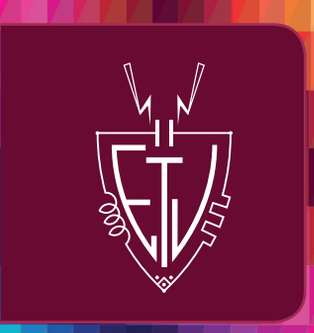
# MAXWELL

Electrotechnische Vereeniging

Issue 23.2 | February 2020

# Resonance



**Running on Sunlight**
Chasing an unreachable dream
**A life after the University**
SLAM orthopedics
**High-Voltages and Large Currents**
An article by our Honorary member

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# From the Board

## The ETV and the COVID-19 virus

*By Shea Haggerty*

It doesn't take a lot of effort to notice that a lot of things have changed at the TU Delft, and thus also at the ETV, in the last few weeks. To address the elephant in the room, or the elephant in the magazine, let me tell you about how we as the board deal with the measures regarding the virus.

It all began when we had to think about giving the Recruitment Days a go or a no-go; the whole situation regarding the virus was very unsure then. However, the Thursday before the event would start, the prime minister Mark Rutte told the nation that large events were to be cancelled. Naturally, we had to cancel the Recruitment Days. The whole situation escalated rather quick after the first press conference. Not much later, we got the message that everyone had to work from home, and only go to the faculty if it was an absolute necessity. As a board, it came down to quickly making decisions regarding how we should tread from there. It was an 'easy' but sad decision to close the board room for members, and to only do board work there if necessary. Our board meetings quickly transitioned into Skype-get-together, and our Whatsapp groupchat is being used more than ever.

In this difficult time for us as a society, it is very important to all live by the guidelines set by the government – even if it means cancelling activities and events which people worked very hard for. After the news hit that no events, no matter the number of people attending, are not allowed until the first of June, it was evident that a lot of events which were already set to be replaced, had to be completely cancelled. We as a board feel sad about not providing activities and an atmospheric board room with coffee for our members, but the health and safety of our members is an absolute priority. This last realisation makes it less hard to deal with the drastic measures – they are simply needed to ensure everybody's safety.

Although all the physical activities have to wait until next year, online activities are making an uprising. We see that members like to do their 'Vrijmibo's" on Skype, or join the ETV server to play Minecraft with one and another. There is even an online General Assembly, where the Yearbook Committee will be installed and where they will present their budget plan. For us as a board the possibilities for connecting with our members online is very new, and sometimes challenging. However, we are trying to make the best of it and are always open to new ideas, tips or thoughts on input!

We hope you all stay safe, healthy and fit during this time. Look out for others, keep studying, and join the Minecraft server once in a while!

# Colophon

Year 23, edition 3, April 2020

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# Editorial

Dear reader,

First of all, we hope you are healthy and safe!

This edition is a special one, as we are celebrating fifty years of EWI.
Hence this time, many of our articles are very department-centric. We bring to you, a few pieces on the education at EWI - on minors and the new graduation project. Additionally, we have an article from an honorary members of the association.

Each edition has a unique theme from Electrical Engineering. To complement this quarter's "Resonance", we have an article about the latest advancements in high voltage technology from a professor from the department. Additionally, providing interesting insights and challenges, we have pieces from a dream team and a student organisation.

This quarter was a strange time for all of us, to say the least - considering the pandemic; But, science never comes to a halt, and neither do we. It is important now, more than ever, to learn about advancements in science and technology and stay informed! Hence, we thought it was especially important to publish this quarter as well.

So, we hope you enjoy our small part of history, and happy reading!

*Archana Ranganathan*

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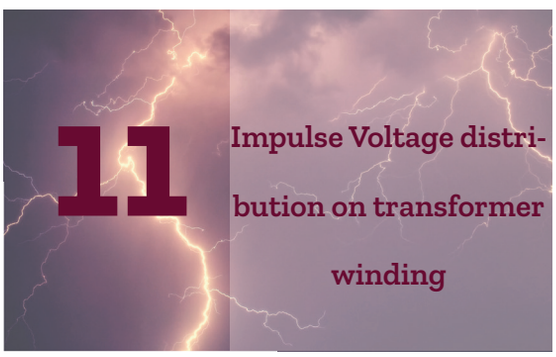
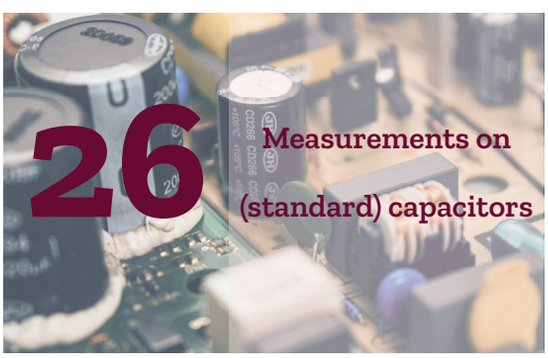
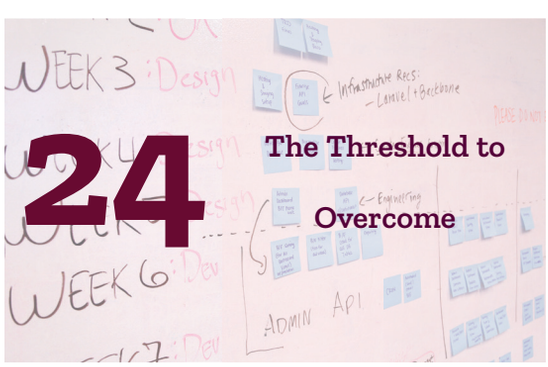







# A Building's History

*Shea Haggerty*
*Sam Aanhane*

**Whenever you drive from your hometown to Delft, there is a hint which means you're getting close – the vague contour of EEMCS on the horizon. This year, EEMCS has reached it's 50 year anniversary on being a true Delft landmark.**

EEMCS, or as the Delft residents say 'EWI', was not always located in this iconic blue and orange building. It's original location, then called the 'Polytechnische School' was along the Oude Delft 95. The first lectures were given there in 1843, for just 48 students! You must keep in mind that this was the whole campus of the TU Delft, so not only the mathematics, electrical engineering and computer science faculty as we know it now. Since 1894 the building was expanded and other buildings were built on the south-east side of the centre of Delft. Many of these buildings which date before the second world war were later sold to student housing organisation DUWO (rings any bells?).

The construction of EEMCS started in 1962 under the architectural eye of G. Drexhage who designed the building. EEMCS was done just five years later in 1967, and officially opened for use in 1969. Since the building is so architecturally special and unique, here are facts you might not (or do) know about our faculty:

Did you know this about the faculty of EEMCS?

EEMCS is, with its 90 meter height, almost the highest building in Delft. The 'Nieuwe Kerk' is the only building in Delft which is higher – the reason for this is that no building is allowed to be higher than the church!

Did you know that EEMCS was recognized as a monument in 2009 because of its architectural value?

EEMCS has two large clocks mounted on the sides of the building. One on the northern side, and the other on the southern side. One of them can even be seen from the central station!

In the original building plan, the idea was to build a second building identical to what we now know as EEMCS, and to place it opposite EEMCS across the Mekelpark. This way, the two building would represent the two poles of a magnet.

Did you know that our faculty originally had a pond in the central hall? It has since been replaced by stairs which lead you to the basement and the /Pub.

Since I have moved to Delft, many things in my environment have changed. My street has been rebuilt, new buildings in the vicinity of the station continue to rise from the ground and expand in every direction (or so it seems), but I always enjoy cycling towards the tall blue and orange (or red?) skyscraper every morning – especially because the huge clock helps me to decide how fast to cycle. Happy 50th birthday EEMCS, to another 50 years of being a Delft icon!

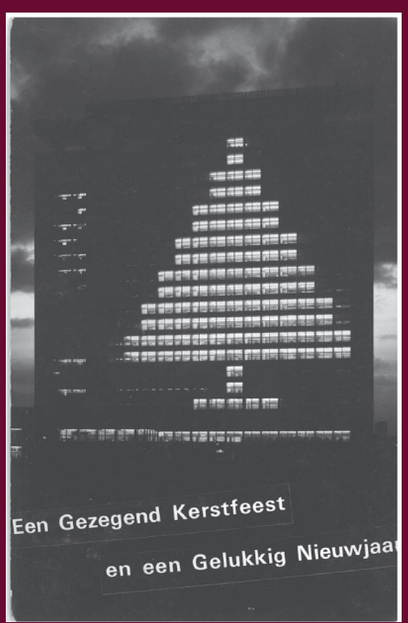



***Figure 1.*** *A christmas card from long long ago...*

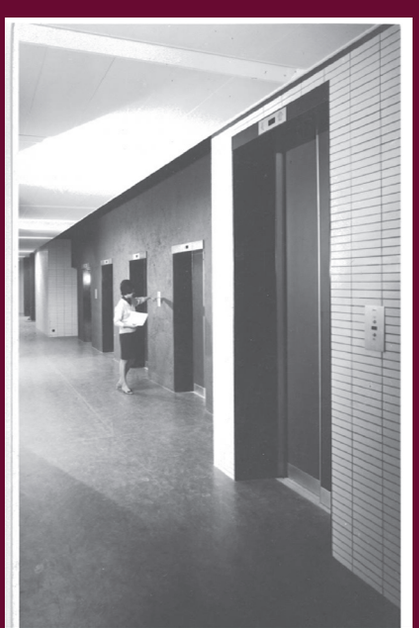


***Figure 2.*** *The (in)famous elevators when they were just in use*

I personally have always held our ivory tower in a high regard. Ever since I set foot in the building as a young highschool student, I have been impressed with everything going on on a day to day basis. Not many people take a step back to appreciate the many purposes of our faculty. For one, educate future engineers and stimulate development in the field of Electrical Engineering. These purposes go hand in hand because they both rely on each other. New Electrical Engineers are required to make advances in the field and developments are needed to provide research topics to educate students. Quite a paradox indeed. Luckily our faculty has done a great job in both cases. In 2017, 472 master students have graduated and this number has increased every year since. Of those 472, 38 graduated Cum Laude. Regarding the privously mentioned purpose of doing research, the EEMCS faculty is second with respect to the amount of inventions reported to the Valorisation Centre. To conclude, I am glad our building has lived to the age of 50 and am looking forward to the next few years!

***Figure 2.*** *EWI in a beautiful spring now*

***Figure 3.*** *And EWI a long time ago.*

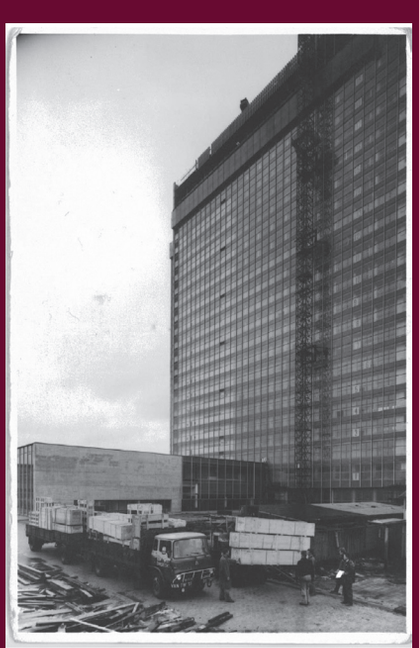


***Figure 4.*** *The contstruction near completion.*

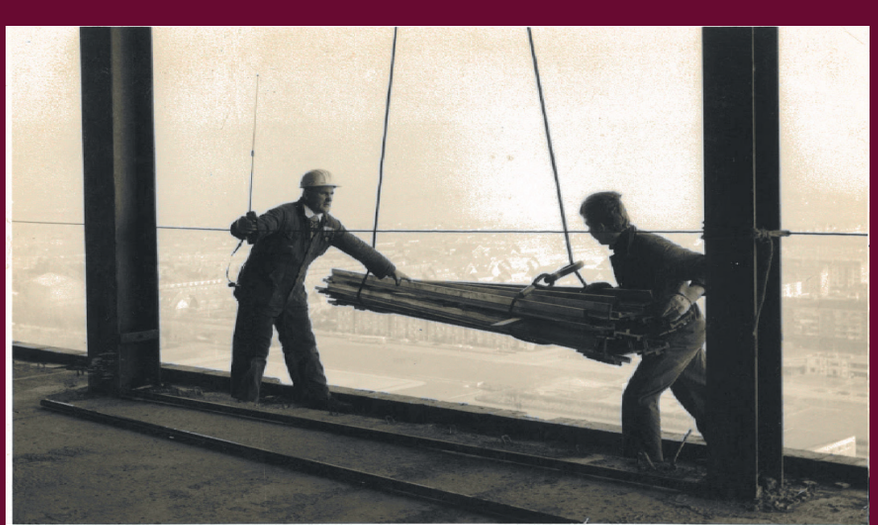


***Figure 5.*** *Getting all the resources all the way up was not easy.*

# A life after the University

*Bart Kölling*
*Kolling@slamortho.com*

**After years of studying, most of us will eventually leave the TU Delft and spread our wings. Most people go to work at a company, but not all of us. We asked Bart to tell us his story about starting a company during his study and continuing with it after graduating. He was happy to share his experiences.**

The years spent studying Electrical Engineering at the TU Delft were a lot of fun for me. I learned a lot during it, not only did I obtain engineering and academic skills, I also got a lot of interesting experiences from extracurricular activities by participating in committees and as an ETV Boardmember. After my time studying at the EEMCS faculty I have been working full-time at my own company, SLAM Orthopedic, that was founded already during my studies. In this article I will elaborate on how the company was founded and what challenges I and the company have faced, and what challenges are still to come. But first I will give a bit more background information by telling you about my time studying.


**Figure 1.** *SLAM orthopedics won the "rookie of the year" award at YES!Delft*

### Studying Electrical Engineering

In 2012 I started the bachelor programme Electrical Engineering at the TU Delft straight after graduating from the Dutch "VWO". During my bachelor I took a year to be a full-time boardmember of the ETV. After completing the bachelor in 2016 I decided I would like to continue to learn more in the field of EE and started the Signals & Systems master track of EE. Next to the courses of that track I also ventured to 3ME to do some systems & control courses and did some courses in machine learning from the computer science department.

When it became time to chose a thesis subject, I chose a project in the biomedical signal processing field. I did not do any biomedical-specific courses but a signal is a signal, so that should not matter too much I thought. It was a project about processing signals recorded during open-heart surgery, where about 200 electrodes were placed on the atria of a human heart. From the signals then anomalies could be tried to be detected to determine if there was any tissue damage present for example. These anomalies could indicate if this patient would suffer from atrial fibrillation in the future. It was an interesting project that was a collaboration with the ErasmusMC, the academic hospital in Rotterdam. I visited them a few times to gain more insight and collaborate with them which was fun. But I was also visiting hospitals for another reason during this period, not only for my thesis.

### Starting a side project

It was the case that during my master and during my thesis I was also working on building my medical technology company that I had started during my studies with a few others, and for this reason I was then also visiting a lot of hospitals. This started back in 2016, when I was approached by a group consisting of an orthopedic surgeon, a mechanical engineer and a business developer. The orthopedic surgeon had experienced a problem during his time working in a hospital and they were assembling a team to try and solve this. I was interested and joined them, and we started working on the first prototypes to see if we could solve this.

So what is the problem? During orthopedic and trauma surgery the surgeon often has to fixate broken bones to allow them to heal properly again. To do this metal screws and plates are used. The surgeon first has to drill a hole, and then select the right screw length. Is the screw too short the implant might break off, is it too long then the tissue around the bones might be damaged. Currently the golden standard is to use a manual depth gauge, a metal hook that is inserted through the hole in the bone and has

***Figure 2.*** *Testing a prototype of the SLAM Orthopedic technology in a real-world setting*

to be hooked behind it. This is time consuming, error-prone and annoying.

With the team we came up with a proof-of-concept to solve this, applied for a patent and founded a company, SLAM Orthopedic. The solution is an add-on for surgical drills, that uses sensors to measure during drilling and then instantly gives the correct screw length to the surgeon when the drilling is complete. This saves expenses OR time, and provides a higher quality of life for the patient.

My background in electrical engineering was useful when designing the prototypes, however I did need to learn a lot of extra skills to go from a concept system to a completed prototype. Furthermore, we also need to very closely listen to the demands of the future users, the surgeon. So we traveled around to visit hospitals and talk to them, and also watch them work in the OR. This was a completely new experience and was awesome to do. Also testing our own prototypes during a training for surgeon on human cadavers was a brand new experience that I did not think I would ever get.

**Current situation**

We participated in the EIT Health Validation Lab at YES!Delft the past fall which was extremely useful and fun. There were 10 startup teams from all over Europe that came to Delft and together we worked on improving our pitches, understanding our customers better and much more. Also we got to travel to Germany, Denmark, Spain, the UK and Ireland during this and got to learn more about the different healthcare systems around Europe.

After completing my thesis in October 2019 and fin ishing the Validation Lab, I started working full time at SLAM Orthopedic. We are now situated in an office at YES!Delft working on taking our solution to the market. This means improving our prototypes and setting up collaborations with hospitals and others to start using the technology in a real-world environment. We are currently looking for more funding to expand our team and produce the next generation of prototypes with which we can do more testing to prove our effectiveness.

If you are interested we would be glad to tell you more about our solution and our vision for more "smart" surgical tools improving the efficiency and the quality of healthcare. So do not hesitate to reach out!

SLAMORTHOPEDIC

***Figure 3.*** *The logo of SLAM orthopedics*

# Impulse Voltage distribution on transformer winding

*Dr. Ir. Mohamad Ghaffarian Niasar, Weichuan Zhao*

**When lightning strikes an overhead line, the resulted transient overvoltage propagates along the line, entering the transformer through the bushing and reach the winding. The overvoltage leads to high electric stress between the windings as well as inside the winding between the turns, layers and/or disks of the winding. While during the normal operation (50/60 Hz), winding behave inductive and voltage distribution along the winding is uniform, during a surge overvoltage because of high dV/dt of the front wave, current predominantly flows through the turn-to-turn and turn-to-ground capacitances which causes nonlinear voltage distribution along the winding. This results in high electric stress near the high voltage connections of the winding. Proper measures have to be taken into account to avoid winding failure during a surge over- voltage. How is this done?**

**Winding structure in power transformers**

In power transformers, layer winding is typically used for the voltage levels below ~70 kV. For higher voltage levels, layer winding requires very complex insulation manufacturing in order to avoid self-flashover inside the winding and therefore it is not commonly practiced. For the voltage level above ~110 kV in almost all cases disc winding is used. This rule of thumb is applicable to both LV and HV windings (in some transformers the LV side is also higher than 110 kV). Figure 1-a and 1-b show the LV and HV transformer winding arrangement. Figure 1-c illustrate the connections of a layer winding with three layers.

**Nonlinear impulse voltage distribution**

To calculate voltage distribution along the winding different models such as lumped RLC ladder network, multi conductor transmission line (MTL) model, and simplified capacitance equivalent model have been introduced and investigated by different researchers. A comprehensive detailed model of the winding that includes all parameters (matrixes of R, L, and C of the winding turns) either by means of RLC ladder network or MTL model is not desirable or tractable in many cases (such type of study is necessary to evaluate self-resonances of the winding which may create severe stress between the turns during a chapped impulse event or occurrence of very fast transients due to gas insulated substations (GIS) switching). In practice a simplified capacitance equivalent model can provide sufficient information about the electric stress along the winding and therefore adequate insulation requirement of the winding between the turns and discs can be decided. In a capacitance model it is assumed that right after arrival of the voltage surge, current cannot flo w through the winding due to presence of inductances. It only flo ws as displacement current through the capacitances of the winding, hence only capacitance network of the winding should be considered. This model is not frequency dependent because it only consist of capacitances. Therefore, when the model is excited with an ideal step function to represent the ultimate case of excitation, even though the step function contains all frequencies, the model treats all frequencies the same way (which is one of the limitations of capacitance equivalent model). While a winding with n sections has a capacitance matrix of order n×n, the capacitance network is usually simplified one step further and only most important capacitances are kept in the model, i.e. the series capacitances (between the consecutive sections) and the ground capacitances (between each section and ground). Figure 2 shows a representation of simplified capacitance equivalent model of a winding. If the total series capacitance of the winding is $C_s$ and the total ground capacitance of the winding is $C_e$, it can be shown that $\alpha=\sqrt{(C_e/C_s)}$ determines how the voltage is distributed along the winding [1]. Figure 2 shows the voltage distribution along the winding for different values of $\alpha$ when the second terminal of HV winding is grounded. It can be seen that one way to improve voltage distribution is to increase the series capacitances of the winding. This is usually done by means of interconnecting the turns and discs of the winding in different electrical sequence than their geometrical sequence. In this case the series capacitance of each double discs is significantly increased and therefore the voltage distribution along the winding becomes more uniform and highly stressed parts of the winding are relieved.

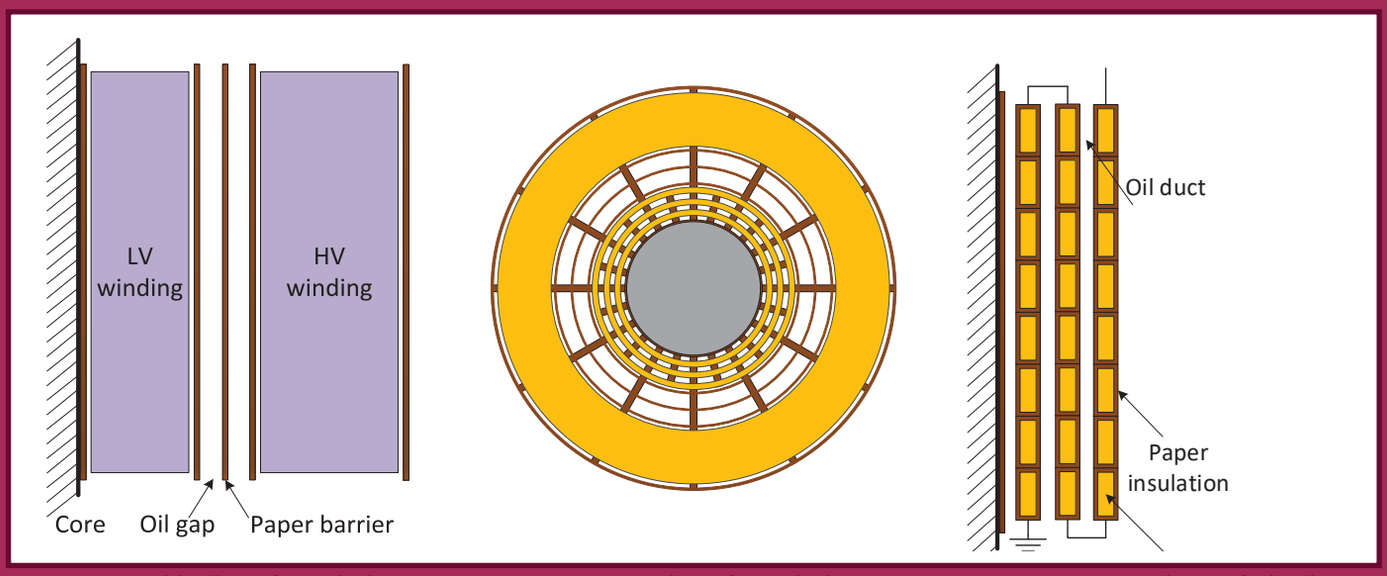



***Figure 1a**. Side view of a typical transformer winding with a LV layer type winding and HV disk type winding*

***Figure 1b**. Top view of a typical transformer winding with a LV layer type winding and HV disk type winding*

***Figure 1c**. Connections of the layer winding with three layers. Note: the dimensions are not proportional.*

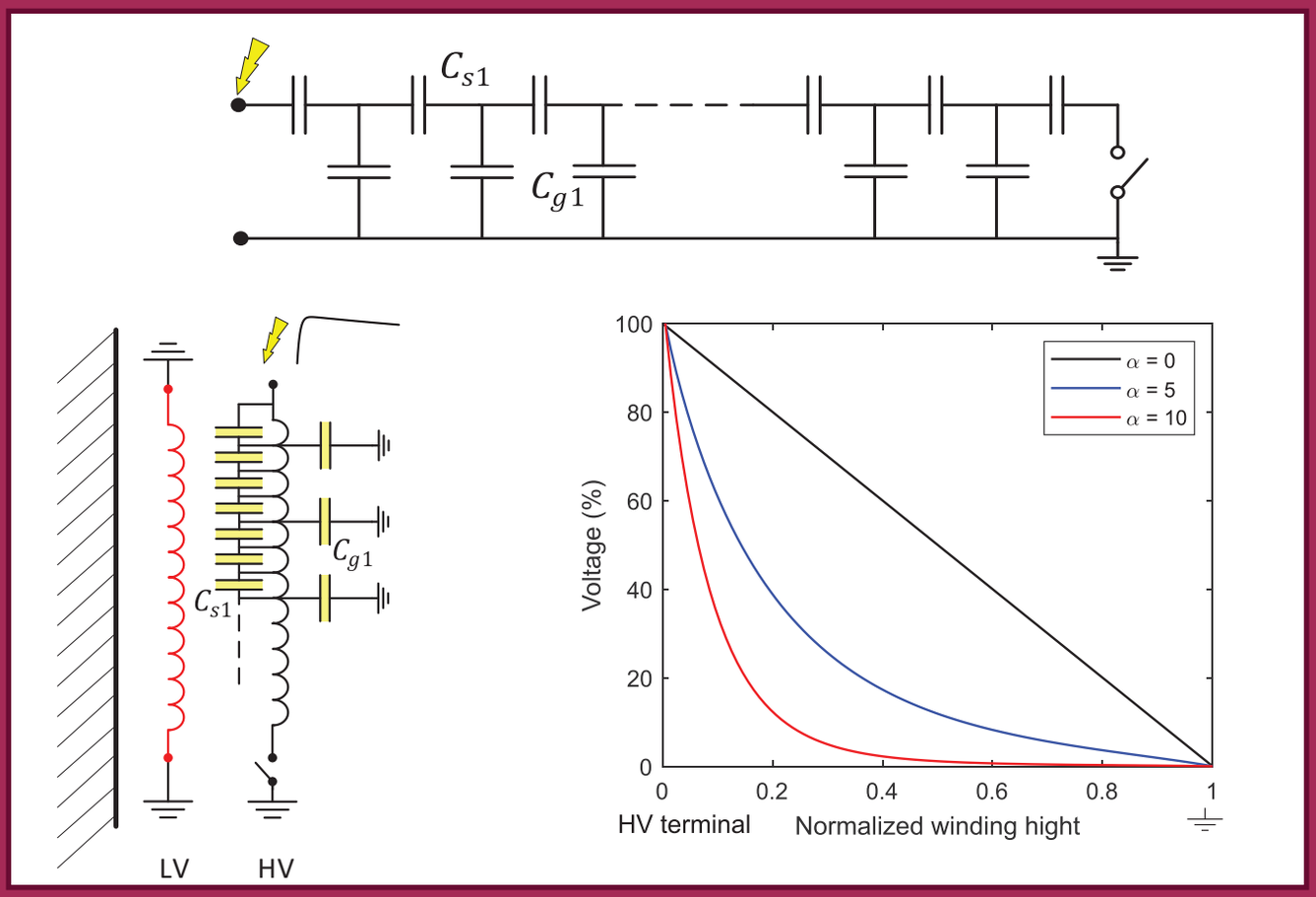



***Figure 2.** left: Winding under test. right-top: Simplified capacitance equivalent model. right-bottom: Influence of α on nonlinear voltage distribution along the winding (a disc winding with 100 discs, C_g1=0,7.5,30 pF, C_s1=3000 pF)*

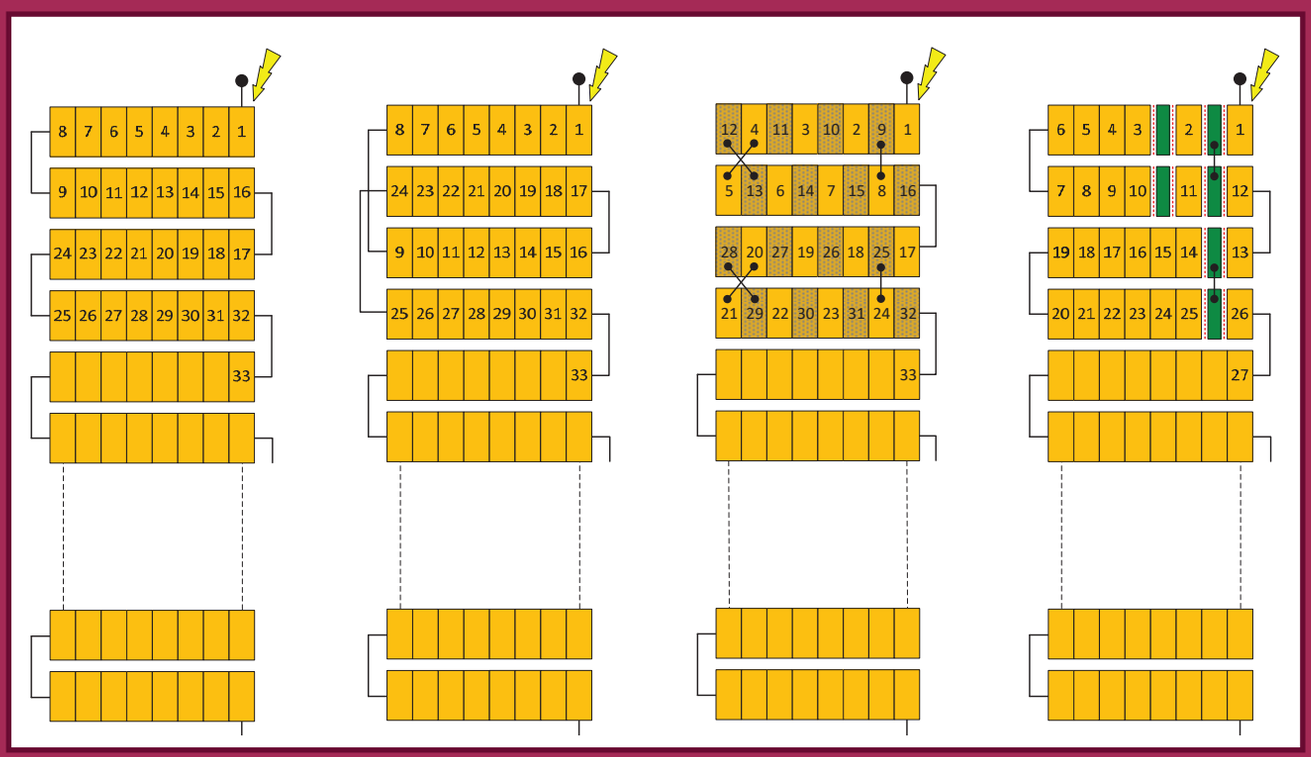



***Figure 3.*** *Different construction of a disc winding. a: Simple double discs winding, b: Combination of simple and interleaved discs winding (SMIT patent), c: Combination of simple and interleaved double discs winding, d: Combination of simple and double discs winding with wound-in shield wires.*

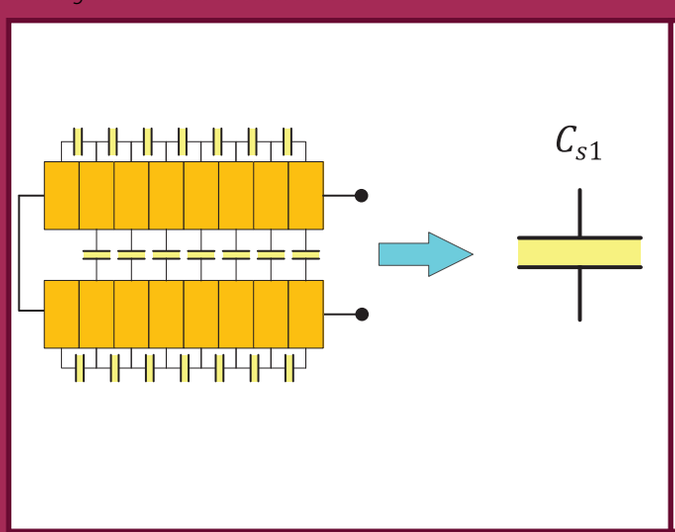



***Figure 4.*** *Equivalent capacitance model of a discs pair.*

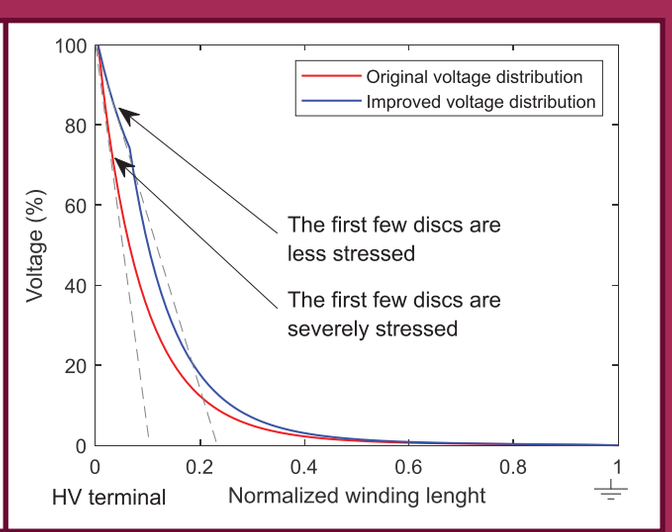



***Figure 5.*** *impact of increase of series capacitances of the first few discs near the HV terminal of voltage distribution along the winding. C_g1=30 pF, C_s1=3000 pF, C_(s1-top section)=9000 pF.*

The reason why series capacitances of a discs pair can be increases by the above mentioned approach is as follows: total energy stored in a discs pair is equal to the sum of energy stored in all internal capacitances of that discs pair. It is common that the full matrix of capacitances is simplified to only se- ries capacitances between consecutive turns and capacitances between turns of the top discs to the turns of the low- er disc, as shown in Figure 3. Energy stored in a capacitor is equal to $E_c=1/2\ CV^2$. When connection of turns inside a disc and between the discs are altered (as shown in Figure 5), the voltage difference between the turns changes. This results in change of energy stored in the internal capacitors which is such that the total energy stored in all internal capacitors of a discs pair increases. An equivalent series capacitance of a disc pair is labelled as $C_{s1}$, increase of $C_{s1}$ is the outcome of such methods [2, 3].

Most common practices to increase series capacitances in a disc winding are: interleaved double discs winding, interleaved discs winding (SMIT patent), and implementing wound-in shield wires in the discs. Such modifications are applied only to the fir st few discs close to the high voltage connection. Implementing these methods along the whole winding does not deliver extra performance improvement while their manufacturing requires additional steps which is not desired. These methods are illustrated in Figure 4. Improvement of voltage distribution by increasing series capacitances of the fir st few discs of the winding is shown in Figure 4.

It is rather complex to implement interleaved disc winding because it requires frequent cutting and Jointing of conductors during the manufacturing process, nevertheless it is used frequently for high voltage winding manufacturing. In comparison, implementation of wound-in shield wires is much simpler from the manufacturing point of view. However, clear guidelines regarding the optimum number of shield wires in each discs and the number of required discs with wound-in shield wires, as well as their influence on inter-turn voltage distribution is not available in the literature. Current practice is to use a large safety margin for the design of insulation systems based on wound-in shield wires method. The aim of this research is to provide design guidelines for opti- mum design of disk winding with wound-in shield wires.

The project is carried out in collaboration with Royal SMIT transformer.

[1] Allen Greenwood “Electrical Transients in Power System”, John Wiely, 1991.

[2] E. M. Del Vecchio, B. Poulin, and R. Ahuja, “Calculation and Measurement of Winding Disk Capacitances with Wound-in-Shields”, IEEE Transactions on Power Delivery, Vol. 13, No. 2, April 1998.

[3] M. Bagheri, A. Hekmati, R. Heidarzadeh, M. Salay Naderi, “Impulse VItage Distribution in Intershield Disk Winding VS interleaved and Continious Disk Winding in Power Transformer”, 2nd IEEE International Conference on Power and Energy (PECon 08), December 2008.

**Once a year, a solar car made by students in Delft travels thousands of kilometres through simmering heat or harsh weather conditions. A team of about 16 students have been working day and night for over a year to finish the car and everything around it. The ultimate goal is to win the solar challenge and defend the World Champion title. Unfortunately, due to a fire close to the finish, last year's dream was shattered in merely minutes. As an Electrical Engineer, I joined the team last year and even though we did not reach our goal, we are certain that we made an amazing car that had a big chance of winning the competition.**

Once every two years we join the competition at the Bridgestone World Solar Challenge held in Australia. This is a 3000 kilometer race from the north right down through the middle to the south of Australia. The year in between this competition a different solar challenge is attended. Mostly, we enter the South African Solar Challenge. A new car is built for the Bridgestone Wold Solar Challenge, while the same car is drastically improved and prepared for participating in South Africa the year after. Last year, we made a brand new car and joined the competition in Australia.

As an Electrical Engineer in the team, you are not just there to design and build a system to given specifications. You have to make sure that the system you design works together flawlessly with the mechanical and structural parts that are being designed at the same time. In addition, you also have to make sure you are maximising the efficiency and minimising the weight of the whole car.

**Brainstorming and designing**

The project starts the moment the regulations are published. After thoroughly looking through it, we entered our brainstorm phase. We let go of all previous knowledge and tried to come up with every idea that fitted in the regulations. Together, we homed in on a general design of the car that we could argue had the most potential. After agreeing on this, we moved on to finding ways to improve the design per discipline, which could be far-fetched like gaining energy from heat in the car or making the system more reliable by producing a dashboard PCB.

During the next phase, it was time to bring it all together. Not yet in real life, but in schematics and a complete 3d-model of the car. While the general overview of the electrical system might not look very complicated, there are countless solutions that can be used to achieve the functionality. It is quite a challenge to design a system while the design of the car is still prone to change. For example, the fin al shape of the car was still being modified for aerodynamic improvements, while the layout of the solar panel was worked on at the same time. We also wanted to place the battery in the front on the left side, however with barely any leftover space, it was only until the battery was produced that we knew it would fit for sure.

**Production of the car**

After the design of the system is done, it needs to be produced and tested. This is done with the help of our testing vehicle. This vehicle is a huge, aluminium

# Running on Sunlight

## Chasing an unreachable dream

Tom Salden


***Figure 1.*** *(Photo by Jorrit Lousberg)*

framed car. Its purpose is to house electrical and mechanical components and find out if all designs work the way we planned. Every time we made new components, we added them to the testing vehicle and took it for a ride.

At this same time, the body of Nuna was also produced. This took several months to complete, but when it was done, we could add in our componens. This was the moment of truth, because only now we had to physically fit the parts in the car. After some weeks of finalising this, it was time to start Nuna for the first time.

**The first kilometres**

A truly magical moment follows. The car you have been working on for almost a year starts driving without major problems. We were extremely happy with how well the tests went and amazed by how much better the components worked inside the real car in comparison with the testing car.

Of course, we were not finished yet. The first testing days were for example done without the solar panel. One of the reasons we waited with this is that solar cells degrade after being exposed to sunlight. The other reason is that we still had to finish the production of the panel. This was a huge project for me, as I took up the task of soldering all 874 solar cells by hand, joined by three teammates that took care of encapsulating the cells.

From this moment on, we took the car to a testing track once a week. This day had as purpose to find all issues that were not fixed previously. Next to that, the drivers had to get used to driving in a super small solar car. Because only a minimal amount of space is made available to the driver. This means that the comfort in the car is restricted because you cannot move a lot.

**Moving to Australia**

At the end of August, we moved to Australia to prepare ourselves for the race. A support crew of old team members joined us to give us a hand where possible. A primary school in Darwin made a space available in their shed for us to keep working on the last details of the car. This school has given us a place to work since the first edition of the solar team almost 20 years ago.

As the weeks passed, we got close to the qualifications. In order to determine the starting position, each team had to drive a lap on a racing circuit and the fastest one would have the first starting position during the race.

***Figure 2.*** *Tom soldering all 874 solar cells by hand (Photo by Jorrit Lousberg)*


***Figure 3.*** *The disaster struck and we are not believing our eyes (Photo by Jorrit Lousberg)*

Unfortunately, less than a week before this qualification lap, we made a spin on the circuit. During this spin, we graced the side of the track, damaging some parts of the car. Luckily, the driver was okay, but we had a damaged car we worked on for such a long time. Instead of panicking, we set aside everything else to fix the car. Luckily, most damage could be fix ed in one night and we could continue testing.

**The challenge**

The qualification itself went flawlessly. We managed to set a great time and ended on the eighth place, which is really good for a car that is not made to drive fast circuit laps. Then, the 13th of October it finally began. We started the challenge. As one of the drivers, I was to drive the first few hours of the challenge, which was quite eventful. Because the teams started with 30 seconds interval in the centre of the city Darwin, we took over some teams. At the end of the day, we even ended up second.

After this exciting first stop, we had a few other just as exciting days. Even though we stayed in second place, we kept catching up with the first place, until we were mere minutes behind them at the end of the third day. Unfortunately, there was a large amount of wind the fourth day, and the contesters were blown off the side of the road, damaging their car very badly. After this, we moved on in the first place and ended the day about 300 km shy of the finish.

The fifth and last day was about to start. We drove Nuna to the place where started that day and counted down for the driver. It was very exciting because even though we were positioned first, the next team was only two minutes behind us. The first kilometres went really well and the lead of two minutes kept it exciting. However suddenly the driver saw smoke in the cabin and was forced to climb out of the car as quickly as possible. Within seconds, flames were visible and in minutes, almost nothing was left of the car. Luckily, the driver got out in time and nobody got hurt, but the one goal we had was now unreachable. After the terrible event, everyone was devastated, but when we arrived at the city of the finish, we decided to stand together as a team and walk through it without car. Even though we did not fin - ish the race, we did experience almost everything. We worked on the project for over a year and from our data, we know that the car we made was amazing.

As an engineer, we would like to make sure everything we make works in every situation. To do this, we put in extreme amounts of effort. This is a great way of achieving goals, but something unexpected can always happen. It is quite difficult to accept it if this happens, but very important to do so. In our case, even after research we are not entirely sure what was the cause is of the fir e. However, because we know that we would have made the same decisions if we were to start all over again, we are sure to have done everything we could to make the best car yet.

# V.O.: Control your innovation

*Advertorial*

*Jasper Groot Koerkamp*

Development of technology always continues: people always have an aim to improve. How can we make thing easier, faster, safer, stronger: better? The answer is often a matter of creativity: a technical solution that is different from the standard: an invention. What drives those inventors? Often, it is to have a commercial benefit over others by using the invention. To enjoy this benefit, it is important not all are free to use the invention. Hence, governments issue patents: an exclusive right to the commercial use of an invention - in return for publication of the invention.

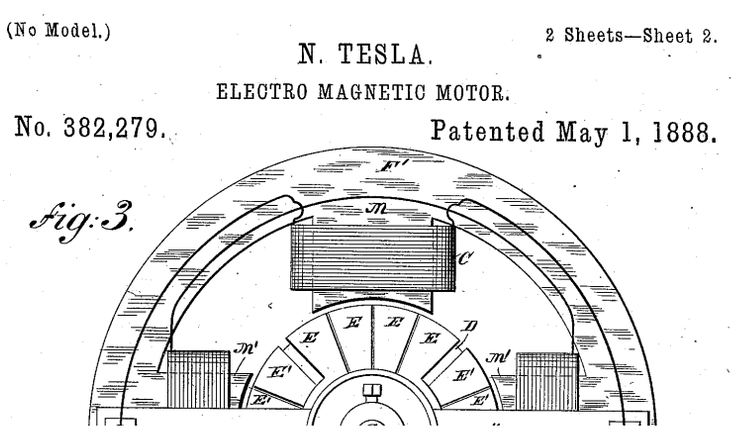
Patents allow a company, either small or large, either starting up or seasoned, to control the use of their innovation to benefit from their innovation. If you are a start-up, you want to make sure the ground breaking invention that is the basis for future growth of your company is yours alone. For larger companies, like telecommunication companies, there is no other option to use your technology other than by using technologies of other companies as well. The other companies may ask you money to use their technology - or permission to use your technology. In this way, patents can bring in money or save money by allowing others to use your technology.

Governments set high standards to inventions for granting patents. Otherwise, many patents would be granted for obvious improvements of technology; that could result in everybody prohibiting everybody to use any technology, stifling innovation. Arguing an invention meets the standards requires both technical and legal acumen, making drafting, prosecuting and enforcing of patent rights specialised work. What makes the difference between the invention and the state of the art and how does that invention achieve that great new effect? And how to argue this before the patent office or the court, taking into account legislation ? This is the work of a patent attorney.

**The work of a patent attorney**

And this is the work I have been doing for almost twenty years. After two years as an engineer in the semiconductor industry, I was looking for an intellectual challenge. But I did not want to lose touch with the technical details of technological development. The position of a patent attorney provided an opportunity to make this happen.

The first good eight years of my patent career, I worked with Philips Electronics and NXP Semiconductors. There, I have had my professional education required to be registered as a Dutch and European Patent attorney. And I supported the business of these companies not only by drafting patent applications and having them granted; I have also negotiated agreements for projects in which patents play a large role: mergers and acquisitions of companies and joint development of technology with other technology giants like Texas Instruments and Intel. To ensure return on investment in R&D, but also to achieve the best possible implementation of the technology, benefiting society as well.
Eleven years ago, I moved to a patent law firm; an office with only patent attorneys that offer service to companies that have no or only few in-house patent attorneys. Instead of one client, I now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N. TESLA.

ELECTRO MAGNETIC MOTOR.

No. 382,279. Patented May 1, 1888.

Fig: 3.

***Figure 1.*** *The patent for the Tesla Motor from 1888*

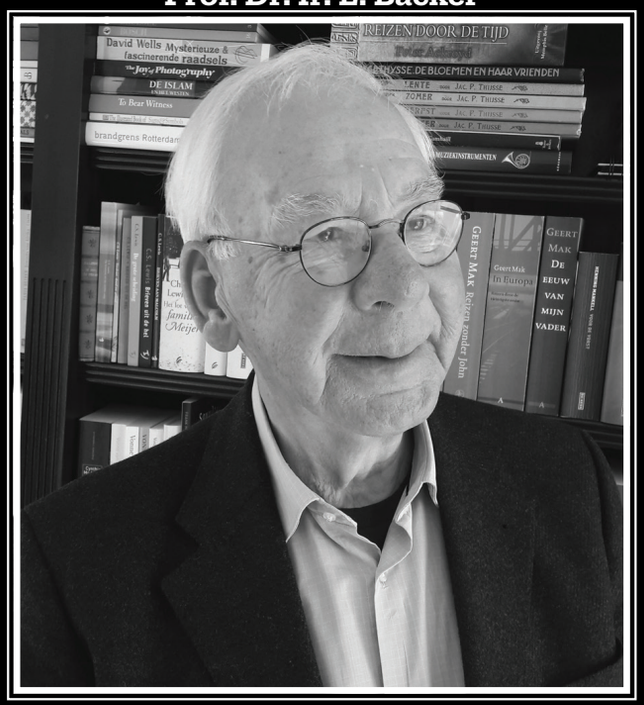
serve over 150 clients. And in addition to semiconductor and telecommunication technology, I also work in the technical fields of high-pressure cleaning nozzles, medical equipment, animal feeding equipment and electrical vehicles. Yes, I still work in the field of semiconductors in which I once graduated, with the honour of having professors of the group I where graduated at as clients.

At the V.O. Patents & Trademarks, I have a wide variety of clients for whom I provide a wide range of services. I set up patent strategies to provide coherent protection for their technology, draft patent applications and address use of technology of my client by their competitors. And in case necessary, we sue them - though an amicable solution is possible in most cases. And yes, also my clients receive such letters from competitors that we have to attend to. With this variety in work and high stakes with our clients, we set high standards to our own work and to our colleagues. This allows us to provide your company with support with the proper protection for your R&D in accordance with these high standards. In case you are interested, we are ready to discuss with you how we can help you control the results of your innovation in a way that serves your interest best. You can contact us via www.vo.eu for an appointment at your place or an office near you for a conversation without any obligations.

**Become a patent attorney**

If you are interested to become a patent attorney, you are invited for an informal interview, at an office location near you. We expect graduates and others new to the profession to attend the regular external professional education programme, as well as our additional internal programme. In return, we offer an informal working atmosphere, career perspective and good benefits. You can find more information at *www.vo.eu/career/*.

# Prof. Dr. Ir. E. Backer




***Emeritus Professor Delft University of Technology***
***Honorary Member of the Electrotechnische Vereeniging***

**** Soest, April 22 1940*** ***† Diepenheim, April 14 2020***

***Thanks to the effort the gentleman Backer put into the ETV, he was awarded with the title of honorary member of our association in 1991.***

***Since then, he has always stayed actively involved with the ETV, and has helped massively forming contacts between students and the faculty.***

***We offer our deepest condolences to his family and friends.***

## Em. Prof. Ir. J.L. de Kroes

*Emeritus Professor Delft University of Technology*
*Honorary Member of the Electrotechnische Vereeniging*

** Overschie, January 15 1924* *† Hilversum, March 31 2020*

*Since 1990, the Electrotechnische Vereeniging had the honor of having gentleman De Kroes as honorary chairman.*

*In his time as honorary chairman, he has assisted the ETV many times, and was always active at the ETV and the faculty.*

*We offer our deepest condolences to his family and friends.*

# Meet The SSD

*Sai Suprabhath Nibhanupudi, Devayan Basu*

**The famous quote of Napoleon Hill goes by "First comes thought; then organization of that thought, into ideas and plans; then transformation of those plans into reality. The beginning, as you will observe, is in your imagination." With this vision, the association of Sterkstroomdispuut (SSD) der Electrotechnische Vereeniging (ETV) was established on 10 December 1964 and is 55 years old as of today.**

Herr W J. Van Gelder, the SSD founder, did not want to become the Chairman of the first SSD board. The SSD's first board consisted of Mr. J.W. The Nijs as President, Mr. M.R. Van den Heuvel as Secretary, and Mr. E. Fernan as Commissioner. Although in November 1964, before the actual establishment, JW. De Nijs and W.J. Van Gelder set the holy grail of SSD as: "This association will aim to conduct activities that are in line with the specific interest of the students in the energy field. It plans to do so by conducting lectures, and excursions in strong-current and related areas".

There has been a wide variety of events focusing on different facets of the high voltage system coordinated. Multitudinous excursions to Smit Transformers, Kabelfabriek in the Netherlands, Siemens, Kema, Metro Rotterdam and Dutch State mines were conducted. Contributions from professors such as Professor De Haas, Professor Schot, Professor Van der Sluis, Professor P. Vaessen were the secret to establishing a good relationship between the student and the businesses. Throughout the years the professors' vast networks have been extensively used.

Trending advances in semiconductor manufacturing emerged in the late 1980s and early 1990s, attracting the bright minds. Because of this, the number of students who preferred the direction of energy technologies decreased. After this reduction in number of students, at the end of the eighties, the SSD had a new mission to increase student involvement in the electrical power engineering market.The SSD coordinated in the 1990s alongside DSD Waldur with the introduction of energy technologies in middle schools. As a result of this promotion, DSD Waldur and the SSD formed strengthening ties.

Soon there was an explosion of students seeking a Master Electrical Engineering Degree at TU Delft with the emergence of greater environmental consciousness and the potential future of renewable energies by solar and wind power. The system bore a new name, Electrical Sustainable Power, in 2013. Since foreign students are typically less familiar with the Dutch environment, through its programs, the SSD stresses putting together students from various cultures. It organizes various lunch lectures, BBQ, industrial excursions, fun activities to familiarize students among themselves and with SSD to carry its legacy forward.

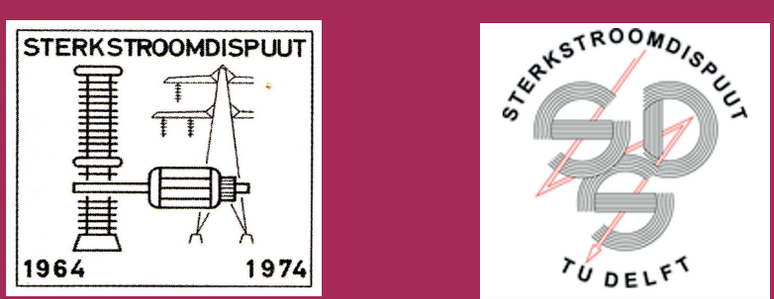



***Figure 1.*** *In 1974, Sterkstroomdispuut had its second lustrum. To commemorate this, a new design was introduced. Before this the SSD used the ETV branding.*

*A second logo was created in the early 80's. This second logo, also pictured here and the main logo to date, consisted of the letters SSD attached to a bolt of lightning. The two logos had been used for a few years but the original version was discontinued after 1983.*

**Recent Activities:**

On February 11th, 2020, the new board of Sterkstormdispuut (SSD) was initiated. SSD, established in 1964 as a chapter of Electro-Technische Vereeniging (ETV) has been the representative for Electrical Power Engineering students for over fifty years. This has in fact provided the new board with an exciting opportunity to keep up with the exemplary work done by the previous boards. The main goal of SSD is to connect students in the world of academics with people and industrial organizations looking forward to young and creative minds which can help them in realizing a sustainable future. The board of SSD 2020 is committed to conducting events such as lunch lectures and excursions which will promote networking and create a bond between the two interlinked worlds.

**Excursions:**

DNVGL, Arnhem

One of the excursions conducted by SSD was to DNVGL, Arnhem in November 2019. This was a very exciting event and the first-year master students participated enthusiastically. A two-hour ride from Delft to Arnhem kickstarted the event with a series of presentations starting with the company and then about the exciting research done here. Each of the department at DNVGL explained the work done in their sector and later on we had the opportunity to talk with the employees over food and drinks. We also played a game about how the power grid can be managed in case of congestion problems created by Universal Smart Energy Framework

(USEF) team at DNVGL

Royal SMIT Transformers, Nijmegen
The next trip for EPE students took place in February 2020 to Royal SMIT Transformers in collaboration with Draaistroomdispuut Waldur from Eindhoven. The factory is located in the middle of the city with Roman origin. The excursion to Royal SMIT Transformers had a lot of activities. A brief talk about the company was followed up with some very interesting research done by the company. This was followed by lunch and then the much awaited "guided" factory tour. To ensure safety, we were equipped with helmets and vests when heading for the tour. The factory tour gave us an insight into each, and every step involved in manufacturing a transformer. It gave us an idea of what goes behind the making of such huge transformers. From the laminating of the layered steel transformer cores to the winding of the paper-wrapped copper conductors around wooden frames, no assembly step was left to our imagination. The distinct task division which enables the overall process to become efficient was very evident.

**Activities:**

SSD also regularly organizes drinks in the /PUB, where all EPE students and staff from the ESE department can meet and socialize with each other. SSD also ensures to have at least one lunch lecture every quarter from a distinguished person of industry or academic life. Apart from these, SSD organizes a Christmas lunch every year where all the staff and students of EPE along with few of the industrial collaborators of SSD come together and celebrate. This year too, the Christmas lunch attracted a lot of attention despite the change in usual location where the event happens due to the renovation being done at the High Voltage Laboratory. This year too, we are looking for an exciting place to conduct the Christmas lunch and the door is open to everyone

**Upcoming/ Planned Events**

In the months to come, SSD has planned to organize a number of such events. As SSD board of 2020, we are looking forward to organizing the excursion abroad to Siemens, Berlin which is a tradition we would like to continue. SSD this year plans to familiarize the students with various labs and facilities in the campus with the help of other student associations under the tagline of Know Your Campus (KYC). In addition to this, several lunch and evening lectures are being planned to be organized in the faculty by inviting experts from the industry to share their experience and insights.

Apart from these events, the aim is to organize barbeques and social drinks regularly where the staff and students can relax. These events help break the ice between the staff and students and hence increases the chance of networking and getting to know others better. SSD is driven to help students identify their own potential and provide them the right platform to connect with professionals from the industry. This being the lustrum year, we are planning to work with ETV on an exciting project.


***Figure 2.*** *SSD excursion to Royal SMIT Transformers, Nijmegen*

# The treshold to overcome

## The context and potential future of the graduation project

*Dr . Ing. I.E. Lager*

**When you receive this Maxwell, the fourth quarter has already started. For the bachelor students who are planning to graduate, this means that they can start on the Bachelor Graduation Project. Because the Electrical Engineering's graduation project has some unique factors, we have interviewed Hansi Lager, who has managed the graduation project for quite some years already. He has some answers on the why's about the uniqueness of our study. One small note: this interview was taken before the isolation orders.**

**Why do we have six people per group in the BAP?**

Because one of the essential aspects in the bachelor graduation project is the fact that we want to test the corporation between students. The reason is very simple: Later, they are going to always work in teams so in this way we like to see how they can interact with each other, whether they can work in larger groups, and how they can address a larger topic by collaboration. That means that they manage to hit several targets at the same time. So first of all, we stimulate collaboration, but we also help them with understanding how projects are elapsing: To monitor progress, trace it down, ad to apply what they have learnt in previous EPOs as far as project performance is concerned.
There is also something else as well: Once you have a project for six, they the project can be larger, so you can have a nicer assignment. It's different when compared with a master project, where you like to see how far a certain person can reach by just himself. In the bachelor, we want to address a certain topic, and the topic itself is important.

**How is that different from other studies?**

It is very different. I'm mainly aware of computer science, because we had previous student that did a double degree who had to accommodate both rules. I also had some discussions with people from civil engineering. I was at one point invited to compare their strategy with ours. They are all working on an individual project, sometimes a couple. Because of that, their format is different: The scope of their work is smaller.
Also, as far as I know, we are the only ones who have the graduation project in one box. The other studies have it smeared over a larger period, and is intermingled with courses. In our case, you just stick to your project like in the master project. Then, you can really focus on a certain topic, and you can go much deeper.

**Why is this different?**

A lot of this difference is because of the way the graduation project has been defined in the first instance. This just perpetuates and there are only minor changes. For a long time, we were the only one to have a business plan, now there are more and more faculties trying to add that in a slightly different format.

**What's the reasoning behind the three subgroups?**

First of all, you have to have collaboration. If all six are working on the same thing, there is no collaboration: It is just going to be a little bit of a chaos. When a student starts with EPO 1, it was a large group and many people didn't do much, and even the splitting of the tasks for doing the sub-assignments was kind of vague. At the end, in EPO 4, there were always just four people, but it was still unclear who did what. In the graduation project, we want to see a large project approached together so students just subdivide the big project into reasonable subsections which together are going to give the final result. That's also how things happen in real life: When you address a project, there's always a coordinator, who splits the tasks depending on the competences of the people in the group. At that point, each subgroup is going to work more or less on that specific topic, and the project manager takes care that it adds up properly. Our graduation project is an image of a true project in real life.

**The main focus was the project, but more research is allowed now. Why is that?**

Initially, the graduation project was plainly a design project, but some supervisors started including a part concerning research. At the beginning, we felt that it was beyond the capabilities of the students, but the students liked it. Then, if the student actually enjoyed going beyond just designing something which is already there, then why not?

**It is called a 'BAP' here, instead of 'BEP' in all the other faculties. Is there any reason for that?**

It's nostalgia. It was the 'Bacherlor Afstudeerproject' and in fact, the official name is Bachelor Graduation Project. But, if you make an acronym for that, it has too many consonants: It doesn't

sound good.

**Are there upcoming large changes?**

Essentially, there is something that I've been working on for a long time but never came from the ground. For already three or even four years, we sense that exactly because there is more and more research going on in the BAP, that time becomes a limiting factor.

As the project is right now, you have the main project where the students work on the technical part, but you also have the business plan and ethics in technology. Of course, these courses place a time penalty on the technical realisation. The question is: Can we take them off? Then, the students would have more time.
The business plan is very hard to take off, because it works together with the BAP and is also the unique selling point of our study's graduation project. We have a long stream of prices won by the EE students because they accompanied the technical realisation with the business points of view.

The big change that never happened, and I constantly try to push it, is ethics in technology. It is certainly a part of the bachelor graduation, it is also one of the end terms for the bachelor curriculum, so the students have to show that they know about it. But, does it actually fit in the bachelor end project? My answer is no. It's too late. It should have been done already. The best embedding of the ethics in technology is split up into pieces with increasing complexity, and put them in the EPOs. So by the time students come to the point of doing the bachelor graduation project, they should take into account ethics in technology elements, but they should have learnt it already. This is going to free time for the technical realisation. The problem is: To show the accomplishments with ethics in technology, you have to have some credits linked to it. In this way, it's very simple, but if you spread it over the EPOs it is more difficult to handle.


***Figure 1.*** *The team that won the UDP-Damen Bachelor Award with BABYSHELL.*

# Study Collection

## Measurements on (standard) capacitors

*Kees Pronk & Piet Trimp*

**The readers of this magazine are probably well aware of what a capacitor is: two conductive plates with an isolating dielectric in between. The purpose of this article is to present a number of special capacitors available in the EEMCS Study Collection in Delft and to discuss equipment to effectuate precise measurements of capacitor values.**

An ideal capacitor has a capacitance according to the following formula: $C = (\varepsilon_0 \cdot \varepsilon_r \cdot A) / d$, where C is the capacitance in Farad, $\varepsilon_0$ is the dielectric constant ( a.k.a. vacuum permittivity) of vacuum ( $8.854187 \cdot 10^{-12}$ F·m$^{-1}$), $\varepsilon_r$ is the dielectric constant of the insulating material, A is the surface of the plates (in m$^2$) and d is the distance (in m) between the plates. To give an idea: with A = 1 m$^2$, d = $10^{-3}$ m, and using vacuum as dielectric, the capacitance is 8.85 nF.

Whereas in an ideal capacitor voltage and current are 90 degrees out of phase, unfortunately the dielectric material is not an ideal (leak free) medium; some leakage of electrons is always present. We model this leakage with a resistor parallel to the capacitor (see figure 2). The impedance of the circuit is $Z = R / (1 + j\omega RC)$, and is therefore frequency dependent. Consequently, voltage and current are not precisely 90 degrees out of phase and we find a loss factor (a.k.a. capacitor loss tangent) which is commonly known as tan δ (see figure 2). It should be noted that the loss factor is frequency dependent; the frequency used during a measurement should always be specified.

Of course, as with other units of Interanational Standards, standard organizations like NIST (National Institute of Standards, USA) and NMI (Nederlands Meet Instituut, Netherlands Measurement Institute) maintain high precision reference capacitors against which other capacitors can be calibrated. This article is not the place to discuss various forms, applications and use of capacitors. Reference [1] gives many useful details on that subject. Instead we will emphasize precision capacitors, their use and carrying out measurements using precision capacitors.

### Fixed value capacitors

The Study Collection has a few Standard capacitors of which two examples are given in figures 3 and 4. This standard capacitor from General Electric has a value of 1 µF and is accurate to +/- 0.05%. This specification is only valid for frequencies below 17 kHz. The maximum voltage is 500 Volt. The capacitor in figure 3 from Sullivan Ltd in London has a capacitance of 0.1 µF. Its dielectric material is mica, an insulating mineral found in volcanic areas. Mica has a high dielectric constant and is a very stable crystal-like material. Of course there do exist also switchable capacitors banks (similar to the well-known resistor banks). These banks have less precision and stability but are more flexible in experiments. Here we show one made by General Radio (USA). It has a range from 1 nF to 1.1 µF, the maximum voltage is 500 Volt peak; the zero capacitance is 40 pF. (figure 7)

### Variable value capacitors

In electronic practices around WW II, it was necessary to have variable capacitors having good accuracy and stability. Figures 5 and 8 show two capacitors available in the Study Collection.

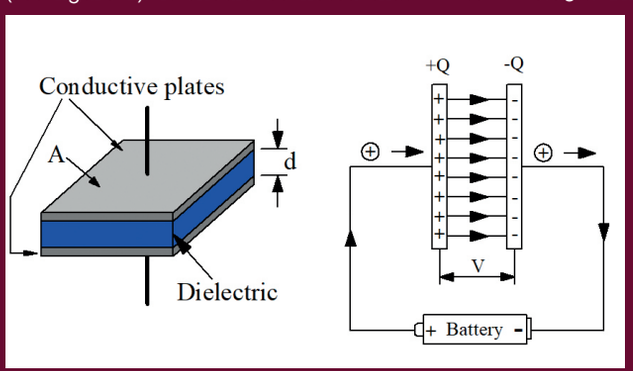



***Figure 1.*** *Model of a perfect capacitor*

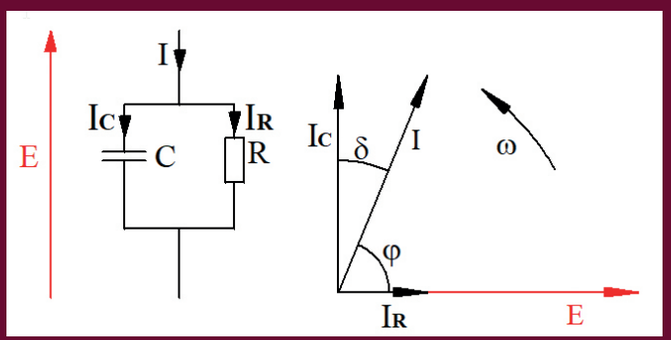



***Figure 2.*** *Adding imperfections to the model*


***Figure 3.*** *Standard capacitor from Sullivan Ltd. (UK)*


***Figure 4.*** *Standard capacitor from General Electric (USA)*


***Figure 5.*** *Variable precision capacitor (external view)*

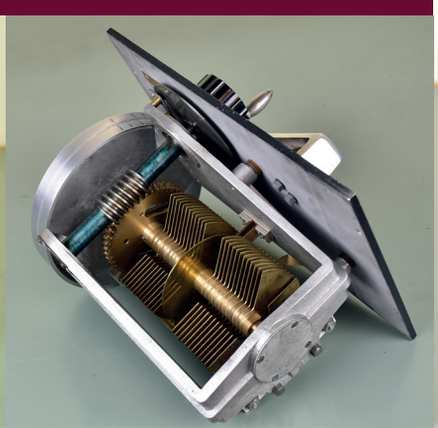


***Figure 6.*** *Variable precision capacitor (internal view)*


***Figure 7.*** *Decade condenser (Capacitor)*


***Figure 8.*** *Philips GM 4352 standard capacitor*

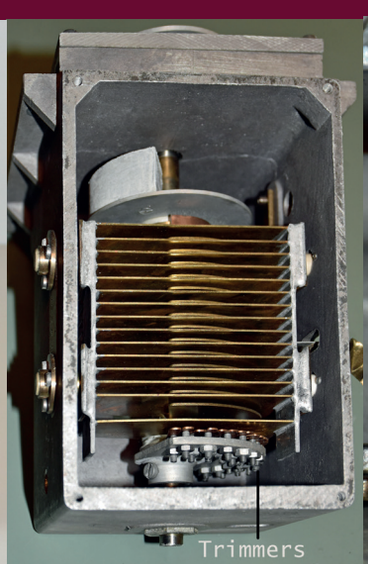



***Figure 9.*** *Internal view of Philips GM4352; Notice the trimmers*

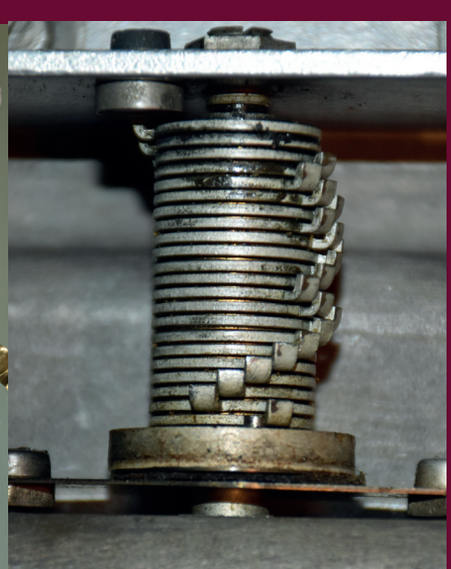


***Figure 10.*** *Twenty turn rotation mechanism*

These capacitors look internally like standard variable capacitors as used in radios but they are more stable and accurate.

The variable capacitor in figure 5 and 6 (Condensateur Etalon) was made by the French firm Verisol (in Paris). The capacitance can be adjusted on the front panel from 70 .. 1200 pF by means of a coarse and fine adjustment dials. By turning the dials the half-round blades are rotated 'in between' the fixed blades. Due to parasitic capacitances, these capacitors need a calibration chart. It should be noted that the creation of a calibration chart requires the availability of higher precision capacitors and a measuring device able to measure the difference between two capacitances.

Another example of such a variable capacitor is the Philips GM 4352 standard capacitor that was introduced by Philips around 1952. This standard capacitor (figure 8) has a variable capacitance ranging from 60 to 300 pF. No calibration chart is needed for this device because of the use of many trimmers (see figure 9).

Thanks to the purely mechanical 20-turn mechanism shown in figure 10 there is only one knob for adjusting the value of the capacitor. To increase the readout accuracy a mirror and a hairline are provided as in well-known high precision volt and ampere meters. The data sheet is available on the web in ref. [2].

**Measuring capacitance values**

To measure the capacitance value of a capacitor usually a bridge circuit derived from the well-known Wheatstone bridge is being used. The Wheatstone bridge (figure 13) is operated by adjusting the potentiometer until the bridge is balanced and the meter reads zero. The value of the of $R_x$ can be calculated from the value of a known Resistance $R_2$ and the potentiometer ratio. Both alternating current and direct current can be used to feed the bridge.

When the resistors $R_x$ end $R_2$ are replaced by the capacitors $C_2$ and $C_x$, alternating current must be used to feed the bridge. When using a frequency in the audio spectrum, a headphone having a high impedance can be used for zero detection. The circuits for this can be seen at ref. [3] and in figure 13. When the bridge is balanced, the value of the capacitance $C_x$ can be expressed as $C_x = C_2 \cdot (R_1 / R_2)$ where $C_2$ is a standard capacitor having a high accuracy. The above reasoning is perfected in a capacitance measuring device from Siemens, to be described below.

As an example of a device capable of high precision capacitance measurements we shortly discuss the Siemens Kapazitäts Meßbrücke (capacity measuring bridge) type Rel. 3 116 (see figures 11 and 12) which was bought around 1958 by the Laboratory for High Voltage Technology in Delft and which is now in the Study Collection. This bridge measures capacitor values from 0.001 pF to 100 µF and is directly readable for frequencies of 200, 800, 2000 and 5000 Hz. The measurement of tan δ is possible from 0.5 .. 100. $10^{-3}$. The accuracy in the range from 10 pF to 10 µF is 1 ‰. The schematic diagram is given in Figure 12. This box only contains the bridge circuit. There are no electronic devices in this box. The input measurement signal is to be provided through the connectors 'Sender'. The output signal of the bridge appears at the connectors 'Empfänger'. Both Sender and Empfänger are coupled to the bridge circuit via transformers and therefore the bridge is floating with respect to the signal earth. With these kind of measurement it is vital to provide for proper double shielding of parts of the bridge as can be seen in the schematic diagram in figure 12. The reference element of the bridge is a capacitor CN of 10,000 pF. In this Siemens bridge circuit the usual bridge resistors are replaced by coils with taps. The switches $S_1$ to $S_4$ are used to determine the measurement range. These switches form a so-called Kelvin-Varley voltage divider (see ref. [4]). The switch $S_5$ is used for measuring tan δ. Using coils is much more expensive than using resistors but leads to an extended measurement range and a better accuracy. Capacitors to be measured are connected to pins a and m on the front panel. Differential measurements are possible by connecting a second capacitor to the pins m and b. Additional documentation is available from the author; see ref. [5].

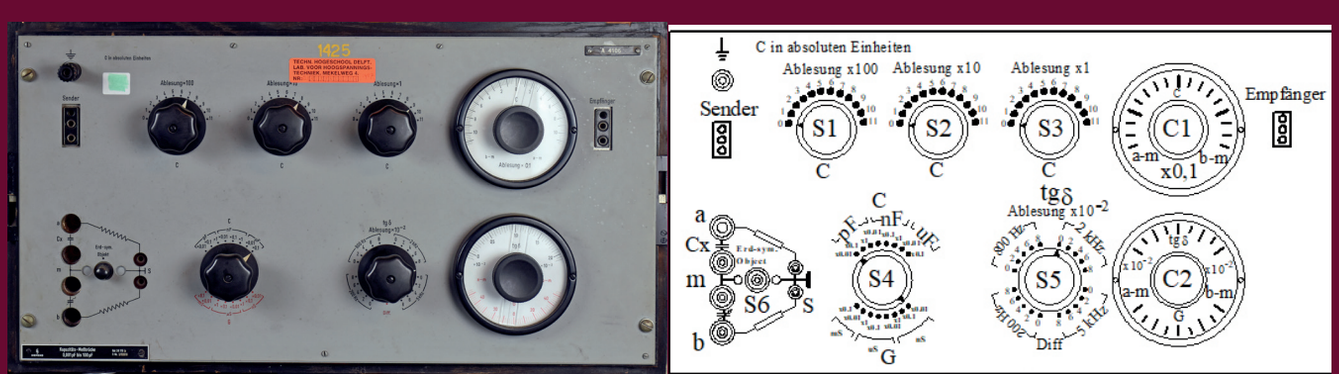



***Figure 11.*** *Siemens Rel. 3 116 high precision capacitance bridge, and the interface's manual entry*

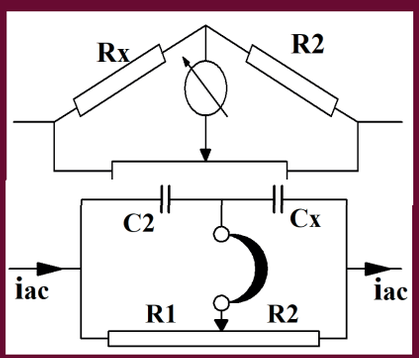



***Figure 13.*** *A wheatstone and the derived Capacitor bridge.*


***Figure 14.*** *Andeen-Hagerling Capacitor Measurement System*

Two final remarks will be made here: (1) Normally, a signal generator using vacuum tubes will be used to provide the signal to the Sender connectors and at the Empfänger connectors a (possible tuned) vacuum tube voltmeter will be used to provide for more accurate nulling (2): It is rather unclear what use can be made of a measurement range down to 0.001 pF. The Siemens documentation only mentions one application area: the measurement of capacity between electrodes in a vacuum tube ( e.g. between a grid and the anode).

**Modern developments**

Nowadays capcitance measurements are done with modern equipment such as the Andeen- Hagerling Inc. AD 2700A shown in figure 14. This machine has an outstanding accuracy and stability traceable to NIST-standards. Some specifications are: Accuracy at 1kHz of 5 ppm; Stability better than 1 ppm/year; True Resolution at 1kHz of 0.5 attofarad (0.000 0005 pF) and 0.15 ppm; Reportable resolution of 0.1 attofarad ($10^{-7}$ pF); Temperature coefficient of 0.03 ppm /°C; Measures extremely low loss at 1kHz down to a dissipation factor of $1.5{\cdot}10^{-8}$ tan δ, a conductance of $3{\times}10^{-7}$ nanosiemens or a resistance up to $1.7{\times}10^{6}$ gigohms; Operating frequency is 50.000Hz-20.000kHz ±0.0025% in discrete steps.

Such a machine also allows for automated measurements using a GP-IB (IEEE-488) bus. A few application areas are copied from the above web page: Capacitance measurements on Carbon nano tubes, on Liquid Cristal Displays and on Superconductivity.

The machine shown here is in use at the group Electronic Instrumentation in the EEMCS faculty for measurements on capacitive gas sensors.

**Conclusion**

This article has provided a short overview ofa the use and measurement of (standard) capacitors. Measurements of capacitors has been important from the early twenties of the previous age and is still important in these days for determining capacitances of many kinds of sensors.

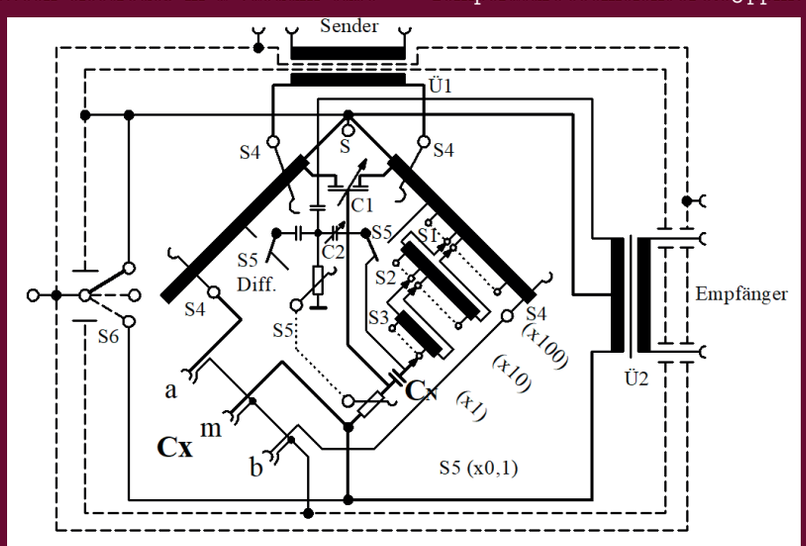



***Figure 12.*** *Circuit diagram of the Siemens capacitor bridge*

[1] http://www.breem.nl/TechThemas/Condensatoren.htm (in Dutch)
[2] Variable Standaardcondensatoren Philips GM 4352: [https://elektrotanya.com/philips_gm_4351_4352_4353_100_300_1000pf_variable_standard_condensators_1952_sm.pdf/download.html]
[3] Meting van condensatoren, in: Meetinstrumenten; De Muiderkring, 4th printing, pp (46-49), 1953 (in Dutch)
[4] https://en.wikipedia.org/wiki/Kelvin%E2%80%93Varley_divider
[5] Siemens Kapazitäts Meßbrücke type Rel. 3 116, 200 bis 10.000 Hz; Beschreibung und Bedienung (in German), 1959

# High-Voltages and Large Currents

*Lou Van Der Sluis*
*Professor emeritus in Electrical Power systems*
*Honorary Member of the ETV*

By crossing the doorstep of the Electrical Engineering building, located at the Kanaalweg 2b in Delft, I made, in 1967, my first step into the world of Electrical Engineering. Repairing and building radios and transmitters during high school had planted the first seeds of interest. That magical things happen in the world of electrical engineering, I had already read in the books of Leonard de Vries. Electronics was the motivation to start my study Electrical Engineering, but that I later switched to Electrical Power Engineering was because of the impressive equipment that is being used and later in my life the circuit breaker became the device that stole my heart. Let me tell you how that happened.

After my graduation in 1974, the obligatory military service still existed, and I was in the fortunate position to be able to choose for taking service in a development aid programme of the Ministry of Foreign Affairs instead. I got the position of electrical engineer with the Ministry of Works and Housing in Northern Nigeria. For nearly two years I lived in Katsina, a city with a long history, at the edge of the Sahara Desert, 80 kilometres from the border with Niger.

After I came back to the Netherlands, it was time to look for a job. I had an interview with the Dutch Railroads, since my graduation subject was about energy storage in flywheels when braking trains feed electricity back to the supply. Another interview I had was for a position with the short-circuit laboratories of KEMA in Arnhem. The two years that I lived in Nigeria helped to put me on the top of the list of persons to be invited for an interview. In the De Zoeten laboratories at KEMA, high-voltage equipment is being tested with high power: currents of ten thousand to a hundred thousand Ampères and voltages of hundreds of thousands Volt are in the laboratories the daily practice. The majority of the devices under test are circuit breakers and many of the customers come from abroad. Therefore, quite a lot of travelling had to be done, and having international experience was a definite plus. During my study at the university I vaguely heard about the circuit breaker, but that changed pretty fast.

*"If that happens at home, a fuse will melt, but faults in the high-voltage grid are of a different order of magnitude."*

The Dutch power system is very reliable, but sometimes there is a problem that causes a short-circuit. If that happens at home, a fuse will melt, but faults in the high-voltage grid are of a different order of magnitude. During normal service, a few thousand amps flow through a high-voltage line, but the current can rise to tens or even a hundred of thousands of Ampères in a few microseconds during a short-circuit. This causes very strong mechanical forces and a temperature rise , and to prevent the whole system from collapsing, it is necessary to interrupt the short-circuit current within hundreds of milliseconds. That requires an extreme force and the circuit breaker does this job.

In the fifteen years that I worked with the De Zoeten Laboratories and in KEMA's High-Voltage lab, I learned a lot about Electrical Engineering. When one graduates from the University and may officially use the title Engineer, one may for one day think that he or she knows everything about electrical engineering. However, when you are going to practice your skills on the job, you quickly realise that the study programme teaches only the basics and educates some fundamental skills. The reality is that, after graduation, you are convicted to a lifelong learning.

The circuit breaker is, in its basic construction not very complicated: a driving mechanism pulls two contacts apart that conduct the current in closed position. The contacts are separated from one another in order to interrupt the current path. The problem is, however, that when the contacts separate, the short-circuit current will try to 'resist' this separation. This is due to the magnetic flux: the magnetic field that is created in space by the short-circuit current cannot be brought back to

*"The reality is that, after graduation, you are convicted to a lifelong learning."*

zero instantaneously, so the current will continue to flow. Therefore, after contact separation, there will be a voltage difference in the medium between the

▷

contacts (air, gas or oil) which gives rise to a strong electric field, and that field creates a plasma. This plasma has a very high temperature with free ions or electrons that conduct the current.

The first generation of circuit breakers simply had air as a medium, or oil. An example of a breaker with air as medium is a manual operated disconnecting switch. A handle is connected, via a spring, with the contact. By pulling the handle, the spring is charged with mechanical energy. This spring will make sure that the movable contact, which is pressed in between the stationary contacts, opens very fast. The arc (being the plasma channel that is created by the current) disappears when the AC current goes through zero every 10 milliseconds, and cooling the arc with the ambient air will creates the circumstances to interrupt the current at that instant.

***Figure 1.*** *at the closing switch, the tension of the springs causes a quick seperation of the contacts*

***Figure 2.*** *The use of oil as isolation mediumnade for a more compact construction of power switches. (Photo: QOC Utrecht)*

For the current generation of circuit breakers, the distinguishing medium is not air or oil anymore, but sulphur hexafluoride ($SF_6$). This gas has very good isolating properties: the breakdown voltage is up to three times higher than that of air, and better than

The choice of the frequency is not as arbitrary as one might think. Between 1885 and 1900, a diversity of frequencies was used in the United States: 140, 133 $^1/_3$, 125, 83 $^1/_3$, 66 $^2/_3$, 60, 50, 40, 33 $^1/_3$, 30, 25, and 16 $^2/_3$ Hz. Each frequency had its own field of application. The power frequency finally came out at 60 Hz in North America, Brazil, and Japan and at 50 Hz in most of the other countries. Nowadays, 16 $^2/_3$ (Europe) and 25Hz (North America) are in use for railway applications, and 400 Hz is a popular frequency on board of ships, airplanes, and oil rigs.

A too low frequency, such as 10 or 20 Hz, is useless for domestic lighting as the human eye records this as flicker. On the other hand, the frequency cannot be too high as:

- The hysteresis losses in the transformer core increase in proportion to the frequency while the eddy current losses increase in quadratic proportion to the frequency.
- The capacitive reactance of cables and transmission lines increases ($X = -1/\omega C$).
- The inductive reactance, and the related voltage drop, increases($X=\omega L$).
- The electromagnetic interference with the radio traffic will grow.

Yet there is also an advantage in using a higher power system frequency: The power-to-weight ratio of transformers, motors, and generators is higher. In other words, the components can be smaller, while the power output is the same. The formula of Esson gives a generalized expression for the power of an electrical machine: $P = K \cdot D2 \cdot l \cdot n$

K the "output coefficient" [J/m3], which depends on the type of machine, the type of cooling, and the magnetic material used. D the diameter of the armature [m] l. the axial length of the armature [m] n the rotational speed of the machine [1/s]

From Esson's formula we see that when we increase the rotational speed, by choosing a higher system frequency, the dimension of the machine can be smaller for the same output power

that of oil when the gas is pressurized. Furthermore, the arc has a smaller diameter for the same current than it has in air, which means that arc heat is dissipated to the ambient air more quickly. On top of that, the recovery of the breakdown voltage of the hot gas is much faster, because of the electronegative properties of $SF_6$. The design and construction of high-voltage circuit breakers has all to do with transients Transients are fast phenomena in high voltage grids that occur after switching.

When I began to work as test engineer at the De Zoeten Laboratory in 1977, I entered the world of circuit breakers. The testing of these devices according IEC- and ANSI standards, the measuring of high currents and high voltages in a very unfriendly electromagnetic environment and a lot more, deepened my knowledge about Electrical Engineering and my understanding of plasma physics. My first introduction to the world of switching transients was Allan Greenwood's classic book Electrical Power System Transients. Furthermore, I read many articles and textbooks giving me an overview of the historical development of the circuit breaker. The most I learned from my former colleagues at the high-voltage and the short-circuit laboratories. Together, we developed new test circuits, designed new measuring instruments and built a computerised measuring system with transient recorders and work stations.

In 1990 I was appointed part-time professor at the Delft University of Technology, to give lectures about transients in electrical power systems. In 1992 I left KEMA and became full-time professor in electrical power systems, as successor of Professor Boerema who retired a few years before. In 1996, I thought it to be time to update my lecture notes and I had the courage to upgrade the lecture notes to a textbook. After four years of blood, sweat and tears, the book was published with Wiley in 2001, under the title Transients in Power Systems. To date there are more than 3500 copies sold world-wide and the book is translated into Korean and into Chinese.

The work for KEMA involved that I became a member of IEEE and CIGRE. Since 1969 I have been a member of KIVI after the completion of my second year of study. I have presented the majority of my scientific publications for the IEEE at conferences in the United States and for CIGRE in Paris. Platforms that are not only very useful for sharing knowledge, but they are also the environment to make friends and to meet colleagues in the field of power engineering.

The real fun starts when you're invited to take part in a working group that aims to deepen the existing knowledge in a specific field of interest or a foreseen problem in or around the transmission and distribution of electricity. These international workgroups bring, as the name implies, work with them that can not always to be done during regular office hours. But the international aspect

compensate for that and it gave me an international network that I could fruitfully use every now and then for the ETV when an excursion abroad was going to be organised.

Who was Professor Dr. Clarence Feldmann?

Clarence Feldmann was born in New York on January 14th 1867. In Fürth in Germany he visited both the primary and secondary school. There after he studied Electrical Engineering in Darmstadt. In 1905 he was appointed as professor in Electrical Power systems at the Delft University of Technology. Since that time, he took actively part in the design and construction of the transmission and distribution grid in the Netherlands.

# Meet The Energy Club

*Simon Teluij*

**The Energy Club organizes exciting projects. They are always looking for new energy transition enthusiasts to join the club. If you already would like to join before reading, go to *www.energyclub.nl* to sub- scribe!**

**The Delft Energy Club**

To start off, let us first take a look at who we are and what the Delft Energy Club actually is all about. The Delft Energy Initative founded the TU Delft Energy Club in 2009. We are a student-led organisation committed to create a platform where sustainable energy enthusiasts like ourselves can meet each other, learn about the latest sustainable energy technologies that are being developed at and around TU Delft. We want to provide students with a platform to connect to the industry, policy makers and researchers in the sustainably energy sector.

The 2020 board consists of Pieter Reith, Sanghita Harmsen, Sofia Jorge, Mateo Zapata, Elena Marabini and myself, Simon Teluij. A diverse group of sustainable energy enthusiasts spread across master tracks at EEMCS-EWI, TPM and Civil Engineering/ Geosciences. We hope to tag you along in our journey towards a more sustainable future, because we believe that students can have a positive impact towards a more sustainable future!

**Activities**

The Energy Club is always looking for interesting topics to host lectures, workshops, excursions and other events about. Our first event of the year was a workshop on how to set up a business in a sustainable energy technology. In the pipeline there are some career events planned, tours and interesting lectures on hydrogen, nuclear energy, data and many more!
Unfortunately, due to the coronavirus we had to cancel all of our planned events until June. However, we will keep providing you all with interesting articles, quizzes on sustainability and online lectures on cool topics such as the role that nuclear energy could play in the energy transition through our social media channels, so don't forget to follow us at Facebook and Instagram!

**Exciting projects**

As you may or may not know, the All Energy Day that is hosted annually is an initiative that come out of the Energy Club Pipeline. Last year, the board also hosted The Great Energy Debate, in collaboration with Imperial College London and Shell. The event was held at the auditorium and live-streamed, and it was followed by over a thousand people online as well! The previous board also took the Energy Club to the European Utility Week in Paris, which proved to be a great success!

One of our most exciting projects that we are working on is the ENLIT conference in October. The ENLIT conference is the former European Utility Week, where we also went last year. However, we are not only working on Energy Club members going there just to visit the conference, but also for you to actually take part in the conference as well! Furthermore, we are in touch with the Flying V project – a joint effort of TU Delft and KLM to revolutionize the aviation industry – on having some first headlines or maybe even a reveal event!

For now, that is enough about us. We hope to see you around soon at one of our events, online or in real life!

***Figure 1.*** *The energy club! from left to right: Sofia Jorge (Secretary), Elena Marabini (Website Coordinator) , Pieter Reith (Chair), Sangitha Harmsen (External Relations), Simon Teluij (Treasurer) and Mateo Zapata (Project and Strategy Manager)*

# Not a Minor Choice

## Student's experiences with their minors

**Everyone will have to make a difficult choice during their bachelor: What minor they will do. For everyone who still has to make this decision, we put together stories of the students who already did their minor.**

### *Self-composed minor abroad*

*Daniel van Paassen*

***Figure 1.*** *The Gators hand sign*

I always wanted to do a minor abroad. Going as far as to the States seemed like a good idea, to experience something completely different than I was used to.

And it definitely was: the people were more laid-back. I had a bit of a "high school" experience, since the courses were less exam focused, but you got more grading for the progress within the semester. Also, the courses were way different than I'm used to.Since I had the opportunity to compose my own minor, I even selected the course Ancient Greek Philosophy. This needed a bit more effort than I liked, but my interest in Greek philosophy got me through it.

UF (University of Florida) helped me well with acclimating to being an international student. I was put in dorms (I chose for this), and got to know the dorm experience. UF organizes a lot of extracurricular activities, such as a club that is focused on designing an app for events on campus. I joined this team and learned a lot about working in a large group (80+ people). It was also strange to see the love everyone connected to UF had for the "Gators", the UF American football team. A lot on campus is Gators-oriented and even I got to enjoy the games and know the Gator chants by heart.

Going to UF was an amazing, educational and interesting experience and I would recommend to anyone to do the same!

### *Self-composed minor abroad*

*Jasper-Jan Lut*

Do you want to diversify or go in-depth on a specific topic? For me, the answer was diversifying, I needed a break from all the theories and equations. I wanted to travel, experience a bit of the world and all the different cultures out there. Therefore I set my aim for The University of Sydney. Many hours of hard work later I got accepted and began July I travel to the other side of the world.

I participated in a self-composed minor in Entrepreneurship, Bussines Negotiations, Object-Orientated programming, and Philosophy. Every single subject was of excellent quality wit amazing lectures, especially the business courses. The content of the material was fascinating. However, philosophy was a bit lacking, in my opinion.

I found my housing at the University regiment building together with 600 other amazing people. Living in this fantastic community allowed me to make many new friends with whom I went on amazing trips across the country. Great barrier Reef, Urulu, Bondi beach, to name a few.

The primary thing I learned while in Sydney (besides all the course information) is being genuinely independent and able to adapt to new environments.
I would recommend such a study abroad experience for everyone! And if I had the chance to do it again, I would!

***Figure 2.*** *In front of the University of Sydney*

## *Robotics*
*Onno Twisk*

I chose the robotics minor because in the Electrical Engineering bachelor you get very little chance to actually apply the theory in a way that is comparable to how you would in an actual engineering career. In my opinion this is a very important and overlooked subject in the area of Electrical Engineering. In the meantime this minor gives you the chance to work with people from different backgrounds and bachelors

In this minor you work together with students from mechanical engineering, industrial design engineering and computer science. This by itself can be quite challenging. To improve cooperation in the first quarter you will follow courses from the others curriculums. Personally I followed the courses statics, software engineering methods and design in robotics. The students from the other disciplines had to do a circuit analysis course, which means that studying together is very effective.

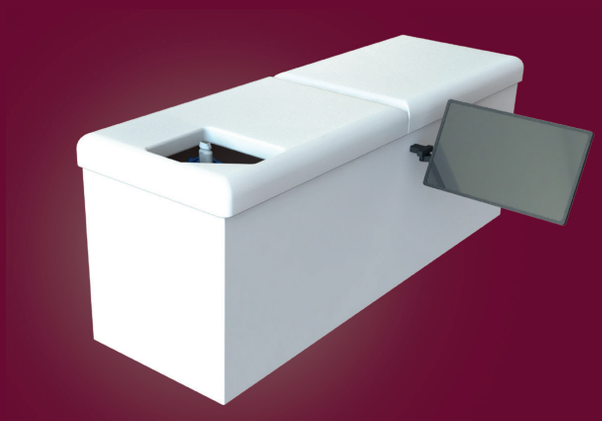


***Figure 3.*** *The project Onno worked on: a heart echo device*

In the meantime you will work together on conceptualizing, designing and building a prototype robot for a real life client. This can be pretty much anything. Examples from last year include: KLM, Ahold Delhaize and Xella. Besides these big companies there are also a few self starters that want to see if their once-in-a-lifetime idea has merit. Last year this brought us a golf trainer robot, a beach cleaning robot and even a robot that can make a cardiac ultrasound autonomously.

This was a very interesting and educational minor, albeit one that sucks up all the time you throw at it.

## *Electrical Sustainable Energy Systems*
*Rein Roeleveld*

***Figure 4.*** *ESES focusses a lot on sun and wind power*

ESES is one of the more prominent choices for an Electrical Engineer because it is an EEMCS minor. The minor is mainly focused on students who are interested in the following topics: Renewable energy sources, power systems and future power challenges. These topics fit my interests and I did not want to study abroad, so I chose for ESES.

The minor consists of eight courses, of which two projects. Three courses are introductory courses on sustainable energy systems: Solar Energy, Wind Energy and Sustainable Energy Technologies. The two projects, which are fairly easy in comparison with the bachelor Electrical Engineering, offer an insight into sustainable energy technologies and more importantly: the challenges of future power systems. I considered the last three courses as broadening courses since these courses are electives for non-EE students: Energy efficiency, Reliability of Sustainable Power Systems and Agent-based energy markets.

It must be said that I really enjoyed this minor. The overall organization was surprisingly good and the learning objectives were met. The study material is very actual and you will definitely get a better insight into the challenges for future power systems.

Also, I would like to point out the following: this minor is, in comparison with other EEMCS minors, considered easy. Especially for students with an Electrical Engineering background, there is plenty of spare time for other activities. It takes little time and effort to score high grades for the courses. Students from other faculties had a harder time since they also had introductory courses on power engineering.

# Bachelor Column

## A day in the life of...

*Laura Muntenaar*

**Hey! I'm Laura Muntenaar, a third year Bsc. student with a passion for Netflix, beer and watching Gordon Ramsay video's on youtube, or differently phrased; I like to listen to old people talking about all the things I could do bet- ter both in the lecture room and outside.**

When I look back at myself from 5 years ago, I've become the one thing I hated; and 'advocate' for more females in EE. But it was necessary, like Bette Davis once said: "When a man gives his opinion, he's a man. When a woman gives her opinion, she's a bitch." And as some of the things that were going on when I fir st started were not okay and needed to be said, I got labelled as a feminist/ bitch quite quickly. As the current atmosphere is much better, I wanted to explain my point of view from that time a bit more.

One of the great things electrical engineering has brought me is the fact that I'm fin ally in the top 5 percent at something. Or top 2 percent even. Yes, when it comes to being a girl, I'm suddenly accomplished. Sounds weird phrased like that but I noticed that we're sometimes treated like its an accomplishment. Where guys are relentlessly scrutinised and grilled about their assignments like they're in the army, I just get a nod or a "good job" and they sign it off. Or when it comes to opportunities, I see guys struggling a lot harder than I ever have too.

Honestly, I would describe it as the double-edged sword of being a girl in electrical engineering. On one end, people notice and applaud me a lot more than they do the guys.

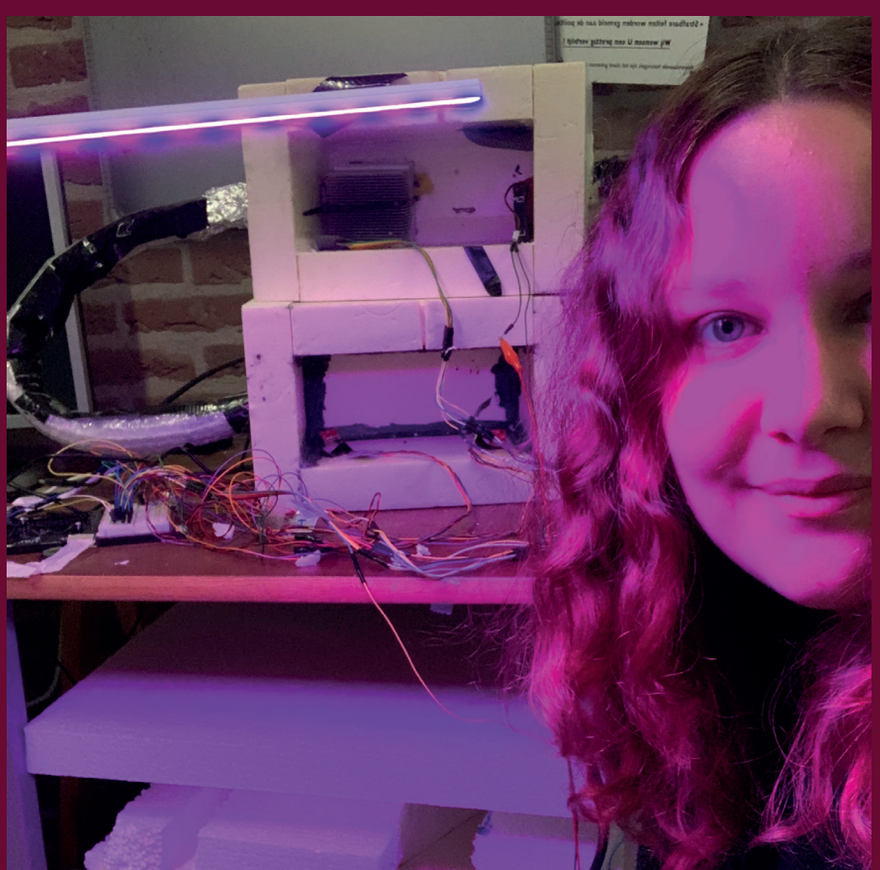


**Figure 1.** *Laura Muntenaar, the Electrical Engineering student.*

On the other side, whenever I get picked for something, in the back of my head, I'm always wonder- ing if they picked me for my capabilities or because I'm a girl. The sad part is that the percentage of women in high ranked technical positions is still so low. As one of these women once proclaimed" When people hire new people, they tend to look towards people in their own circle. So, a white male would be more likely to hire a white male." Or, in other words, it takes a woman to hire a woman. And that is quite sad, as it means that we need to try so much harder to get noticed for the qualities we have gained and not the ones we were born with.

# Master Column

## A day in the life of...

*Michael Kraaijeveld*

**Why did you pick Signals & Systems?**

When I started studying I initially thought I would go for an Embedded systems master. This changed however in the second year when the Signals & Systems courses started. I found that the abstract nature of it clicked with my brain very well. In addition, the examples and applications given in these courses were often audio related. I have been a voluntary audio engineer in a small music venue since 2012 and have since been in charge of all the associated systems. It was thus very interesting to learn about the theory behind the devices I would use every weekend and the system setups presented in the courses felt very familiar.

**Figure 1.** *Michal Kraaijeveld, the Signals & Systems student.*

**Is Signals & Systems what you expected?**

It does involve a lot more statistical methods than I may have thought, which makes a lot of sense given how theoretical the track is. I would maybe have expected a bit more on hardware implementations but in general the content still excites me. In addition to the core DSP stuff I chose to take a few Wireless Networking and Computer Engineering courses to broaden things up a bit and possibly add some useful context for the future.

**In which field would you like to work after your master?**

Given my passion for audio and live music it would excite me very much to work in music technology. A personal goal would be to once work on a large format digital mixing system as used in festivals and large venues. A bit less impressive looking, but way more capable than their analog counterparts (which aren't really produced in big numbers anymore). Besides, I think there is still a lot to be gained in public address sound reinforcement, especially when there is no one available turning dials all the time. A more creative instalment like working on synthesizers would also be very cool. Most of the large companies in this field are not located in the Netherlands so this would likely have me move abroad for a couple of years.

**How is studying from home working for you, with the current situation? Are you still able to have fun?**

Studying from home has never been a strong point of mine so having to do an entire quarter from the kitchen table will almost certainly not be the nicest experience. There's no real choice here though so I'll probably get better at it, there's not much else to do anyway (besides closely watching current affairs). I mostly live with my boyfriend who still works full time from home so that helps maintaining the usual rhythm.

To relax we started playing Age of Empires together and I took the Wii from my parent's home. There is also no shortage of online social initiatives and I'm turning an old smoking room into a small stage (which I consider fun) during the weekends.

Nevertheless, not being able to go to/help with a bar/festival or see a band playing is very weird to me as I haven't not done that for any extended period of time and eventually there will be no communal DIY projects left. Keeping busy won't be a problem but social interaction is still a basic human need. Let's at least hope we all learn something during these times.

# Wordsearch

## Can you find them all?

*Archana Ranganathan*

**Have fun solving our Resonance themed word search puzzle! Words are hidden from left to right, right to left, up down and diagonally. Can you find them all?**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Z | E | Y | E | N | U | F | L | Z | D | Z | Z | S | R | H |
| P | E | C | L | L | I | A | I | N | T | M | T | C | E | O |
| O | Y | B | N | L | E | E | N | R | W | I | C | I | C | S |
| M | L | O | T | A | Y | C | E | N | U | S | B | N | E | C |
| M | B | E | A | J | N | H | T | C | E | R | L | O | I | I |
| P | R | I | A | C | Q | O | R | R | E | T | H | M | V | L |
| T | R | A | N | S | M | I | S | S | I | O | N | R | E | L |
| G | V | R | O | Z | C | G | I | E | U | C | D | A | R | A |
| N | O | U | R | R | K | S | B | E | R | J | I | H | A | T |
| I | L | N | O | I | T | R | O | T | S | I | D | T | S | O |
| P | T | D | C | A | M | R | O | F | E | V | A | W | Y | R |
| M | A | B | N | M | A | X | W | E | L | L | H | I | G | H |
| A | G | C | F | R | E | Q | U | E | N | C | Y | P | D | H |
| D | E | G | N | I | N | U | T | H | Y | G | W | B | J | B |
| O | U | Y | I | X | L | Y | K | T | F | K | G | X | W | Z |

**ANTENNA**
**CIRCUIT**
**CORONA**
**DAMPING**
**DISTORTION**
**ELECTRICITY**
**FILTER**
**FREQUENCY**
**HARMONICS**
**HERTZ**
**HIGH**
**MAXWELL**
**OSCILLATOR**
**RECEIVER**
**RESISTANCE**
**RESONANCE**
**TRANSMISSION**
**TUNING**
**VOLTAGE**
**WAVEFORM**

# Activities

## In times of strangeness

*Koen Peelen*

**In these times of isolation, many events had to be cancelled. While everyone sit at home, people have found other ways to get their weekly dose of interaction and have some fun with their friends and colleages from the university. Discords, Zooms and Slack channels are popping up from every community big and small, proving that we are social creatures after all.**

**Physical distance need not be an issue, whith all these tools. Normallity can somewhat be maintained. Our board agrees with that and organized a wonderfull online pubquiz. They were a great success with a lot of funny zoom backgrounds.**

**A few weeks later they organized the Motibo which also was a lot of fun. Though there was no free beer like usual, it turns out that it is about the people you are with and not (the price of ) the drink.**

**More events are in the pipeline, so keep an eye out on whatsapp and any other channel!**

**Joris van breukelen** (derdejaars): Ik ben echt helemaal klaar met de tentamenweek, het liefst zou ik weer gewoon lekker gaan borrelen.

Dinsdag 14 April
ETVolkskrant

MotiBoKrant

MotiBo van ETV gaat ondanks Corona door

Joos Vrijdag
Delft, Nederland

**De MotiBo (motivatie borrel) die de ETV elk kwartaal organiseert gaat ondanks corona gewoon door. Dit keer met het thema: Geen dramain je pyama. Ga dus lekker met je pyama en een biertje achter je laptop zitten.**

Op dit punt begin ik spijt te krijgen van het idee voor deze poster, het is namelijk best wel moeilijk een artikel vol te blaten als je weinig te vertellen hebt. In ieder geval heb ik wel zin in een borrel. Laatst had ik ook al een online borrel gedaan met mijn jaarclub (Condor Vo) en dat was verassend leuk. In een ETV borrel zal dus ook wel de potentie zitten voor een goede escalatiesessie. De borrel is te bereiken via etv.tudelft.nl/motibo, dit zal ik straks groot midden in de tekst terug laten komen zodat iedereen dit meekrijgt.
Om dit stuk op te vullen met tekst, zodat deze poster op een krant lijkt, ga ik nu leuke feitjes kopieren en plakken hierin. Deze feitjes gaan over het favoriete onderwerp van heel veel ETVers: Onderwijs.
Nederland telt 642 scholen voor voortgezet onderwijs. Op het HBO zitten 445.900 studenten, van wie 51,4% vrouw is. In de Europese Unie is het percentage voortijdig schoolverlaters 12%. Van elke honderd leerlingen die op de basisschool beginnen, halen er uiteindelijk 13 een master. Van de studenten die het HBO na schooljaar 2011/'12 verlieten, had meer dan drie kwart op 1 oktober 2012 een baan.

**De borrel is te bereiken via etv.tudelft.nl/motibo**

Er staan ruim 260.000 studenten ingeschreven aan Nederlandse universiteiten; iets meer vrouwen dan mannen. Veruit de meeste studenten stromen rechtstreeks vanuit het vwo naar het wo. Ook stroomt een aanzienlijk deel in met een buitenlands diploma. Gemiddeld verblijven studenten 5 jaar in het wetenschappelijk onderwijs. De verwachte verblijfsduur in 2016 is 5,1 jaar; iets minder dan in 2015.
Circa driekwart van de studenten verlaat de universiteit met een diploma. Binnen de sector Landbouw & natuurlijke omgeving zien we het hoogste slagingspercentage. Dit is ook de sector waar studenten het hoogste aantal uren per week aan de studie besteden. Bij de sector Gedrag & maatschappij staan de meeste studenten ingeschreven. Gemiddeld besteden studenten 32 tot 44 uur aan hun studie. Studenten binnen de sectoren Economie en Recht, besteden de minste tijd aan hun studie. Ik hoop dat ik wat heb kunnen leren aan de lezers van deze zeer interessante krant door deze onderwijsfeitjes. Kom vooral naar de motibo als je zin hebt in meer van dit soort slappe verhalen!

**Maandag 20 April 16:00**
Bij zijn is meemaken, dus ga naar etv.tudelft.nl/motibo

Shea gaat in haar pyama naar **de MotiBo**

Maandag om 16:00

Wie heeft de mooiste Badjas? **Max** of **Thomas**

ETV Dekens

Niet te koop

Helaas verkopen we dit product **niet**, maar er hoort wel wat reclame thuis in een krant.

**Mocht je nu wel heel graag ETV producten willen kopen? dan kan je na de coronacrisis aan de ETV balie gewoon weer truien en dassen kopen!**

Nu al zin in een lekker **biertje?**
Niet doen, ga studeren.

De ETV adviseerd alle studenten te studeren tijdens de tentamenweek.

**Onderwijs** etv.tudelft.nl/onderwijs

**Thema** geen drama in je pyama

Het thema van de motibo is ontstaan door een proces van een paar uur. Het begon tijdens een bestuursoverleg waarbij bijna iedereen in pyama zat te skypen. Toen opperde Shea het idee om er een pyamamotibo van te maken. Iedereen vond dit een leuk idee.
Een paar uur later begon ik aan deze krant en wilde ik het thema er in zetten. Maar het woord pyama op zichzelf staand klonk niet echt lekker als thema. Daarna ben ik dus woorden gaan bedenken die rijmen op pyama. Gisteren heb ik ex on the beach gekeken dus daardoor kwam het woord drama al snel naar boven.
Dit hele proces leide uiteindelijk tot het thema: 'geen drama in je pyama'.

**Joos Vrijdag**

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Gratis

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Technolution

/ the right development

# > Hardware en software met elkaar laten praten

## Dat wil ik!

Ik heb altijd een duidelijk doel voor ogen gehad: werken met computertechnologie. Dat heeft mijn studiekeuze bepaald en daarna mijn keuze voor Technolution. Projecten waar hardware en software elkaar raken, daar wordt het voor mij echt spannend. Wat wil jij?

**Leon Noordam**
Afstudeerder

**www.technolution.nl/leon**