point for radar community. On a broader level, the design of a next generation mm-wave MIMO radar for autonomous driving needs to include a 4D imaging radar, i.e. including range and velocity, with a sparse topology of both transmit and receive arrays, which is the future of these systems. Also, it requires technologically advanced RF and base-band integrated circuits that are optimized for MIMO radar functionality and careful integration of these circuits with the antenna part.are optimized for MIMO radar functionality and careful integration of these circuits with the antenna part.■

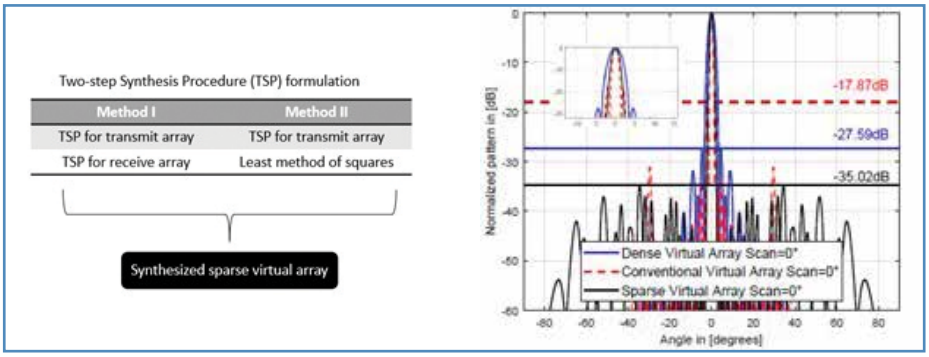


Figure 6: Two methods for the sparse virtual array synthesis and their results (right)

Electromagnetic influence within residential areas

By: ir. J.G. Tams

Introduction

Nowadays the demand for both an increase in energy supply and an increase in newly built housing requires significant adaptation of the electricity grid. With less construction space available electrical substations, powerlines and residential areas are placed much closer to each other.

A substation near a residential area might cause adverse effects for residents. Electromagnetic fields caused by large currents can induce dangerous voltages on nearby piping, but also adversely affect children [1]. For new situations where residential areas and the power grid intersect, the influence of electromagnetic fields should be investigated.

Witteveen+Bos delivers consultancy services regarding high-voltage systems, like power substations. In this article a hypothetical case is investigated where a substation is to be built close to a residential area. There exist different types of electromagnetic influences. This article covers a case where the inductive influence is determined on piping nearby the new substation. This gives the reader an example on how work is executed at Witteveen+Bos. With projects, such as described in this article, Witteveen+Bos contributes to better environments for man and nature, which is one of the main objectives of Witteveen+Bos.

Approach to investigating inductive influence

Figure 1 shows a case where a new substation is going to be built close to a residential area. Witteveen+Bos is asked by the grid operating companies (for example TenneT or Enexis) to investigate if the placement of the substation and power lines has an intolerable inductive influence on the surrounding environment. The case is tackled by starting at a crude approximate and refined in four different steps.

Figure 1: New substation with close by data cable and gas pipe

Step 1: Distance and the parallel run of power lines

Figure 1 shows both a gas pipe and a data cable that can be adversely effected by the new power station and lines. In this step we determine the distance and the parallel run between the power lines and the to be influenced objects.

Based on the distance and the parallel run an estimate can be made of the inductive influence, which shows if further investigation is required. To this end, norm NEN 3654 'Mutual influence of pipelines and high-voltage circuits' is used.

Step 2 Unity check

In this step more details are considered to determine if there is an unacceptable amount of inductive influence. This is done through the Unity Check (UC):

$$UC_I = I \times K_1 \times [\log(K_2) - \log(a)],$$

where I is the length of the parallel run of the lines (in km), a the heart-to-heart distance between the pipe and the high voltage line measured horizontally in meters, K_1 and K_2 are constants dictated by NEN 3654. In the case presented in Figure 1, the UC gives a value larger than one. This suggests an unacceptable amount of inductive influence is exerted from the high voltage lines on the gas pipe and the data cable requiring more detailed steps.

Step 3 Adjusting the unity check

In step 2 the values for K_1 and K_2 might be overestimated and are therefore adjusted in this step to be specific to the situation. More information, such as the local earth resistivity is used to refine K_1 and K_2. On-site investigation and measurements might be required. After adjustments, if the UC-value is still larger than one, the next step is necessary.

Step 4 Refined calculations

To determine the exact amount of inductive influence we calculate in this step from the geometry and Carson's equations the induced voltages [2]. Based on the comparison between the calculated voltages and the current standards and regulations, we determine if the design of the power station in combination with the data cable and gas pipe complies with the law and regulations.

Continuation

Witteveen+Bos closely collaborates with the client about the continuation of the project. If the design does not comply with law and regulations the design has to be adjusted. To this end, together with the client Witteveen+Bos starts a discovery process on redesigning the station.

Conclusion

Witteveen+Bos, in collaboration with the parties involved, is investigating whether inadmissible electromagnetic influencing may take place and advises on possible alternatives where necessary. The goal is to work together on a safe environment in which there is space for both the increasing energy demand as well as the growing need for residential areas.

[1] RIVM, „Electromagnetic fields in daily life," RIVM, november 30th 2020. [Online]. Available: https://www.rivm.nl/en/electromagnetic-fields/emf-dailylife. [Accessed July 1st 2021]

[2] J.R. Carson, "Wave propagation in overhead wires with ground return," in The Bell System Technical Journal, vol. 5, no.4, pp. 539-554, Oct. 1926

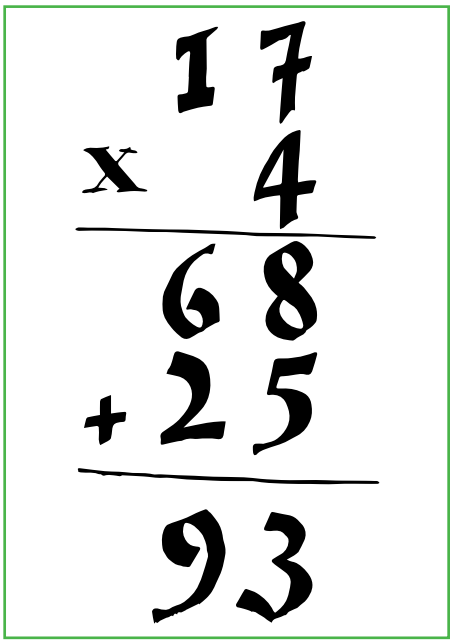
Puzzle

New puzzle
In the puzzle in the top-right you can see a number of circles, 'islands', with a number in them. This number represents the number of connections the island has with neighboring islands. These connections have to be straight lines, they cannot cross each other, and between two islands there can be a maximum of two connections connecting them.

Don't forget to send in the answer to connecthor@thor.edu at the 1st of May 2022 at the latest if you want to have a chance at winning a pie!

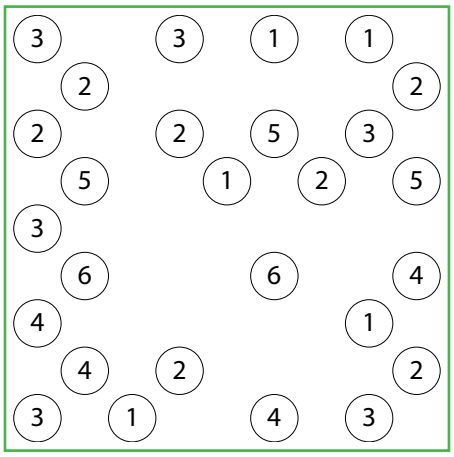
Good luck!

Answer and winner of the December puzzle
One of the answers of the December puzzle can be seen on the right. You can easily verify if your solution was correct too.



One answer to the December puzzle.

The winner of this puzzle is Henk Huisman! He sent in a staggering 68 solutions to the puzzle. Congratulations Henk! ■



The new puzzle!

Henk Huisman receiving his prize pie.

Whose desks are these?

By: Jan Vleeshouwers

Many of the desks of our offices in Flux have had a quiet time the past two years. But not the desks of these two close colleagues: they moved! They do not immediately give away their owners. The image on the monitor looks like a beautiful holiday destination, but it is a standard Windows desktop image: "I don't know where this is, I have never been there." They are both at least frequent readers of Connecthor, but that is hardly distinctive. A little hidden beneath the desks is a small electrical heater, to prevent cold feet. Perhaps that reveals a little more.

Now look at the details. The pink mousepad is from a company which sells the green, red and orange pens most of our upcoming students are familiar with. One of them is lying on the other desk. There is also a small yellow electric toy car, formerly a gadget in the Automotive promotion but now lacking a battery. Or did it once have a small solar panel?

The tea mug and the glasses case show the preference of the desk owner for decorative design. The mug is old, it has already survived three moves: one from Potentiaal to Flux, and now it is already the 2nd move in Flux. What also originates from Potentiaal is the notepad which lies between the two black monitors. The front picture looks like the spike shell of a corona virus and you know what: it is actually a device from the former Corona lab.

It is quite clear that the owners of these two desks already have quite a history at EE. I may be wrong, but I suspect the spoon is also from the cafeteria at Potentiaal – never returned after a warm cup of soup one cold winter day long ago. ■

Does my company make the world better?

By: Tom van Nunen

Recently, Unilever has been under fire from some of its shareholders, because the revenue and profit of its two main competitors has been growing faster than theirs. The main accusation is that the company has been focusing too much on sustainability, instead of profitable growth. It sounds a bit like it's only allowed to strive for a better world if that is accompanied by a better bank account.

I'm not saying that Unilever is the textbook example of a perfect company, but their ambitions do sound more sustainable than many other competitors of similar size. Already in 2010, they presented an ambitious sustainability plan, for example, and the focus is on purpose, rather than profit. At least they are sticking their head out and doing something, and the fact that this infuriates some very wealthy shareholders, tells me it's substantial.

It made me think about an article about the municipality of Bergeijk, published in a local newspaper. It turns out that Bergeijk owns over 2700 hectares of land, which is the most of all of Brabant, and third of the country. Part of the article was about how the municipality is carefully planning for the energy transition on part of the land, and how the land ownership represents a financial buffer worth 110 million euros.

The most remarkable part of the article, however, was the part about forests in the area. The article mentions that the forests don't yield anything and need to be maintained. In fact, they can cost quite a lot of money, when certain types of insects target shrubs or trees.

It's striking how this suggests that everything should have a financial motivation. Can't we look further and realize that areas of green and forest around us are good for so much more than just using it to build houses, solar farms, or windmills, or to be able to sell it when the municipality is in a critical financial position.

The clothing company Primark crosses my mind. A while ago, it announced that it wanted a more sustainable image. I can hardly think of a less sustainable company than Primark, so improving that image should not be too hard, I guess. Instead of the 5 washes that they guarantee for their products to last, the plan is to improve that to 30.

I beg your pardon, but what?! There is a company with around 400 stores worldwide that sells clothes that last 5 washes? Why is that even allowed?

Apart from that, it's hard for me to imagine how someone with even the slightest moral compass would consider buying clothes that are known to last 5 washes. I mean: you're practically buying trash. For just a few euros more, you could have a product that lasts literally 10 times longer, with a significantly lower overall environmental impact. It sounds so easy: invest in quality products that last longer and save money on the long run. Then again, maybe I'm just over-rationalizing it.

Can we at least all agree that there is more in life than making money? Granted, for a business to be successful, making profit is essential, but it doesn't have to be the main purpose. As a business owner or employee, one should wonder whether this company makes the world better, or whether it only makes the bank account of the owner (and its employees) better. I expect that, when this becomes the general mindset, the world will indeed become a better place for all of us. ■

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