



**Life after EE**

**Neuromorphic Computing**

**AI: more than just a buzzword**

**Dies natalis**





Connecthor

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The first Connecthor of this new decade lays in front of you. Our new year's reception pleasantly went by with coffee, tea, cakes and tiny warm sausage rolls, a new year's speech however was missed. Bart does have something that he wants to share with us all, therefore you will find the words that our dean had in mind for us in this Connecthor on page 4: his fifth new year's speech in Flux.

We are very proud of the achievements and the work of the people in our department. Patty Stabile's article about brain-inspired photonics, which will brighten the future of the Cyber-Physical Era, can be found on page 22.

Twan Kamp, who graduated in 2012, writes about his life after EE. His story can be found on page 24.

Sander Verdoes writes in his travel column about his internship project 'designing a backpack for rats' in Tanzania. You can find out what that project has to do with Electrical Engineering on page 21.

Martijn de Kok was fortunate enough to do his internship abroad at the NASA Jet Propulsion Laboratory. Read about it on page 28.

Furthermore, we also pay attention to a new student association, E.S.A.I.V. Serpentine (page 14), and the new TU/ecomotive car Luca, which will be entirely made out of waste materials (page 13).

We take the opportunity here to welcome Stefan Eijsvogel as a new editorial-board member.

The unique situation occurred that we could not hand out the vlaai this time, since there was no correct answer to the puzzle of the December issue. The editorial board was therefore forced to eat the vlaai themselves. To avoid this a next time, we hope that you will do your utmost to solve each issue's puzzle.

We hope you will enjoy reading this new edition of the Connecthor!

The Connecthor editorial board ■



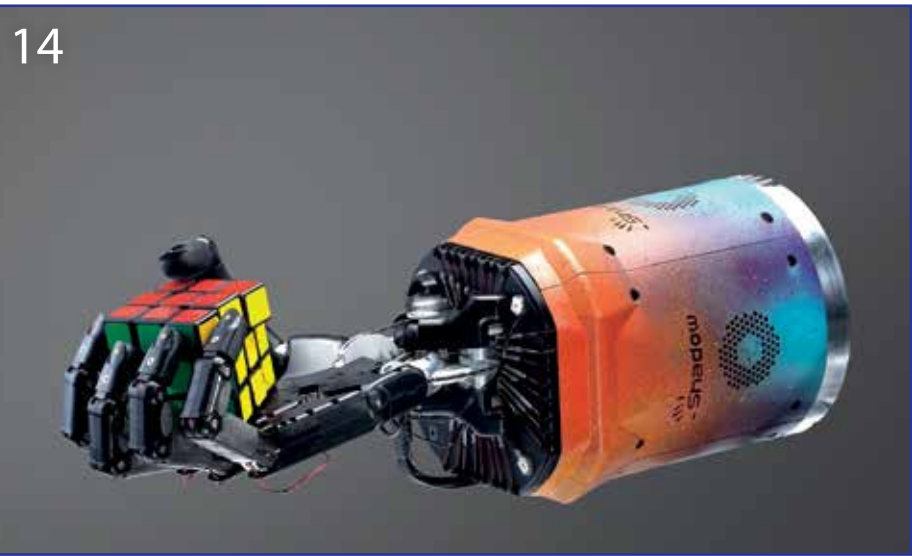
Still wondering where to go for your intership? You can read all about Martijn de Kok's experiences on page 28



Read more about Twan Kamp's life after graduating on page 24



Read more about Luca on page 13



Read more about serpentine AI on page 14

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## Board Issues

By: Bart Smolders



**D**ear Colleagues and students of Electrical Engineering,

First of all, let me wish you a happy and healthy New Year. For me this is already the fifth new year's speech as a Dean. I am looking forward to work with you all in the year 2020.

2019 was a year with many highlights in the department, but also a couple of low-lights, in particular the loss of several close family members. Another issue was the early drop-out of our youngest student ever. I hope Laurent will find a good place to develop himself further.

Last year was the first year for our department, since at least a decade, with a substantial increase in financial budget. We received about three million euro additional first-tier money from our University board. On top of this, we received additional budget directly from the Dutch government to open fourteen new scientific staff positions as part of the sector plan funding. This provides us the opportunity to further strengthen our capacity groups, develop new research areas, give new employees start-up packages and invest in new lab

equipment. The good news is that this additional budget is structural, for at least the upcoming six years.

The recruitment of new scientific staff is a big issue at this moment. Although we hired quite a few new staff members in 2019, we still have many job openings. An extra challenge is the new Irene-Curie fellowship program where the University has decided that we should only consider new female staff members, at least for the first six months after a vacancy was opened. In addition, at least a third of all new staff members needs to be female, else we will lose a significant part of the sector plan budget. Please help me in finding new female staff members. If you know potential candidates, contact me!

From an educational point of view, I have two announcements. First of all, Marion Matters will be appointed as our new program director (in Dutch: opleidingsdirecteur) of the Graduate program EE, which includes our master, PDEng and PhD programs. Marion will be the successor of Huug de Waardt, who did a great job in the past four years. Next to this, we will start a new master program in September 2020 on Artificial Intelligence Engineering. It will start as

a track within Electrical Engineering, but the plan for the near future is to create a new multi-disciplinary master program together with Mechanical Engineering, Computer Science and Applied Physics. Our department will coordinate this new master. ■

## From the President

By: Sanne van den Aker



**A** lot has happened since I last wrote a piece. The Dies has taken place, the first (and very successful) Thor party of the year and of course the holidays have passed. So a lot of time has been spent relaxing and partying, but with the exams right around the corner, it is time to start working again. Even after such a long and relaxing period, this might bring a lot of stress.

Luckily it's the season for warm and comfy clothes and hot chocolate. As I am writing this I am in my pajamas, hugging a pillow pet, surrounded by a lot of other people in their pajamas or fabulous, yellow 'Zeeman' clothing. Everyone is ready for the pajama-Zeeman party, so they can get destressed in the middle of their exam weeks. This drink is one of the things that makes a board year much more fun, as we need some destressing from time to time too. Right now however, there is no stress to be found with me. Hugging a pillow pet and drinking some hot chocolate leaves no room for stress.

I know there are already a lot of people that have stuffed animals at home and I can recommend anyone to get one. These cuddly toys really can give some

support during stressful times, as they are very soft and always there for you. If you need hugs but do not (yet) have a stuffed animal, most of the times you can just come to the board room and receive some as well. You might even have seen one of the board members dressed up as a dog to give you some mental support and, of course, hugs during the exam weeks. We will always do our best to help you through these weeks, be it by providing exam trainings, making coffee with some extra love or dressing up as a dog.

Luckily, the exam weeks are over before you know it. Which might give a little extra stress, but it is also really relieving, as there is time for other things again. Talking about time, it truly flies since attending university, and that feeling continues even now I am barely studying for a year. We are already halfway our board year and you are halfway your academic year. Right now I am already looking for members that are interested in becoming the next board of Thor. It is crazy. The years spent here really fly by and seem like only a fraction of your life, but at the same time you learn so much in such a short time. So this is really also the time to, whenever possible,

relax and slow down. Just take in what is happening around you, because it is gone before you realize. And you might not miss the exams, but you will definitely miss everything else here.

So go on and enjoy the last half of this academic year, as it will be over in a heartbeat. Do it any way you like, as you should look back on this time with a smile. Do it by finishing your studies, screaming your lungs out at a party, just chilling a little, hugging your new stuffed animal or trying to become the next board of Thor, it is all up to you! Just do not forget that when you are working your ass off, some well-deserved relaxation should be paired with it.

Veel gedonder!

Sanne van den Aker

President of e.t.s.v. Thor ■



# Introducing...

**H**ello! My name is Lizeth Gonzalez-Carabarin. I recently joined the SPS Group as a Eurotech Postdoc. I was born in lovely Mexico City in 1984. In 2011 I went to the other side of the world to complete my PhD in Hokkaido University, Japan. There, I focused on bio-inspired and noise-tolerant circuit design. This was followed by two years at Intel Corporation where I acquired a hands-on understanding of the semiconductor industry. In 2017, I moved to the cheese and mountains country to start a postdoc at EPFL in Switzerland. There I worked with efficient Deep Learning to detect epileptic seizures.

Currently, I focus on low-power and low-memory Deep Learning for epileptic seizure prediction. I am very passionate about producing technology for social good, especially for people in developing countries where resources are limited.

As not everything is research, in my free time I enjoy being outdoors. I do love mountains and hiking, and thanks to my Latin-American blood I also love dancing. Of course, having a beer with my friends is a must every week. I am usually in the Flux Building on the 7th floor, so hope to see you around! ■



**H**ello everyone. My name is Mahdi Azizi, and I'm working as a postdoc at the EES group since September 2019.

I was born in 1986 in Tehran, Iran. I received my BSc degree from the University of Tabriz, Iran in 2008. Then, I earned MSc and PhD degrees both from the Tarbiat Modares University in Tehran, Iran in 2011 and 2016, respectively, all in Electrical Engineering-Power Electronics.

Since 2011, I have worked at some research centers and companies on various projects such as high-voltage pulse power supply, Electric Motorcycle, Stabilizers servo-mechanism, and Li-ion

charger and BMS. My main research interests include high-voltage power supply, power electronic converters, electrical machines drive and renewable energy systems.

My project is the design and implementation of fast and flexible high-voltage pulse power supply. We, my colleagues and I, are working to develop techniques on fast high-voltage power pulse generation using power electronics devices.

I am sure, working at the Eindhoven University of Technology, and also living in Eindhoven, will be a great experience for me. ■

**H**il I am Tim Slangen and started my PhD October 1st in the EES group. My first day at TU/e was in 2014, when I started my bachelor Electrical Engineering. Three years later I continued with my masters and did my graduation project at ElaadNL, the Dutch knowledge and innovation center on electric mobility. Here I analyzed the effects of electric vehicles (EV) on the power quality in low-voltage grids. All inverter-based devices like EV, PV and fast-chargers produce so-called "supraharmonic" disturbances, which potentially influence the grid and all devices connected to it.

These disturbances are not yet treated in standardization and their large-scale impact is still unknown.

During my PhD, I am working in a project in cooperation with ElaadNL, DNV-GL and two grid operators to further analyze the large-scale impact of electric vehicles and fast-chargers in our grids. I will develop models for the grid operators to take these effects into account in grid planning and operation, and my results will be used as input for future requirements and standards on electric vehicle chargers. I am looking forward to my time at TU/e and hope to meet you soon! ■



**H**ello everyone, my name is Vojkan Vidojkovic. After quite a few years I am back at TU/e, working as associate professor in the IC design group. In the same group I have earned my PhD in 2007.

I have nineteen years of experience in the field of RF integrated circuits/systems/architectures for wireless communications (2G, 3G, 4G, 5G, mm-wave) in combination with strong technical leadership of multidisciplinary teams. I built my experience working at different places. In the period from 2004 to 2008 I was working in Philips Research and Sitel Semiconductor in the Netherlands. From 2008 until 2013 I was with Imec in Belgium working as principal researcher. Finally, from august 2013 I was working as a member of technical staff/technical lead at Intel in Germany.

By interleaving scientific and industry career paths, I have built a strong network in academia and industry. As a recognition for scientific contribution to the solid state circuit community I served as TPC member of International Solid-State Circuit Conference (ISSCC) in 2015 and 2016. In industry I have a proven track record of taking multiple generations of transceivers from concepts to high-volume production shipped to leading phone makers.

Combining facilities at TU/e and my experience I would like to work on new ideas/applications for integrated circuits in wireless communications. I am looking forward to teaching. I hope that my experience can help students to find their way in the world of integrated circuits.

My wife is also an electrical engineer. She works in Dialog Semiconductor. We live in Waalre with our two sons, Nikola (15



years old) and Luka (7 years old). All our free time goes in supporting our children in their different activities and in spending time with them. ■

**H**ello everyone! My name is Mathieu Sprengers and I joined the Electromagnetics group in October 2019.



I was born in Ghent (Belgium) where I still live. After finishing my secondary school, I had to make a difficult choice: do I want to become a doctor or a civil engineer? Eventually I decided to study medicine and after many years of study and clinical internships I finally graduated as a neurologist in 2019. Although the multitude of neurological syndromes and diseases was one of the main reasons to choose for neurology as my discipline of specialization, I have a particular interest in epilepsy.

Next to clinical activities, I have spent much of my time doing research. The topic of my PhD was deep brain stimulation as a treatment for refractory epilepsy. It comprised clinical studies in epilepsy patients to evaluate the efficacy and safety, as well as preclinical studies in rodents to investigate the mechanism of action and to optimize the stimulation protocol.

At the TU/e I am working as a postdoctoral researcher in the PerStim project. In contrast to my PhD, this project focuses on a noninvasive neurostimulation method, where electrodes are placed on the scalp instead of directly into the brain. The ultimate aim is to develop a personalized transcranial electrical neurostimulation therapy for refractory epilepsy patients. I will perform most of my activities at Ghent University Hospital in Belgium, but one day per week you can find me at the TU/e.

In my spare time, I like to mountain bike, play the piano, have dinner with friends and travel abroad to hike or ski and explore new countries and cultures. I am looking forward to meeting you and having interesting conversations on (neuro)science, Belgian politics, foreign countries, sports or any other stimulating topic. A good joke on the Belgians is of course also always appreciated. ■

## Welcome all new colleagues!



## Master graduates November 2019

### Master graduates November 19<sup>th</sup>, 2019

Justin Nkoh  
Jeroen van Oorschot  
Firstian Kautsar Adiguno  
Samuel Akpobome  
Odysseas Votsis

Congratulations!



Photo by Photodette



### Master graduates November 19<sup>th</sup>, 2019

Floran de Putter  
Luca Badea  
Xiangying Zhang  
Louw Roel van der Zon  
Floor Fasen  
Iris Huijben  
Wouter Luijten  
Jinhui Qian  
Xin Liu

Congratulations!

Photo by Photodette

## Master graduates January 2020

### Master graduates January 21<sup>st</sup>, 2020

Yuk Hang Yuen  
Sfia Bearzatto  
Anouk Hubrechen  
Shruti Easwaran  
Jules Verhaeren  
Joris Witteman  
Alexandros Rikos  
Bart Pieter Cornelis van der Sanden  
Johannes Cornelis Jacobus Maria  
Stevens

Congratulations!



Photo by Photodette

## DownCo: extreme downhill cycling

By: Nicky van Roijen and Bas van Steenberg

Hello Connecthor readers, we are Nicky Roijen and Bas van Steenberg of the DownCo. We originally started downhill cycling when I saw Nicky looking at downhill videos on YouTube and commenting on how awesome it looked. Nicky responded by asking if I wanted to join him and his friends, a couple of weeks later, on a bike. My answer was yes, of course. After that, we went one more time together and started talking about how it would be nice if the next time one or two Thor members would join us.



So, we decided to see if we could get one or two Thor members to join us for our downhill trip to Willingen, Germany. Apparently, Thor members are more interested in downhill cycling than we could have imagined and at one point we had eighteen guys and girls being interested and six girls and guys ended up joining the trip for a total of eight crazy thrill-seeking Thor members on bikes in the German hills.

The trip started with meeting each other at 7 o'clock in the morning and driving to Willingen. When we arrived there, we were surprised by the fact that it was so muddy there and that there was snow laying there... But that did not take any

hype away. We started with collecting the protective gear and bikes from the rental shop and changing into clothing that could handle the dirt and keep us warm. Then it was time to go up the mountain for the first time with special ski lifts that we could hang our bikes on. When we arrived at the top, the fun could start. The first time going down the

mountain was for a big part just looking at what they needed to do and which way the trail went. But after the first or second time going down everybody started to get the hang of it and the speed started increasing and the ramps started becoming jumps.

After the lunch we only had time for two more trips down the mountain and the last time going down the biggest part of the group went to the hardest trail they had in Willingen, the world cup trail. This trail features many big rocks, stones and steep descends, and due to the mud and snow it also was extremely slippery. After the last descent we brought back the bikes and gear and went for a drink before we started to drive back to Eindhoven.

So for everyone who is interested in downhill mountain biking, join us next time. We plan on organizing more of these trips, so look out for our activities!

Op de DownCo en van de berg! ■





# Highly innovative in hi-tech

By: Prodrive technologies

**Highly competitive products are a good start, but at Prodrive Technologies we do a lot more. Electronics manufacturing is at the roots of the company: highly efficient and flexible with superior output quality. But what do our employees say? Take a look...**

Nikolay Mihaylov is at Prodrive for six years now. Coming from Bulgaria he studied at Fontys in Electrical Engineering. During his HBO and his Master at TU Eindhoven he already started to work part time as a designer at Prodrive, where he completed both his HBO internships and the MSc graduation project. His specialty is in Electromechanics & Power Electronics (EPE). He has worked in test development, as Magnetics Designer and now he is a Power Electronics Designer. He works on special applications, like various power converters for MRI-scanner amplifiers which power up to 80 kW.

Frederik Oudman completed his Master last August in Embedded Systems at TU/e and did his Bachelor in Computing Science at RuG. For his graduation project he worked at Prodrive in test automation for PCBs. "The PCBs that are produced at Prodrive need to be tested. Therefore, the PCBs are put into a machine which clamps the boards and tests them. The part of the machine that clamps the board is called the fixture. But for each PCB, a custom fixture is designed and

produced. These fixtures are static, the test machine that uses the fixtures to test the different PCBs can be configured with different hardware such as different fixtures. I designed the software which can automatically set the configuration for the fixtures, so we can test the boards faster and more cost-efficient." Of course, Prodrive wanted him to stay after this project.

Prodrive designs, develops and assembles machines for customers in medical and industrial areas like automotive, IoT and high-end computing. It's a wide range, mainly around electronics. Production extends from smaller parts to complete systems, like amplifiers for MRI-scanners.

## It's the engineering freedom

Both Nikolay and Frederik knew Prodrive already from their study. Why were they so eager to start working here? Frederik: "I think it's the engineering freedom. We get a goal to fix something, and we get the freedom to fix it in a way we think works best. It's my own approach, at my own responsibility. Maybe we make mistakes, but it's better to just start working, make a few design mistakes, correct these, and keep working towards the perfect solution, than it is to wait with making design choices, which might avoid making mistakes, but also avoids getting to the perfect solution. Just try something! That generates creativity. Of course, when you work in a team you have to count them in, but it's really bottom-up instead of top-down."

Nikolay: "Yes, it is this freedom to work in your own way, and the flat organizational structure. I also like the flexible working hours, which for me was especially interesting in combining work and study. It is also improving efficiency as one can work when he/she feels like. At Prodrive I was studying what I wanted to study and working where I wanted to work. And the both enhanced each other."



Nikolay Mihaylov

The combination of study and work is more common at Prodrive, at all disciplines of the development department. Prodrive doesn't believe only in the degree and the certificate you get at university. You can make a huge contribution during your study days, although completing your studies in addition to your work is highly encouraged. In fact, you are encouraged to continue to learn throughout your career. Keep on developing yourself.

## A common passion for technology

So Prodrive is a technical, innovative company, that gives its engineers a high degree of freedom in their work. But what about the atmosphere?

Nikolay: "Prodrive wants you to stay motivated. So, if you have worked for a longer period on a project and like to do something else, they will try and find a new source of inspiration for you."

You're also encouraged to speak up when you see something going wrong, outside of the actual responsibility you're assigned to. It's the culture to correct each other. And asking for help is easy: Prodrive uses a R & R matrix (resource & responsibility), with all your colleagues and their competences. Just look up the



field of knowledge you need someone's help for and find the people that can help you.

The employees at Prodrive share a common passion for technology, even the people in HR, marketing or sales. But in addition to the work itself, there are many activities in which colleagues get together. There are five or six different sporting events per year and various festive gatherings.

To stimulate you in your personal development, every engineer at Prodrive has an HR coach who guides him through his development. One or more times a year, during a conversation you will look at how you are doing and what steps you could take.

## Recommendation

Could you recommend Prodrive to current TU/e students in one sentence? Frederik: "Would be a sentence with lots of comma's! At Prodrive you get lots of possibilities, lots of freedom in your work. The slogan of this company is 'a passion for technology' and that's really what it is all about here. If you're mad about technology, this is the place to be."

Nikolay: "If you value freedom, if you value your learning process and the

technology, those are the three most important things you'll find in working here."

## Prodrive Technologies

Prodrive Technologies is a privately-owned company. We aim to provide more than just shareholder satisfaction. We operate under a healthy ambition to be of relevance, and to contribute to meaningful innovation that tackles major challenges in society. We create technologies that are essential links in the systems which form the basis for today's and tomorrow's world. Our technology, for instance, improves the quality of medical imaging, which allows for diagnostics that recognize diseases earlier and more accurately. Our techniques also contribute to reducing the global dependency on fossil fuels, and to minimizing human exposure to air pollution.

Another example is the contribution of our technologies to global digitalization, which lowers barriers for people in third world countries wishing to access the information and education that are essential for their welfare. Therefore, our joint mission is to create meaningful technologies that make the world work.

## Are you as ambitious as we are?

We do everything in-house, we cover virtually every conceivable market and we use the very latest process techniques, many of which we have developed ourselves. As a result of this innovative approach, we are among the fastest-growing technology companies in Europe.

With an average age of 28 and over 70% of our employees holding Bachelor's, Master's or PhD degrees, our workforce is young and very well educated. With offices in 6 countries and as many as 26 different nationalities, Prodrive is a diverse and international company.

*Do you have a passion for technology? Get in touch:*

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# Organizing the Career Expo

By: Stan de Rijk

**Career-oriented activities for all students of the TU/e, are organized by Wervingsdagen, a joint initiative of nine study associations. Each year several students of these study associations commit themselves for a year to host these events. In this article, Stan de Rijk will give you an insight into his life as a board member of Wervingsdagen.**

Visiting several music festivals always kept me wondering: how do you start with such an event? It requires great organizational skills to plan each and every little thing to create an entertaining day from the ground up. This interest in organizing events has been there all my life and therefore joining several committees at my study association was a logical choice. This again confirmed that I am enthusiastic in working with a team to create a nice event. However, I wanted more. Therefore, I actively looked for a board year in my third year of studying here in Eindhoven.



The wervingsdagen committee, Stan stands on the right

Earlier that year, I visited the Skill Sessions of Wervingsdagen. Here I followed a three-hour workshop about performing a persuasive presentation. I was really inspired by the tips that I learned in this brief period. Doing that made me realize that (soft) skills are an essential aspect for a future employee of a company. Since I enjoyed this event so much, I also decided to visit the Career Expo, where I was surprised about the scale of this event. And then again the question popped into my head: how do you start with such an event?

Knowing that I enjoyed the Skill Sessions so much and seeing the Career Expo confirmed it for me: I had to do a board year at Wervingsdagen. Therefore, I applied for the board as an Event Coordinator. As an Event Coordinator,

you are responsible for all the logistical aspects of each event and also for the direction of the people who help you.

This year Iona Beerling and I will do these tasks. Although most of you probably had a relaxing vacation, we spent our summers preparing for the events. In the summer vacation, we contacted training companies to eventually arrange more than sixty workshops in the week of the Skill Sessions. Also, we started on making the big planning of the Career Expo, starting with a map for the stands of the companies and also writing a safety plan. Although this sounds simple, each little detail has to be thought of to make the planning of the day as effortless as possible.

As a Mechanical Engineer at Wervingsdagen, I got the opportunity to step out of the bubble of the studies and focus on completely different aspects of an organization. It starts immediately from the start by working in a multidisciplinary team. You noticed that everyone had their way of working and different ways of tackling a problem. Although we learn a lot in our group projects in the studies, I did become conscious that Wervingsdagen is a totally different level of group cooperation.

We have to think about how we can reach each and every student at the University, but also organize interesting events for these students. Daily, we are strategizing and trying to improve the contents and promotion of our events. To do that you have to be critical on yourself and also learn to respect each other and each skillset. Growing as a group is one of the coolest things I already experienced during my year. You learn about each other, but also about yourself.

In the upcoming months our events will take place, which will be interesting events for you as students. And if you then have the same question as I had, come and have a chat with me and I will give you my perspective on the issue: how do you organize the largest technical Career Events of the Netherlands?



The Career Expo

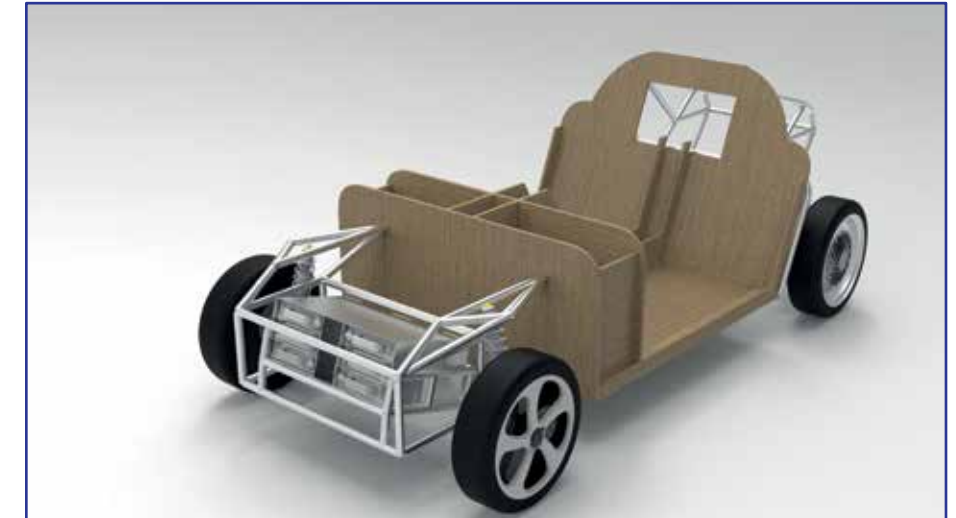
# TU/ecomotive develops Luca: embrace waste!

By: Matthijs van Wijk

After months of hard work, TU/ecomotive revealed the design of their sixth car: Luca. With this car, the team wants to address the problem of waste in the world. Therefore, the car's structure will be made entirely out of materials that would normally have been thrown away. To show that this is a realistic goal, the team also wants to make the car road-legal. Luca will be finished in June 2020 and shown to the world through a promotion tour.

By now, there is a world population of 7.75 billion people, and predictions say that this population will grow to 10 billion by 2050. All these people consume lots of resources, most of which are thrown away shortly after use. As a result humanity creates 2.1 billion tons of waste annually, enough to fill the Philips Stadium to the roof 7380 times and, without urgent action, this number will only increase. By far the biggest part of all this waste is not recycled, but ends up in rivers, oceans and landfills. Even though the situation here in The Netherlands is quite good when it comes to landfills, we will eventually also have to deal with the consequences. These landfills namely contribute massively to the greenhouse effect; a fifth of the annual methane emissions come from this source.

With Luca, TU/ecomotive wants to show that waste can also be a valuable material, that can still be used in many



Luca's chassis, render by Keyshot by Luxion

complex applications. This will be done by developing a bio-based composite, made out of flax and recycled plastic. Part of the plastic will even come straight out of the ocean. This composite will be implemented in the chassis. For the body, another material will be developed. This is done in collaboration with an Israeli start-up: UBQ. This company makes a kind of plastic out of household waste. This way, the team wants to stimulate that the amount of waste that ends up in landfills reduces. Besides materials, the team also wants to prevent waste in all other aspects of the car: Luca will be very efficient, because in-wheel motors will be used. This mitigates a lot of losses

in the drivetrain. The two electric motors will have a combined power of 15 kW and are powered by six modular battery packs. These can be replaced easily by full packs or even more modern batteries with new technology if this is available in the future.

When Luca has been built, the team wants to obtain a license plate for the car. During the test, the car will be judged for reliability and safety. By making Luca road-legal, TU/ecomotive wants to show that it is already possible to build realistic cars in a sustainable way. During the coming months, TU/ecomotive will focus on the production of Luca to make sure the car is finished in June 2020. Afterwards, the team organizes an event to promote Luca and the vision of TU/ecomotive.



Luca, render by Keyshot by Luxion



The bio-based composite, photo by HOWDO Creative Direction



# Artificial Intelligence: more than just a buzzword?

By: Bram Hooimeijer and Thymen Rijpkema

**With the increased availability of computing power, artificial intelligence (AI) has gained a lot of traction. The TU/e now has its own Eindhoven AI Systems Institute, and as of last year, we started Eindhoven's Student Artificial Intelligence Association: E.S.A.I.V. Serpentine. How will AI shape the future of engineering, and why is this relevant for us Electrical Engineers?**

Over the recent years, we have heard a lot about Artificial Intelligence. It led to the promise of autonomous cars, it predicts cancer and it can already be used to create deep fakes: video material in which people seem to say things they have never said. We see AI agents outsmarting the researchers that build them, as for example OpenAI's hide and seek agents surprised researchers by finding unexpected ways to hide themselves.

Not only do agents outsmart their builders, but also the brightest minds in games. While chess was already beaten in 1997, more complex games as Go have long proved difficult. Still, in the last years algorithms have beaten world champions in Go, after which they beat the world's top players in even more complex games of Dota II and Starcraft II.

The recent advancements in AI have been caused in part by the application of modern computing power to the field of machine learning. Success has been booked by the application of reinforcement learning to Markov Decision Processes (MDP), which is visualized in Figure 2. MDPs are about an agent taking actions in an environment trying to maximize a reward which it perceives from the environment. Using the reward, it is possible for the agent to learn the consequences of their action and, after sufficient iterations, learn successful policies to solve the problem at hand. These policies are commonly learned



Figure 1: AlphaStar against MaNa in StarCraft II, with AI's neural network activations shown.

using neural networks. In contrast to supervised learning, no labelled data is required for this class of algorithms.

The importance of AI for me as Electrical Engineer became evident for me during my internship at a chip design company. I had to verify and prove the functional correctness of processor designs, for which various algorithms are available based on satisfiability (SAT) and binary decision diagrams (ROBDDs). We know that these algorithms are theoretically slow, yet often surprisingly fast in practice.

For some designs and requirements SAT-based approaches outperform ROBDDs strongly, and vice-versa.

Choosing the right approach is hard, so the usual approach is running both in parallel. This is the fastest approach but wastes computation resources.

It came to my surprise that modern tooling already offers AI which is able to choose from over twenty different algorithms. By effectively combining the nature of the design and the algorithms, it predicts reliably what approach will be most efficient.

Later, I learned that such problem can be formulated as a reinforcement learning problem, with a clear verification environment defined by the chip, the requirement and the verification algorithm. Choosing the correct approach translates to choosing appropriate actions, which are rewarded based on computation effort and proof strength.

Although we do not understand the black-box nature of such models, it is aiding engineers to make better decisions. From an academic viewpoint, understanding why one approach outperforms the other is still interesting, but this chip design company was just glad it could free up computational resources.

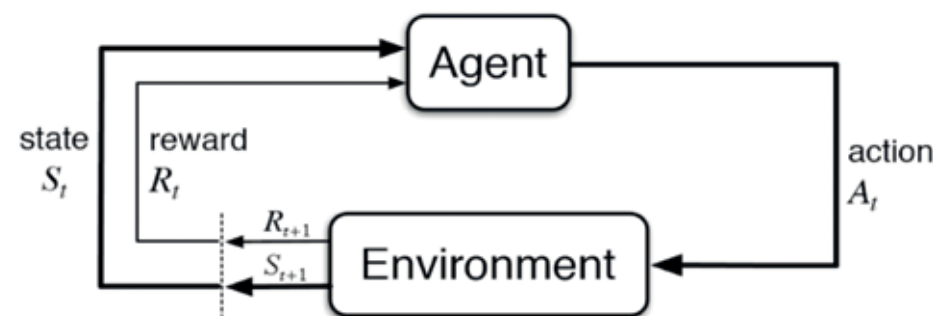


Figure 2: A schematic overview of a Markov Decision Process

The experience in my internship made it clear that Artificial Intelligence can be a valuable tool for a whole spectrum of problems, including those of an electrical engineer. At Serpentine we use artificial intelligence to beat games, which is an excellent way to learn about AI algorithms quickly.

We use games for the same reasons as researchers in the field: games are a relatively stable and controlled environment, and it is easy to get the algorithms set up and running. There is no need to buy robotic hardware or build experimental setups. All you need is a laptop. Many of the Atari games, such as MsPacman or Breakout, that we played as kids are fun to beat and are available in OpenAI's gym which makes a setup even easier.

Building algorithms for games generalizes in two ways. On the one hand, it teaches us a strategy to dealing with problems we encounter at other places. If you can create an algorithm that beats Tetris, can you also create an algorithm that packs up an airplane efficiently, or lays out a chip?

More importantly on the other hand, recent developments show that the algorithm itself can become generally "intelligent" to some extent. An algorithm that beats chess has already been available for decades, but last year Deepmind's AI has been able to master chess, go, and most of the Atari games in the OpenAI Gym, all using the same algorithm.

Similarly, OpenAI itself has been using the same algorithm it used to beat the Dota-2 game for learning a robot to control its own robot hand for dextrous movement, for which environments are available in OpenAI Gym. Here, neural networks can aid in the design of controllers, a field of research that is also explored in our own CS group.

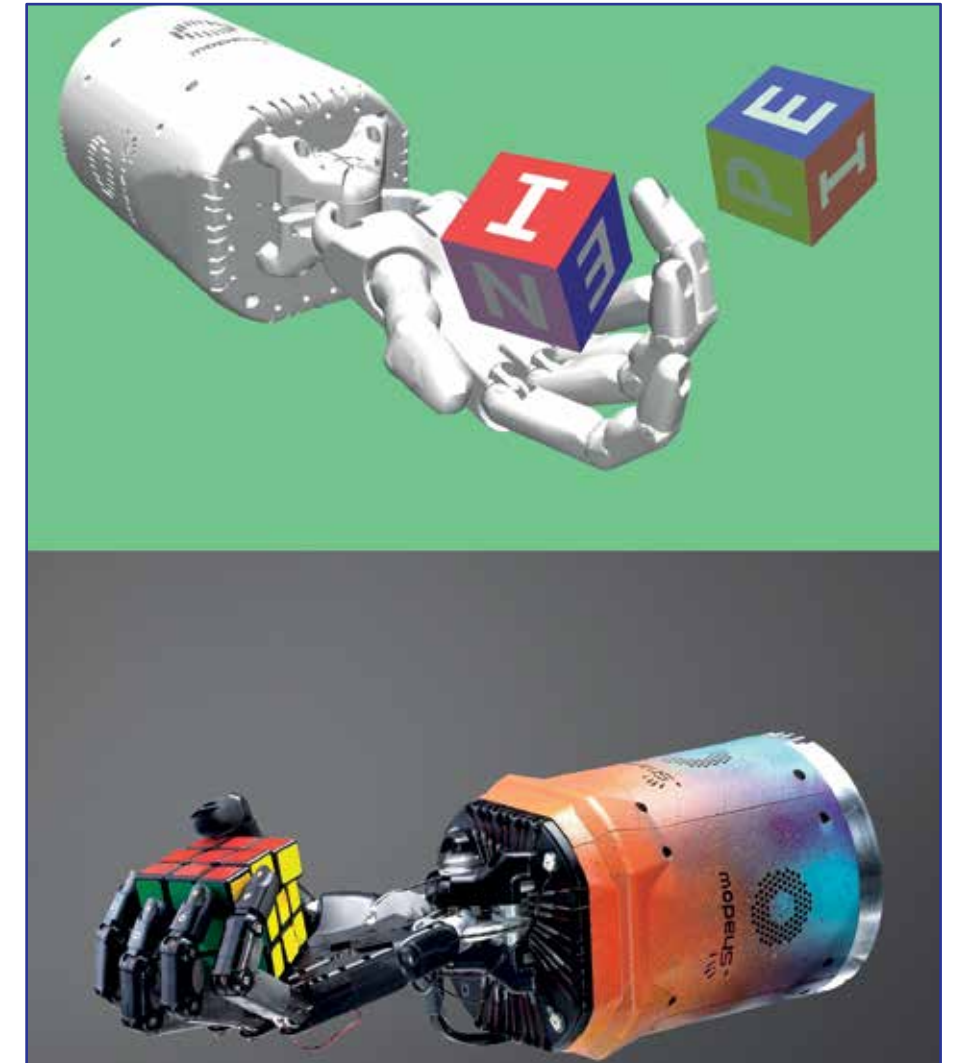


Figure 3: OpenAI's robot hand has to learn to take a required pose efficiently

Here we see that the focus of research is shifting from performance to generalizability and integrating short- and long-term decision making. With AI becoming more and more general, it will also influence different fields of engineering more easily.

Some engineering challenges are currently not solved by AI, partly because its black-box nature cannot give the

guarantees that are needed in e.g. safety-critical systems. The future will tell whether these hurdles can be overcome. AI will not prove to be a solution to everything but is still a valuable tool for every engineer. The progress seen so far shows that at least AI is more than just a buzzword.

Want to know more about Serpentine yourself? go to [serpentineai.nl/joinus](https://serpentineai.nl/joinus). ■

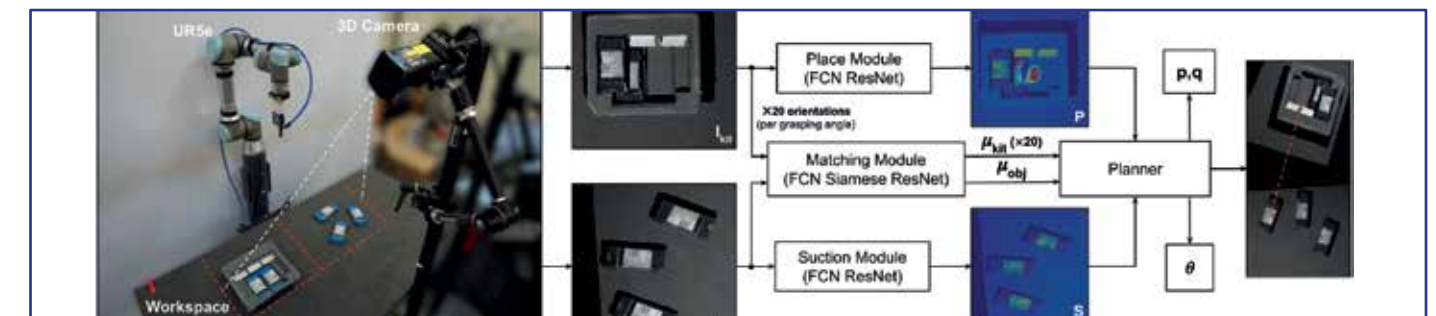


Figure 4: A robot has learned itself to assemble products by disassembling it first.



# The End of the Year Happening 2019

By: Pauline Hoen

On behalf of both boards of Management, all colleagues and the boards of the study associations of Electrical Engineering and Applied Physics, were invited to celebrate the Year's End on Monday evening December 9th. A grand buffet with plenty of delicious food was arranged and a coffee bar with an espresso coffee maker and schnapps to complete the dinner. The study associations of both departments staffed the Walhalla / Salon bar.

After the hungry crowd was fed, some of our colleagues shared their talents with us. Sjoerd Hulshof on the keyboard and vocalist Margot van den Heuvel wowed us with their version of Billy Joel's 'Just the way you are'. We saw more singing, dancers performing, and poems recited. Simone Cardarelli showed his talent by drawing portraits of people who dared to sit in the chair in front of him.

We even got to see colleagues on the dancefloor, something that we don't get to experience a lot. The cause for this all was the excellent performance by the band of the evening: De Heeren Van. They knew what the crowd liked, and delivered.

We tried to capture the evening by taking many pictures. Enjoy!





# Mission-driven research and The Value of Everything

By: Jan Vleeshouwers

Mariana Mazzucato is an economist who is shaping the European mission-driven research funding program 'Horizon Europe' (see [1]). The direction she envisions is one of pre-described, concrete and appealing long-term targets for research, with a firm connection to solving real and global societal problems. Although it is tempting to think of 'mission' as a kind of 'man-on-the-moon'-like endeavor, real missions are much more complex, much less structured and often cause of a lot of debate, which is why they are generally categorized as 'wicked problems'. If the idea of missions is cumbersome, why does Mazzucato promote the mission concept? What perspective leads her toward this way of structuring and coordinating European research?

A proper starting point here is Mazzucato's view on *value*, on what is valuable to a society. In 'The Value of Everything' [2], she argues that *value* deserves to retake a central position in economic thought and reasoning. Instead of the current mainstream opinion that something has value if someone is willing to pay for it, she posits that value is an independent primary concept. Money paid is secondary and may be at odds with value completely. Her analysis of the 2008 economic crisis is that too much money was being paid for financial services which had little to no value, and that it even destroyed goods and assets which were valuable to society. Frustratingly, in the aftermath of the crisis and continuing today, major financial executives maintain and even boast their valuable productivity.

The most worrying trends she notices is that while shareholders appear to obtain larger revenues from their shares, real investments decrease, which actually reduces company value on the long term. Companies which are listed on stock exchanges, invest just half as much as those which are not. Patents, which should be a way to have society profit

from new findings while protecting the inventor, have turned into obstacles for disseminating new knowledge.

So the 'story' that something has value if one pays for it, is problematic. It gives a variety of activities which actually extract or destroy value, the appearance of being valuable. GDP calculations formalize this confusion, which brings legitimacy to this way of reasoning. As a result, this makes it also more difficult or even impossible for value creation outside the private business sector and it misguides policymakers into thinking along the same money-is-value pattern.

There are straight-forward ways to remedy these problems. The financial sector must turn away from short-term gains, and certainly from high-frequency trading, and instead must become more focused on long-term investments. The governance structures of corporations must change so that they are 'less focused on their share prices and quarterly returns', 'quick speculative trades' must be taxed more heavily and there must be an end to 'the excesses of executive pay'. But underneath all this, she concludes, 'value, a term that once lay at the heart of economic thinking, must be revived and better understood'.

Value is a result of the interaction of people, which is conceptualized as markets. Mazzucato follows Polanyi's views here, that markets are societal constructs which only function within the context of a society. 'There is nothing inevitable or deterministic' about markets. One 'should not reduce everything to an individual choice, stripped from the social, political and economic context in which decisions are made. It is those very contexts that are affected by the (objective) dynamics of technological change and corporate governance structures.'... today we can work to ensure that all activities – in both the real economy and in the financial sector – promote the outcomes that we want: if the quality and



characteristics of an activity in question help deliver true value, then it should be rewarded...' In this way Mazzucato redirects the inwardly view of value as the result of market mechanisms to the much wider context of value as the result of society collectively.

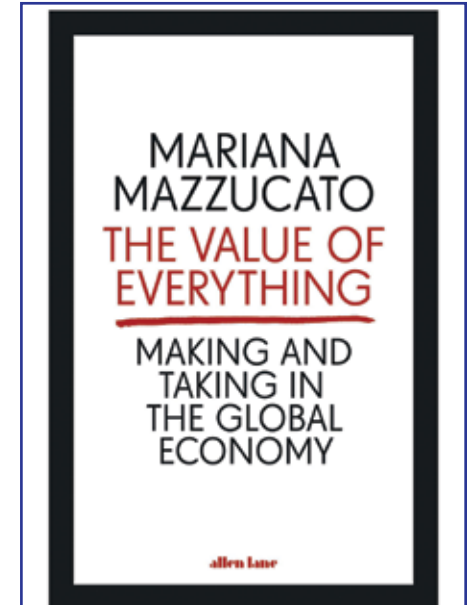
How does this relate to European research? Value is essentially a collective creation, not just in theory but also in practice. Just consider the huge infrastructure built with public money, and the large public investments in high-risk research. Private companies build and flourish on this ground work, so it is necessary and logical that they provide some form of social return. They have to recognize and support the society that made their activities possible, and that is much more than just paying taxes. They will need to be part of 'a framework that allows us to shape a new type of economy: one that will work for the common good'.

Of course 'common good' is a vague description. Mazzucato equates this to long-term growth; it then follows that it is crucial for governments to direct spending and investment towards that goal. 'The question of growth must thus focus less on the rate of growth and more

on its direction.' Historical missions did not subsidize a sector, but focused on solving problems together. This required many sectors and different types of public and private actors to collaborate. 'Concrete missions that involve different types of collaboration are required to drive the fight against climate change or the fight to eradicate cancer – with clear targets, a multitude of sectors and actors, co-investing and exploring new landscapes, but also patience in achieving long-term goals.'

These are the roots of the mission-oriented research Europe is intending to evoke and organize. For our Electrical Engineering research it means that connection to real-world problems becomes even tighter than it currently is. Our Centers will obtain a larger role

in organizing collaboration in order to connect to 'missions'. It may also mean that Electrical Engineering as a general, widely applicable but quite neutral enabler of a variety of developments, will move into the background or that more fundamental activities become fragmented, as we have seen before. It will be our own responsibility to retain the coherence and the synergy of the discipline. That is a realistic target; we just need to keep an eye out for the true value of our work. ■



## Icons of EE: Seymour Cray

By: Author Name

One of the technologies we use nearly every day, which enables us to do some quite complex stuff, is the computer. This technology was already invented back in 1906, with the use of a Babbage Difference engine, which could calculate some easy calculations mechanically. Nowadays we do not use such big mechanical devices, but small backpack-size laptops which can outperform these mechanical rooms full of computer engines by a lot. However, what a high-end laptop or desktop computer can achieve, is just a glimpse of what a supercomputer can achieve. If we do not take into account quantum computing, the Summit supercomputer made by IBM is the reigning champion among fast computers, with a maximum speed of 200 PFLOPS. But who started this race for the fastest supercomputer?

The guy who is credited for creating the supercomputer industry is Seymour Cray. Seymour was born in 1925 in Wisconsin. His father was a civil engineer, which helped Seymour to become interested in the field of science and engineering. Already at an age of ten, he was able to design and build a machine which could convert punch cards to Morse signals. After high school, he was drafted to serve during World War II in 1943 to help as a



[1] Mariana Mazzucato Mission-Oriented Research & Innovation in the European Union A problem-solving approach to fuel innovation-led growth. European Commission, Directorate-General for Research and Innovation, 2018. Download at <https://op.europa.eu/en/publication-detail/-/publication/5b2811d1-16be-11e8-9253-01aa75ed71a1/language-en>.  
[2] Mariana Mazzucato The Value of Everything. New York: Public Affairs, 2018.



radio operator. Next to operating radios, he also had the task to break Japanese naval codes. After his return, he earned his bachelor in electrical engineering and master in applied mathematics by the year 1951.

Cray started his career as an engineer at the Engineering Research Associates (ERA), where he helped building the first commercially successful computer used for scientific purposes. He was quickly known for his skills on digital computer technology and was known within the company as "The Wizard of Chippewa Falls". After a company reorganisation, Cray got dissatisfied with his role within the company, and started a new company with William Norris called Control Data Corporation (CDC) in 1957.

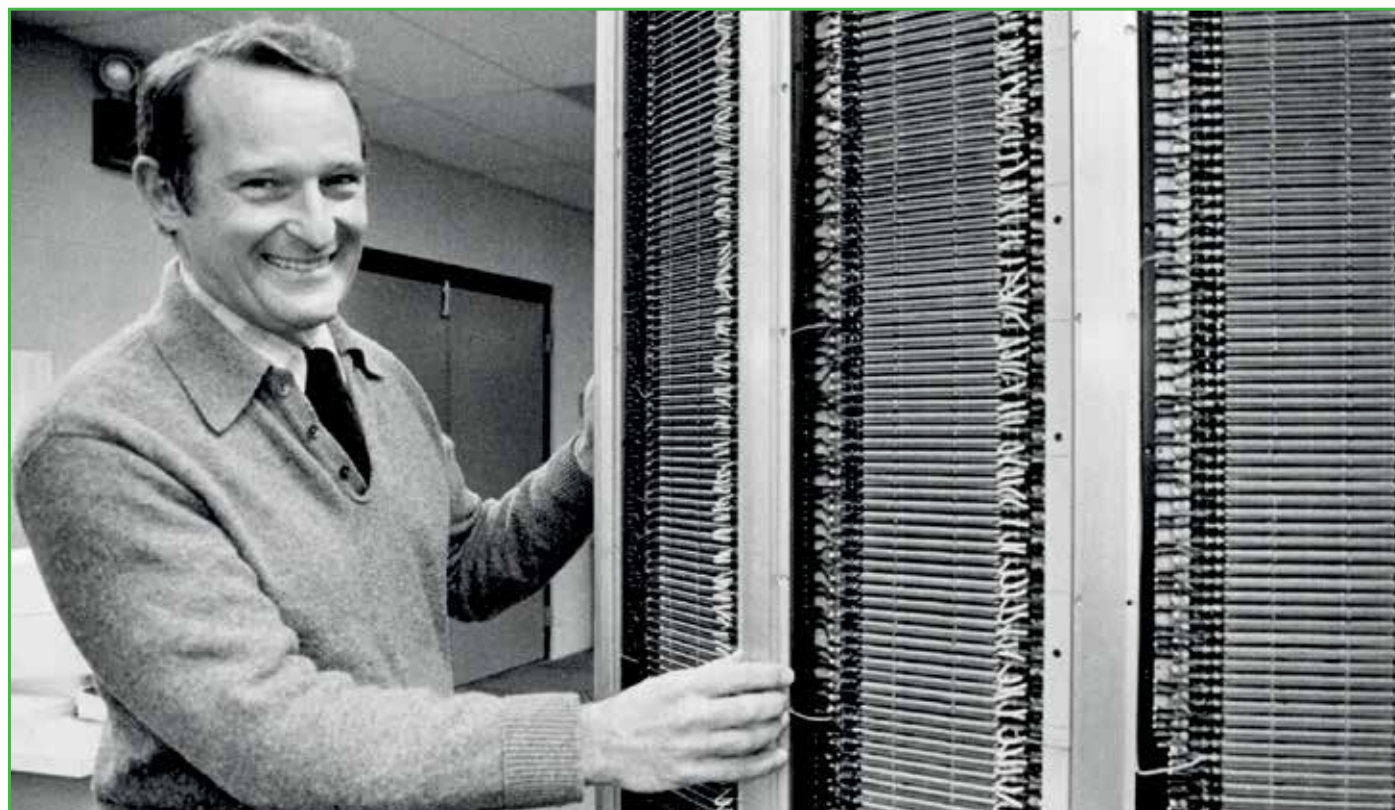
By the year of 1960, the company was about to release its first commercial computer, which basically was a low-cost improved version of the computer Cray designed at ERA (the model of this first computer was the CDC 1604). This computer was special, because it was one of the first computers that used transistors instead of the more commonly used vacuum tubes. The computer was mainly used within the US Navy for Fleet operations control applications, especially for weather prediction. When this product

was not even launched yet, Cray was already working on his next computers. After a while he got bored designing low-cost computers, and wanted to focus more on the fastest computer he could build. This resulted in the CDC 6600, the fastest supercomputer at that time. While many other companies focussed mainly on their processor speed, Cray started to focus more on the system as a whole, which meant that he focussed more on I/O bandwidth to provide enough data to the processor to make it work more efficient. Other companies, like IBM, struggled to create a system which could outperform the 6600 because of these I/O issues.

After some more successful super computers at CDC, Cray started to get more and more irritated by the interference of middle managers who used Cray as a marketing tool instead of respecting him as an engineer. When he didn't get the funding to build his newest machine, he decided it was time for a fresh start, and founded a new company called Cray Research with a first investment from his former colleague Norris. In the beginning they struggled with finding enough money to fund a new computer, but when making a trip to Wall Street, they found out that Cray's reputation was already well known and they gathered

the necessary money with no problems. After a few years of development, Seymour released the first computer, called the Cray-1. With the same design philosophy as with the CDC 6600, it beat nearly every competitor with ease, including his former employee CDC.

Cray's reputation as "the father of supercomputing" cannot be disputed. He was the supercomputer architect behind the best supercomputers for a couple of decades. Every time he would switch between companies, that company would become the market leader. His design philosophy for super computers was to remove heat wherever you can, and make sure that all signals arrive at the right position at the same time, which did not only include the CPU. Not much is known about Seymour's personal life, as he mainly avoided any form of publicity, but he is known to love skiing, windsurfing, tennis and tunnel digging (he dug a tunnel beneath his own house). One story tells us Cray's answer towards the management when they asked him about his one-year and five-year plans, on which he responded with a quick note: "Five-year: build the fastest computer in the world. One-year: Build one-fifth of the fastest computer". ■



# Travel column

By: Sander Verdiesen

**'Designing a backpack for rats' was my response when people asked me what I was going to do for my internship project. I was usually met by bewildered faces and responses like, 'what does that have to do with Electrical Engineering?'. Allow me to explain.**

**A**n NGO named APOPO has been training African Giant Pouched rats landmine detection for over twenty years in Tanzania. The rats are able to smell TNT, but are much too light to set off an unexploded landmine. Next to this, the rats are easy to train and do not listen only to only one trainer, unlike dogs.

Another application where APOPO believes the rats to be effective is search-and-rescue. The advantage is that rats are able to travel deeper into a rubble site, such as collapsed buildings, than people and dogs. However, the rats are not able to communicate to their trainers where they have seen survivors. In order to know whether or not the rats encountered any survivors, the rats should be equipped with some kind of a high-tech backpack. Some of the key components in this backpack are a camera, microphone and transmitter. The backpack must also be small and light enough for the rat to carry easily. For my internship project I attempted to make a prototype of this backpack.

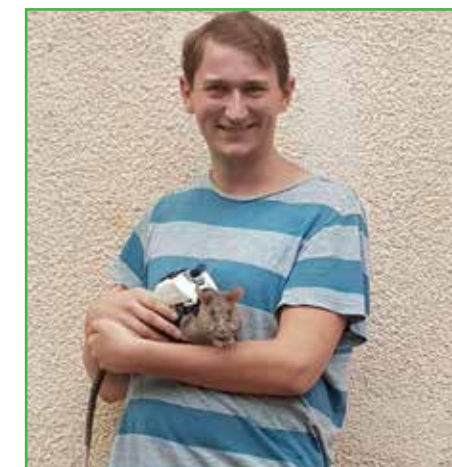
After several months I finished two prototypes and it was time to test them on some real rats. APOPO's operational headquarters are located in Morogoro, Tanzania, where all of their rats are trained. Naturally this is the place I needed to go to test the prototypes. Two bus rides and two flights later I arrived in Morogoro to a warm welcome by the CEO of APOPO.

The next day I met some of APOPO's dedicated R&D team and demonstrated the prototypes. They were very impressed! All that was left to do to begin proper testing was make a harness to put on the rat on which we could then attach the prototype. Somebody quickly fetched one of the retired rats to measure up a harness.

Morogoro is a city that is rarely visited by tourist, despite its close proximity to various national parks. Most notable are the Uluguru Mountains which are only a ten-minute ride with a Bajaj (type of tuk tuk) from downtown. It is great for hiking and boasts some impressive vistas and waterfalls. Due to the change in elevation, locals are able to grow many different kinds of fruits, including some berries which are hard to find in sub-Saharan Africa.

We made the harness out of a diving suit, because the material is quite flexible and comfortable for the rat. It took several iterations, but in the end the rat was able to move around with the backpack without any issues.

Another very interesting place I visited was the field where they train the rats. In this field APOPO has buried several hundreds of deactivated landmines. Some are completely covered by soil, but others can be seen protruding through the surface. This field is divided into different sections and rats never train on the same section twice. It is very impressive to see the rats at work. Especially the



older rats approaching the end of their training seem very effective and almost never miss a mine. In operations they have never missed a single mine!

The last few days at APOPO I spent doing various different tests in order to find the limits of the system. We also brainstormed for various other applications where a camera backpack might be useful, which yielded some very interesting unexpected results. All in all we concluded that the prototype was very successful and it taught us a great deal.

There is still a lot that needs to be done before the prototype can be used in the field. Many are related to the rat's training, but many technical challenges remain also. If you have any ideas or want to get involved, do not hesitate to contact me! ■





# Brain-inspired Photonics

By: Patty Stabile

We create nearly 2 500 000 000 000 000 bytes of data every day, and surprisingly, this information corresponds to about a half of the information of the human genome on this planet! This exponential increase of data generation in the world today is leading to new paradigms in data processing, exploration and utilization, and, supported by artificial intelligence, is pushing society into the cyber-physical era.

Cyber-physical systems, involving the close integration of the cyber world and physical environments (Fig. 1), will contribute to safety, efficiency, comfort and human health, and help solving key challenges of our society, such as the ageing population, limited resources, mobility, the shift towards renewable energies. In this context, also the way people use computers has been radically changing, moving for example to cloud computing – without the need of owning a computing resource. Also, for more specific applications (time-sensitive applications such as autonomous vehicle and virtual reality), edge computing is now provided to a site as close as possible to where the events happen. Additionally, computing resources have become available anywhere via mobile computing.

## Post-Moore era

But what about the computing hardware that we use? Is that enough to satisfy the increasing demand of fast and clever processing of huge amount of data? The answer is no! Every two years, we create more data than we've created in the past (Fig. 2): our ambitions are growing faster than our computers can allow.



Fig. 1 A cyber-physical system involves the close integration of the cyber world and physical environments. [https://fp.jaist.ac.jp/data/kenkyu/fig01236.jpeg]

We need to reinvent our core technologies so we can sustainably deliver innovation to a computer-hungry world.

Device integration in electronic circuits such as microprocessor chips has been making a steady progress at the pace of Moore's law. But as Moore's law has been coming to an end, the clock frequency of processors has levelled off after 2006. Multiple processors have then helped sustain a steady growth of performance gains by parallel computation but at the expense of energy consumption, as well as facing the throughput limitation governed by Amdahl's law. As a consequence, there is a strong motivation behind exploring novel technology frontiers in the post-Moore era via different approaches.

Scaling advances are expected via further planar scaling and 3D integration (More Moore approach). Other strategies address the realization of different functions on different material platforms and the co-integration of different technologies to achieve the desired performance improvement (More than Moore approach). Here, integrated photonics is already playing a major role. Alternative solutions, e.g. semiconductor nano-wires in the place of conventional planar MOSFET channels, are also explored to extend the CMOS roadmap (Beyond Moore). Within this same strategy also electronic accelerators like GPUs, TPUs and FPGAs appear: these are hardware optimized to perform specific tasks. However, performance is eventually limited by the electrical interconnections, as skin effect, dielectric loss and wiring density exacerbate the power dissipation issue and limit the achievable data throughput.

## Neuromorphic electronics

With the continuous advances in microelectronics, supercomputers, the core of the information processing, can now execute around hundreds of petaFLOPS (floating point operations per second), but at the impractical cost of about tens of millions of Watts. Our brain, in comparison, is able to perform about the same order of operations of a supercomputer with only 20 Watts power consumption (Fig. 3).

There is a wide consensus that designing future hardware circuitry by getting inspiration from brain connectivity can offer a real opportunity to overcome the limitations of conventional

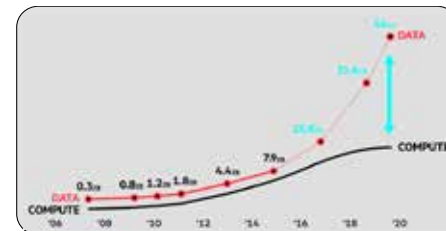


Fig. 2 Today's huge gap between the data we are creating and the actual computing resources. [Data curve from IDC/EMC Digital Universe reports 2008-2017, Compute curve HPE analysis]

electronics. As a consequence, novel (non-von Neumann) computing architectures, such as neuromorphic or other biologically-inspired architectures, have attracted renewed interests in the last decade. Notable examples are IBM TrueNorth, Neurogrid and SpiNNaker for spiking neural networks, FPGA and Google TPU for deep neural networks (DNN). These have reported advancements in power efficiency down to a few picoJoules per operation. However, neuromorphic processing for high-bandwidth applications requires about GHz operation per neuron, which calls for a fundamentally different technology approach.

## Neuromorphic photonics

Neuromorphic approach is being applied to optical computing. In contrast to electronics, there is negligible energy overhead for moving light-encoded information around, which enables unprecedented circuit interconnectivity and speed. Moreover, while in electronics, information is processed at the bit level, photonic engines are bit-rate agnostics. In other words, with photonics we are able to decouple speed from power consumption.

Photonic integration technology has matured to a point where high-performance sophisticated integrated circuits are made available. Computational architectures based on the interconnectivity of multiple neurons are called artificial neural networks, where the base model of an artificial neuron is mainly composed of two functions: a (weighted addition) linear function and a nonlinear function, or activation function. Deep neural networks are feedforward neural networks built from a sequence of layers of interconnected neurons. These are able to run inference, prior to being programmed. The need for scalable photonic

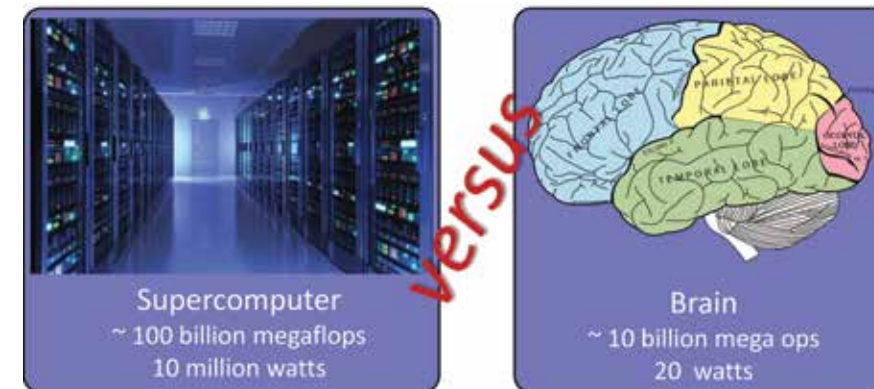


Fig. 3 The human brain, compared to the best supercomputers in the world, is still far more efficient.

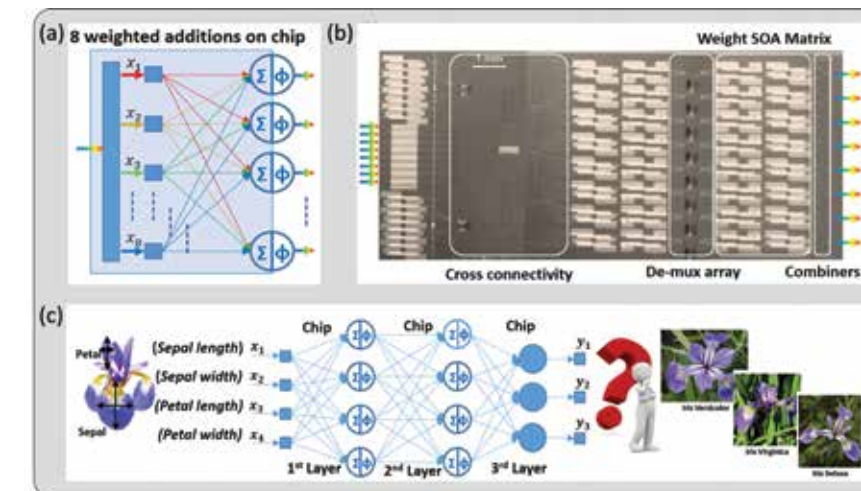


Fig. 4 (a) One layer of 8 weighted additions in a DNN, as implemented on chip. (b) Composite microscope image of the fabricated PIC. (c) The DNN for the Iris flower classification problem, trained on a computer first.

architectures suggests that the use of lossless monolithic or hybrid integration of gain and non-linear components is desirable.

Within ECO group we research large-scale photonic integrated circuits to co-integrate multiple stages of gain and passive elements and we exploit time, space and wavelength domains to reach the highest level of interconnectivity. Within his project on "Photonic Neural Networks", Bin Shi, ECO PhD candidate, has recently demonstrated the novel concept of an amplitude-based weighted addition operation in a neuron through the use of multiple semiconductor optical amplifiers (the weights), optical combiners (to sum up) and photodetectors (Fig. 4). This has allowed us to run Iris image classification problems at a data rate of 8 000 000 000 (giga-) operations per second.

## All-optical neural networks

So far, photonic integrated approaches have been proposed to realize the linear and nonlinear functions, but until now these implementations have relied on hybrid

integration schemes and on the involvement of power-consuming O/E/O conversions, hindering the realization of a scalable photonic neural network. All-optical neural network implementation, based on all-optical neurons, is expected to offer a route to scalability. However, losses happen while light crosses the chip and the accumulated noise can be quite substantial. We are therefore working on a way to amplify and regenerate the signal on-chip, without leaving the optical domain. In doing so, we can guarantee low power consumption regeneration and scalability at the same time.

Preliminary results obtained via a monolithically integrated photonic neuron, which includes the non-linear function, suggest that a scalable all-optical neural network is possible (Fig. 5). The obtained on-chip gain and the level of accuracy achieved for Gb/s data rate level, allowing for 2 orders of magnitude more algebraic operations per energy unit than in a conventional digital processor, suggests the possibility to address faster time-scale real-time applications in the near future. If you would like to read more about it, please do go here: <https://ieeexplore.ieee.org/abstract/document/8859353>. Also if you are interested in a master project on this topic, or simply to know more on this, please feel free to contact me.

This research is financially supported by the Netherlands Organization of Scientific Research (NWO) under the Zwaartekracht programma: "Research Centre for Integrated Nanophotonics."

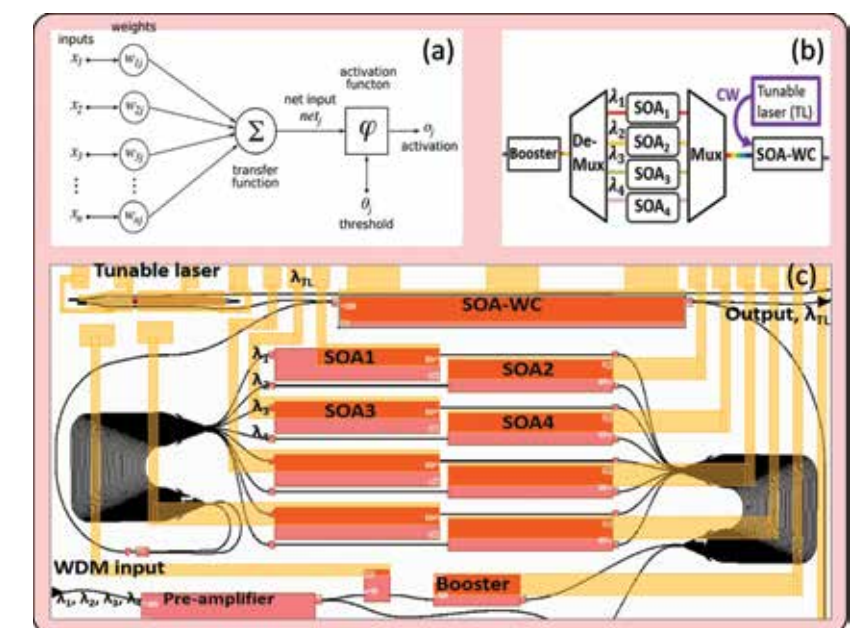


Fig. 5 (a) Basic representation of an artificial neuron. (b) Scheme of the implemented photonic integrated neuron. (c) Mask details of the chip. WC=wavelength converter.



# My life after EE

By: Twan Kamp

**In my first Electrical Engineering semester, we were taught software development by prof. Groeneveld. It wasn't about programming a whole lot. Large parts of his lectures were about fun stuff like dissecting the latest gadgets. He also shared his adventures of building a successful tech company in Silicon Valley. As the largest tech hub in the world, that place sure sounded exciting to me. Fast forward a few years, and now I am leading my own engineering site in Silicon Valley. Let's see how that happened.**

## Becoming a 'burger'

My time as a student was quite a ride. Next to the core EE subjects, I specialized in electronic systems and broadened with technology management and computer science. I was also a member of the board of Thor, organized a study tour to China, promoted EE to high school students, had a side job as an engineer at Prodrive, and was a student advisor to the TU/e board of directors. Some other hobbies like playing video games had to give in a bit, but I still managed to squeeze in the 'occasional' beer in the Walhalla.

After completing my internship at IBM and graduation at ASML, I started in a job rotation program at Philips. This turned out to be a great decision: Philips offers a huge variety of products to work on, making it the perfect place to explore. I took on three totally different roles with the common theme of using digital technology to reshape a product domain.



Hiking in Yosemite Valley

My first job was very technical in helping to develop the world's first fully digital MRI scanner. I built embedded software and FPGA firmware for the control and

data acquisition system. I remember one day debugging for hours why my reported latency compensation values changed. Turned out someone had swapped my fiber optic cable for a shorter one, not realizing I already got to light speed level accuracy. It was quite a hands-on dive into some pretty complex tech, but very rewarding when I finally managed to take my first MR image.

Some advice that worked out well for me is to start with a job you know you are good at, even if you plan to broaden your scope later. It gives the opportunity to prove yourself and create a basis to venture out from.

## I mean business

Venturing out for me meant moving to Singapore. Singapore is an awesome place: a melting pot between western and eastern cultures, amazing food, over-the-top efficient, and with all of South East Asia on its doorsteps. Main downside is that going out is expensive. On a weekend trip to Bali we joked that we

already 'earned back' our flight after a few beers, given the \$15 beer price difference between Bali and Singapore.

Along with my manager and another colleague we set out to start a home healthcare business in Asia. The goal was to get people out of the hospital back to their homes faster, while monitoring them through internet-connected devices. We planned to adapt programs already running in the US and deploy them in Asian countries. That was quite a challenge, certainly for me as it was purely about business strategy. I planned to catch up my business skills by working some overtime. Unfortunately, it turned out that everyone already worked crazy hours by default. This started an intense period, yet fruitful as it helped me understand both the business and technology side of innovation.

At some point I managed to set up a meeting with leaders in a large hospital chain. Quite proud of myself, I brought my manager so he could present our product vision. Their responses were not at all what I expected though – they criticized most of what we brought up. Bumped out in the taxi back, I asked my manager how he thought the meeting went.



Dragon dance in our Singapore office

To my surprise he said it was great and they would become a key partner. And surely, after a lot of hard work, he was proven right. I learned that an optimistic mindset is a great asset when trying to do something disruptive.

## Things got lit

Next up came a tough decision. On the one hand I could start in the corporate strategy group, which was very exciting and a good career move. On the other hand, there was this new initiative ongoing around smart home lighting, called Philips Hue. There were no vacancies, but I saw that a former Thor board member was leading a team. I reached out to him and he was able to create a position which would move me closer to product development again. After a lot of thought I decided to go for it.

The Hue system consists of lights, sensors, cloud services, mobile apps, SDKs, and so forth. My role as a system architect was to make sure all those work together seamlessly to deliver new features with the best experience. Philips Lighting – nowadays split off as 'Signify' – is the world leader in lighting, but it can be hard to sustain that position through a changing technology landscape. Just think about who is using Windows Mobile on a Nokia phone right now. I was determined to help us stay ahead by creating the best product. So far, we are still the leader in smart lighting with no signs of slowing down. ▶



My first MR image on new system (scanning fruit)



No photos allowed inside Apple Park, so flying over





Demoing new products at E3

An important moment in my career was when tech giants like Apple and Google stepped up to also get into smart home, with products like HomeKit and Google Home. As part of my job I led the integration between their systems and ours, creating a new dimension of joint product development with partners. This became so successful that we decided to

set up an office in Silicon Valley to collaborate further, with engineers working side by side whenever needed.

That is how I eventually ended up with my dream job of leading an engineering site in Palo Alto, while living in San Francisco. It is a combination of people management, overseeing

our partnership portfolio, and technology leadership. Nowadays we don't only work on partnerships, but also on some of our strategic new products. Most notably we just released the 'Hue Sync Box', which you can plug between your TV and game console or streaming device. It then uses Hue lights to create an immersive 'surround lighting' experience synchronized with the movies or games. What's more, this gave me a great excuse to play some video games again, which also helps with all the travel (thanks Switch!).

How is living in the Bay Area? In exchange for ridiculously high rent, you get the best of two worlds. First, California has beautiful weather and nature – ideal for being outdoors. That combined with an unrivaled tech culture where some of the world's most impactful products are created and engineering skills are highly valued all the way to the top. Ideal for... life after EE? ■



Lighting up Las Vegas at CES

# Dies Natalis

By: Martyn van Dijke

As each year goes by, also study association Thor gets older and older. Last November we had the chance to celebrate the 62nd birthday of Thor, and what a week it was! The week Thor becomes a year older is known as the dies week (based on Dies Natalis), and consists a lot of festivities, ranging from fun activities such as the opening or the dies party, to more serious activities like excursions and a lunch lectures.

Just like every year there is a central theme to the dies week. This year the theme was 'Time flies'. We have tried to give every activity during the week a dedicated era and incorporated them each into the big picture of "Time flies when you are having fun!". And this worked pretty well, especially during the dies party where every 1.5 hours the music and party attributes changed according to the time period.

Because the week was so dense in activities I want to highlight some activities that are the most noteworthy to mention.

## Dies opening

We started this dies week as always with the famous "vlaai opening" to kick off this special week. While it is always nice to have some delicious pies as a lunch, it is even better to share pie with the faculty and our members who have made it possible to make Thor grow every year!



## Dies Pub quiz

This year we had a technical pub quiz which has been organised in collaboration with Alten. Alten provided us with some very interesting questions for a pub quiz such as: "what's the nominal impedance of a USB cable?" Or "how much power does CERN actually use annually?" (The answers to those questions are 90 Ohm and 50.7 TW.)

## Dies party

As already stated, the theme of this year's dies really came together as the dies party on Thursday. Every time period from the 80s till the mysterious future has been brought to Het Walhalla to celebrate the dies. Every era had their specialised party prop: during the 80s we had very retro-looking sun glasses, during the 90s everyone had Tamagotchi to play

with it, and in the 00s we had Pokémon cards to hand out to the party animals in het Walhalla. While handing out these party props we noticed all the students getting as excited about the party as about a Tamagotchi or an old Pokémon card from their youth!

## Dies Diner

As everything great inevitably comes to an end, unfortunately, the 62nd dies week of Thor ended as well. We ended the dies week with a very nice dinner at the Evoluon in Eindhoven, to symbolize the future and thus the end of this festive week. ■





# Internship abroad

By: Martijn de Kok

**JPL? Last March I didn't have the faintest idea what that abbreviation meant. I should have paid more attention to the Sci-Fi film *The Martian*: the astronaut who gets stranded on the red planet would not even have set foot there if it wasn't for NASA's Jet Propulsion Laboratory. And if it were up to JPL, the idea of a human on Mars won't remain science fiction for long. I was fortunate enough to call JPL my place of work for four months.**

The NASA Jet Propulsion Laboratory, based in Pasadena near Los Angeles, does so much more than just rocket propulsion: it has been responsible for countless space missions such as Explorer 1 (the first successful American satellite) and the two Voyager satellites outside of our solar system. All rovers that have ever driven around on Mars were built there as well. At the time of writing in late 2019, JPL engineers are performing the final test on Mars 2020, the new rover set to launch in July next year. This rover will investigate the surface for signs of past life and habitability, and cache samples for a potential future Mars sample-return mission. It will also carry a small helicopter, designed to fly autonomously in Martian atmosphere. Isn't that awesome?

The spacecraft assembly area, the massive clean room where Mars 2020 has been assembled and tested, was only five minutes walking from my office up the hill. Like many other JPLers, I made a point to visit regularly and watch its progress. Standing there, imagining how that car-sized robot will be transported millions of miles over a period of seven months, land autonomously and then casually drive around, gave me goose



bumps. It makes mankind seem small and insignificant on the grand scale of things, but impressive at the same time.

## Caltech

JPL is managed by California Institute of Technology (Caltech), which puts this NASA center in a unique position: the lab, including all buildings and equipment, is owned by NASA whilst all personnel are

employed by the university. This situation makes it possible for international students like me to do research projects for NASA as visiting students of Caltech. Nonetheless, US students were the vast majority amongst the interns, many of them attending high-profile universities such as MIT, Princeton, Yale, USC, UCLA, Boulder and Caltech itself. Having had great times with many fellow interns, I never felt that Eindhoven University of Technology was noticeably inferior to these bigger names. Except perhaps in reputation and price tag.

The lines of communication with Caltech researchers were always short, and to be in the real-life setting of *The Big Bang Theory* was a fun bonus. The compact campus is beautiful and pristinely kept, and a fancy wine and dine with my JPL supervisor at the prestigious Caltech Athenaeum was one of the many highlights in my visits to Pasadena.

## Deep Space Network

One of JPL's many buildings houses the control room of the Deep Space Network (DSN): an international array



of massive (70-meter) radio antenna dishes forming the largest and most sensitive scientific telecommunications system in the world. There are antenna arrays located in Goldstone, Canberra and Madrid, all pointed 120 degrees apart to provide full-sky coverage. The DSN provides communication for all US interplanetary missions, all of which is routed through this control room. This is why the control center is also called 'The Center of the Universe'. During a tour for interns we were free to walk around the control room, take pictures and eat some of the 'lucky peanuts' that have been on the checklist of every launch since the Ranger missions in the 1960s (although JPLers deny that this is a superstitious habit, the absence of peanuts at launch has led to failures and delays in the past). Visiting this building has been a very impressive experience.

## My Project

The group I worked in was the Advanced RF and Optics group, and all I knew beforehand was that I would be working on a novel inter-satellite optical communication system. I ended up designing an entire mission concept for a space-based radio interferometry array behind the Moon that could potentially detect ultra-low frequency emissions that are not measurable from within the Earth's atmosphere. A portion of this project aligned with my knowledge as an Electromagnetics master student, but most of it clearly didn't. This meant that I had to dive into literature and meet with JPL scientists to learn about (radio) astronomy, orbital dynamics and satellite

propulsion techniques, for example. It was a new, exciting and incredibly motivating experience.

## Los Angeles and California

California is a beautiful state, and there is so much to do in LA that after four months you still haven't seen and done it all. The Walk of Fame in Hollywood, the Warner Bros Studio Tour, Rodeo Drive in Beverly Hills, the Pier in Santa Monica, the Millennium Falcon in Disneyland and the view of Downtown's skyline after a hike from Griffith's Observatory are just a few of the highlights.

The LA region houses many large and well-known aerospace companies such as Boeing, Lockheed Martin, Raytheon, Northrop Grumman and SpaceX. Amongst them, the Jet Propulsion Lab is a well-respected and even admired institute. Every summer, all these companies

and others get together to play beach games. It was a fun day, where I and other interns contributed to get JPL to the second place overall. This was the optimal result, as the winner would organize next year's games and JPL would rather spend its federal funding on rocket science.

During my four months in California, there were only two cloudy days: all others were sunny and around 30 °C, perfect for outdoor activities! Nature wasn't kind on all fronts, though: I experienced my first earthquake on the beach on the fourth of July, and others followed later. In my last month wildfires started appearing all over LA county, with one of the first just a few miles away from where I stayed. On all my hikes, the scars of past forest fires were still clearly visible.

## Results

The results of my research and mission design have been compiled in a paper that has been submitted to the 2020 IEEE Aerospace Conference. The paper has passed the reviews and was accepted, and thanks to the TU/e's Electromagnetics group I'm thrilled that I can go back to the US next year and present my work! This experience has also solidified my interest in electromagnetics and the applications of phased arrays. Most of all, it has made me very enthusiastic for the subjects of radio astronomy and aerospace, two fields of study I never expected to delve into. But what made this experience unforgettable, above all else, were the fantastic people I met and spent time with. ■





# Puzzle

## Open the last drawer

A cabinet with 25 drawers is full of valuables. In order to win everything that's in it you need to play a game against a very skilled opponent that has the most optimal strategy, you are given the opportunity to start first.

The player that opens the last drawer wins everything. You are only allowed to open 1, 3 or 4 drawers at a time. In the last move you are not allowed to open more drawers than there are left (you cannot go below 0). What moves should you take to win?

Hint: you need to make sure your opponent is always opening a "losing" drawer number – a drawer number that always results in a loss.

There is only one possible first move.

## Solution previous puzzle

The previous puzzle could be solved by arranging the dices next to each other. Doing so would create a pattern.

There were no correct answers submitted, so we were forced to eat the vlaai ourselves.

Good luck with this edition's puzzle!

If you know the answer to the puzzle, please send your solution to [connecthor@thor.edu](mailto:connecthor@thor.edu) and you might win a Vlaai!

This edition's puzzle is sponsored by Alten.



ALTEN



# Broaden your view

By: Tom van Nunen

In my research, I have quite some contact with people in other disciplines, such as brain surgeons, MRI specialists, AR experts, and visually impaired people. Presenting an electrical engineering subject to those people can be quite a challenge, which is a good thing. I believe that this helps you understand your own subject better. Furthermore, listening to them presenting their research, and engaging in discussions about them, is truly an enrichment of your mind.

My sister recently graduated and acquired her degree in psychology, with a specialization in behavioral change. Allow me to enrich your mind by giving you an insight in her research about burglary prevention.

The field of behavioral change focuses on motivating people to change certain aspects of their behavior. Most of us don't like change that much, and this aversion to change is not limited to engineers. To overcome this, they usually aim to change people's behavior without them actually realizing that something is changing.

One example is an area where people throw their litter on the street, instead of in the bin. Placing some shrubberies can change this behavior, and, interestingly, so does placing a sign with eyes looking at you. There is something about being watched that makes you behave better.

Another example, invented by the company my sister is now working at, is related to the Dutch tax authorities. Some people have difficulties paying their tax debts. The company found out that the letters are mainly focused on the debt and the penalties if one fails to pay. The content was changed towards an aid to clarify how the debt can be reduced. This caused a significant increase in the number of people paying.

As said earlier, the research of my sister focused on burglary prevention. It was executed in cooperation with an insurance company and the company she is working for now. The main research



question was how people can be moved to make their house less attractive for burglars.

Many people unintentionally make their house interesting for burglars. This can, for example, be because valuable items can be seen through the windows, or ladders and litter bins are located such that an open window or the garden can be accessed easily. How can this behavior be changed?

My sister designed a flyer that was handed out to everyone in one neighborhood. This flyer provoked the reader to look at their house from the eyes of a burglar. Can I see things that make me want to break in? Can I use nearby objects in my break in attempt? To keep the tone from becoming too serious, the flyer contained a cut-out burglar mask, so the reader could really empathize with his role. So, did it work?

Before the 'intervention', two neighborhoods were thoroughly studied on the aforementioned aspects. Then, the flyers were handed out, and after a few days, the change was inspected. During the second inspection round, the behavior of the residents was noticed to have changed compared to the other neighborhood and the situation before: fewer valuable items were visible, and it was more difficult to gain access to gardens or open windows. Additionally, during her second inspection round, one woman actually called the police, because there were some suspicious-looking people walking around the neighborhood, looking through windows and over fences. These people were, of course, my sister and her two assistants (who were in fact cops). What a great result!

I encourage everyone to engage in activities that include interaction with people from other disciplines. It can lead to very interesting points of view, and you might hear a nice story or two. Enrich your mind! ■





**Fatma**  
Technologist (Former Trainee)

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