Maxwell

Issue 19.1
November 2015

High bit rate audio sampling

Why 24/192 makes no sense

Hyperloop
Van Amsterdam naar Parijs binnen een half uur!

Studieverzameling
Psychrometer

Sterkstroomdispuut
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For students who think ahead

From the Board

President

Dear reader,
A new academic year has commenced. For some yet another year at the TU Delft, but for some the beginning of a new era. Our first-year students have left the comfort of their high school to take on the adventure of studying at TU Delft.

At the end of their summer holiday it all started for them. They were introduced to Delft, Electrical Engineering, the Electrotechnische Vereeniging and the student life as a whole. It's always fun to see how quickly our freshmen go from a little anxious to confident students. At first they don't know what they've gotten themselves in to, but soon enough they are more than ready to get started. Although we had all been studying at the TU for a few years already, it was still an exciting new start for us as well.

We decided to set aside our study programme for a whole year to take place in the ETV Board. This means that during the entire year, we will take care of the ETV and even try to make it better.

As of now, we already have one period behind us. A period during which we have all learned a ton. Of course we've also had a lot of fun during this time and it's great to see so many enthusiastic people in our Board Room during coffee breaks. I can truly say that I look forward to the rest of the year, because there is so much more to come. I would also like to encourage you, the reader, to keep an eye out and miss as little as possible of this wonderful Lustrum year!

Daniël Kappelle

Commissioner of Education

As the new commissioner of Education it my duty this year to preserve the quality of education for Electrical Engineering. Here are some of the things which have taken place on educational matters.
First of all it has been announced that the bachelor Electrical Engineering will not switch to English next year. The decision was made to convert some courses next year but not do the full program because of the low passing rate to the second year and the tight schedule. Besides, the new curriculum for the master program is watched closely to avoid any issues in courses. Each quarter is being evaluated at the MiM(master information meeting) sessions. A quick check-up for all the courses was done via Feedbackfruits. This gave an indication of which courses had major issues and which didn't. Further evaluation of the problematic courses will follow.
Furthermore, emails have been send to the first-year students regarding their grades of the first exams. Depending on the grade they are advised on their study progress.
Jan de Jong

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Editorial

This Maxwell in series 19 is the first of a new study year, which means that there are a lot of new students who read this periodic. Not only the students have changed, also the Maxwell Committee and the ETV-Board have changed. However, the Maxwell doesn't look any different than the previous ones. Only the committee behind the Maxwell changed a little bit. I have laid down my study books for a year of new experiences. I would like to thank the 143rd Board for their effort and I look forward to a wonderful year. Enjoy reading this edition!

Elke Salzmann

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Advertorial DNV-GL

Onze haat-liefde verhouding met Maxwell

René Smeets, innovatie manager KEMA Laboratories DNV GL

In 1865 toonde de Schot James Clerk Maxwell (1831 – 1879) met de publicatie van "A Dynamical Theory of the Electromagnetic Field" aan dat elektrische en magnetische velden door de ruimte bewegen als golven met de lichtsnelheid. [1]

Dit jaar gedenken we dan ook het 150 jarig bestaan van de wetten van Maxwell .

In dit artikeltje wil ik de aandacht richten op de betekenis van de vier Maxwell wetten voor de beproevingstechniek van hoogspanning apparatuur, mijn vak.

Als verantwoordelijke voor innovatie van KEMA Laboratories, een onderdeel van DNV GL, heb ik dagelijks te maken met de nukken van elektriciteit. Maxwell is ons dagelijks brood, maar tevens een niet aflatende lastpost in onze rol als wereld marktleider in beproeving en certificering van hoogspannings apparatuur voor de elektriciteits voorziening.

We zoeken Maxwell op in het grootste kortsluitlaboratorium ter wereld, zo maar in Nederland, in Arnhem aan de Rijn.

De eerste wet van Maxwell (zie de afbeelding), eigenlijk al geformuleerd door Gauss (1777) beschrijft hoe het elektrische veld ontstaat vanuit ladingen. Dit doet me denken aan onze condensatoren, die lading opslaan. De velden die van daaruit ontstaan worden gebruikt om adequate spanningen te genereren bij het beproeven van schakelaars voor de grootste elektriciteits netten ter wereld, nu al in China op 1100 kV nivo, binnenkort in India op 1200 kV. Wij gebruiken huizenhoge condensatorbanken om de juiste transiënte spanningen te maken voor schakelaars, precies zoals ultra-hoogspanningsnetten dat doen.

Ook in kabels, bij voorbeeld voor onderzees transport van wind energie naar land, komt deze wet op de proppen. Kabel isolatie moet net dik genoeg zijn om de grote velden bij hoge spanning te kunnen beheersen, ook dit beproeven wij tot de allerhoogste spanningen.

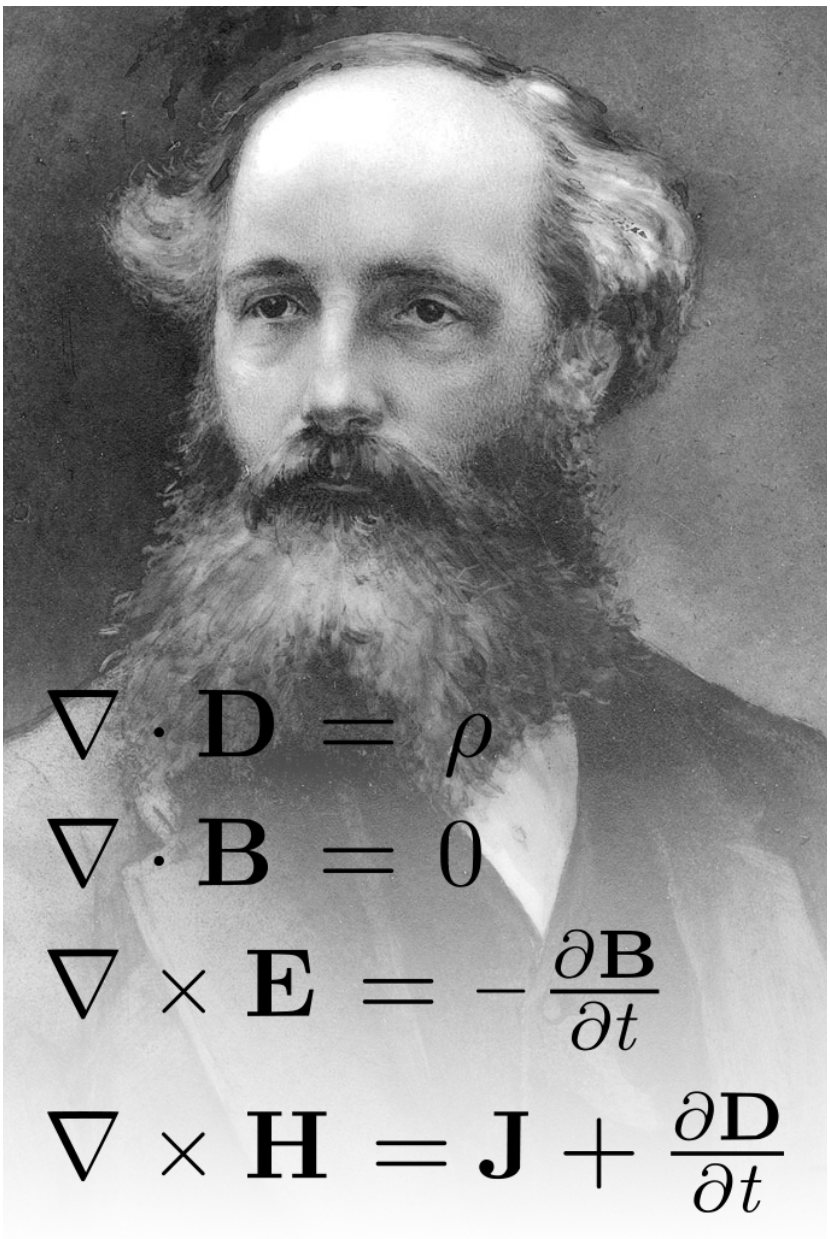
De tweede wet van Maxwell beschrijft dat magnetische veldlijnen niet afkomstig zijn uit een bron, zoals elektrische veldlijnen wel altijd ontstaan vanuit een lading. Er bestaat geen magnetische bron, en daarom zijn magnetische veldlijnen gesloten. Dit is vooral duidelijk te zien in transformatoren. In onze test-installatie gebruiken we speciale kortsluit-transformatoren om de testspanning op het juiste nivo te krijgen. Dit gebeurt door het magnetisch koppelen van spoelen gewikkeld om een metalen kern, die de magnetische veldlijnen concentreert en op de juiste manier door de windingen stuurt. Vorige maand zijn vier grote transformatoren (van Nederlands fabricaat) geïnstalleerd om straks transformatoren van supernetten te kunnen beproeven. Deze komen vanuit de hele wereld per schip naar Arnhem en worden aan boord getest. Transporttijd is maanden, kortsluit belasting is maar een kwart seconde, maar genoeg om bij een grote sluiting in het elektriciteits de transformator te verwoesten.

De derde wet van Maxwell is eigenlijk al opgesteld door Faraday (1831) en beschrijft hoe veranderende magnetische velden spanning in geleiders induceren. De belangrijkste toepassing daarvan in ons laboratorium zijn de generatoren (nu vier stuks, binnenkort zes) die de zeer grote stromen opwekken nodig voor de beproeving van apparatuur onder kortsluiting. Deze generatoren wekken netfrequente stromen

op tot enkele honderden kilo-ampères, en daar zit meteen al een geweldige uitdaging. Dergelijke enorme stromen zijn erg lastig onder controle te houden, enerzijds vanwege de krachten die gepaard gaan met deze stromen, maar niet minder omdat ze zich niet makkelijk laten uitschakelen. De wet van de Arnhemmer Hendrik Lorentz (1853), een soort aanvulling op de wetten van Maxwell, beschrijft dit krachtenspel, in TU colleges meestal uitgelegd als de kracht op een bewegend elektron in een magnetisch veld, en van de middelbare school bekend als de linkerhand regel.

We hebben ook last van de eerste Maxwell wet: de grote magneetvelden in onze laboratoria wekken ongewenste spanningen op geleiders naar meetapparatuur, iets wat alleen met veel kennis van elektro-magnetische compabiliteit (EMC) te beheersen valt.

De vierde Maxwell wet, eigenlijk een uitbreiding van de wet van Ampère (1775), beschrijft de relatie tussen stromen en veranderlijke elektrische velden, eigenlijk het omgekeerde van de eerste Maxwell wet. In de meest simpele vorm is dit de wet van Ohm, die de stroom beschrijft als gevolg van een spanning. Ook deze wet is van groot belang voor de beproeving techniek, omdat bij alle kortsluitingen vanwege de hoge spanningen ook zeer grote kortsluitstromen ontstaan. Al onze



verbindingen in de laboratoria zijn dan ook niet uitgevoerd als kabels, maar als solide massieve balken met minimale weerstand. Veel van onze proeven zijn er op gericht te verifiëren dat apparatuur korte tijd een zeer grote stroom moet kunnen weerstaan, in geval van een sluiting in het elektriciteits net.

[1] Zie ook: http://spectrum.ieee.org/telecom/wireless/the-long-road-to-maxwells-equations

Bachelor Graduation Project

Cognitive Radio

Robin Hes

The final quarter of each Electrical Engineering bachelor student is devoted to the Bachelor Graduation Project, or BAP. During this quarter, students are required to apply the knowledge and skills they have gained during their studies so far, to design and even theoretically market an actual product, or at least a proof-of-concept thereof. The students go through the entire design cycle, including drawing up a set of requirements and testing the final product using these requirements, which makes the project an excellent final test before reaching the ultimate goal: a bachelor's degree.

This year's selection of available projects entailed some interesting assignments, covering a wide range of subjects. Whether your interests lie in, for example, bettering the world by means of a cheap device to monitor a baby's health, targeting to reduce baby mortality rates in developing countries; in increasing productivity by optimising the performance of teleconferencing solutions by means of beamforming using smartphones; in the design of a game for visually impaired children to train their senses for real-world situations; or in building parts for a robot that once might find its way to Mars, a suitable project was there for you.

Willem Melching presenting the project

Picking one of these was of course only the first step in the journey that was the Bachelor Graduation Project. The next one was getting comfortable with the theoretical background of the chosen subject and putting together a list of useful literature and other resources to guide your progress during the rest of the project. At least as important as this was the process of familiarising yourself with your team mates, getting an impression of each other's skill set and setting up a work flow that everyone in the team is happy with and allows each of the team members to function in the most efficient way.

It was then time to actually get to work and begin the process of design and implementation, with the next milestone being the mid-term symposium, a few weeks later. The symposium gave a nice overview of each team's strategies and progress, although it was clear most teams were most eager to get on with their work instead of just talking about it.

In the weeks following this event, the business plan became increasingly important. In addition to just designing a product, each group was also required to think about a way to sell a (hypothetical) market-ready version of that product. A series of lectures and team appointments with Koen Bertels gave some insight in how to best tackle this problem, although the teams were very much encouraged to think of their own original ways to make a lot of money.

This ultimately led to the final tests: the bachelor thesis, its defence and the

The group

`Grand Finale'. During this final event, every team presented their business plan in front of the other teams, family and friends, as well as a qualified jury that would come to the final verdict followed by a casual drink and poster session, making it a worthy conclusion of the project.

Our project

Nowadays we cannot imagine a world without wireless technologies. The enormous increase in wireless applications has lead to a situation in which it has become increasingly difficult to find a piece of the wireless spectrum that is yet unused – or at least unlicensed – and therefore can be used for new technologies or to increase the capacity of existing ones. This so-called spectrum-scarcity problem makes it valuable to be able to gain insight in the current use of the radio spectrum in a fast and efficient way.

To alleviate the spectrum-scarcity problem the concept of Cognitive Radio (CR) has been introduced. A Cognitive Radio detects available channels in the

In the EWI Hall

spectrum that may be used for communication. The concept of a network of Cognitive Radios is that each Cognitive Radio gains access to the spectrum but does not interfere with other – licensed – users. Therefore it is important that large bands of the spectrum can be sensed, so that it is possible for each Cognitive Radio to find a free channel for communication. To reduce the interference with licensed users to a bare minimum, the Cognitive Radios should be able to not only sense large bandwidths, but also be able to sense those bandwidths as fast as possible. Sensing large bandwidths, however, cannot be achieved with conventional techniques, as those require Analog-to-Digital converters that operate at very high sampling rates. ADCs like this either do not exist, or are to expensive or power-hungry and therefore cannot provide a feasible resolution in the band to be sensed. Because of this, the need for other, revolutionary techniques arises.

For our Bachelor Graduation Project we have built an implementation of a technology that can be used to accomplish just that, by sampling at sub-Nyquist rates (i.e. requiring less samples than required by the Shannon-Nyquist sampling theorem). Obtaining samples at a lower sampling rate implies that cheaper and less energy-hungry hardware may be used to obtain the same results as with conventional sampling or, conversely, that using the same hardware, reconstruction of signals with higher bandwidths can be reconstructed than with conventional techniques. This technique is called compressive sensing and forms the basis of our implementation: an Extensible Toolkit for Real-Time High-Performance Wideband Spectrum Sensing.

As indicated by its name, the implementation comes in the form of a Python software toolkit, which should make it easy to run it on a large number of platforms. It has been designed in such a way that it should be simple to extend and integrate in existing systems, whilst retaining a performance level that is sufficient to meet the requirements dictated by the spectrum-scarcity problem and its solution: Cognitive Radio.

Although CR is a very tangible application of compressive sensing, it does not stop there. During our search for applications of compressive sensing to be able to come up with a business plan based on this technique, we also found that the military was interested. Our technique would enable them to jam enemy data transmissions in an efficient way, whilst retaining their own communication. Thus the Cognitive Jammer was born. This led us to visit the Netherlands' naval base in Den Helder, resulting in a fruitful discussion of the potential of compressive sensing in the military. From this experience we can conclude that networking is a very useful thing, even so soon in our career.

Building on our experiences and the large potential of compressive sensing and its applications, we finally came up with a business plan that was awarded the IEEE Best Business Plan award during the `Grand Finale'. An awesome reward for a lot of satisfactory work!

McCANN KF4 PHOTO: TILLMANN FRANZEN

We play our part in the bigger picture.

James Dobbin, Senior Engineer at DNV GL, holds a part of the solution to one of the greatest challenges of our time: how to meet growing energy needs in a responsible manner. Recently, his team has shown how a fully integrated approach to design for offshore wind can lower the cost of clean energy production by up to 10%. Experts like James work with customers every day to solve problems and challenges across the entire energy value chain. They take a broader view on the industry and work relentlessly to make sure the small parts DNV GL play impact the bigger picture.

Following the recent merger between DNV and GL, we are 16,000 employees worldwide dedicated to enabling businesses to meet their challenges in a safer, smarter and greener way; in the energy, oil and gas, maritime and a range of other industries.

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Studieverzameling

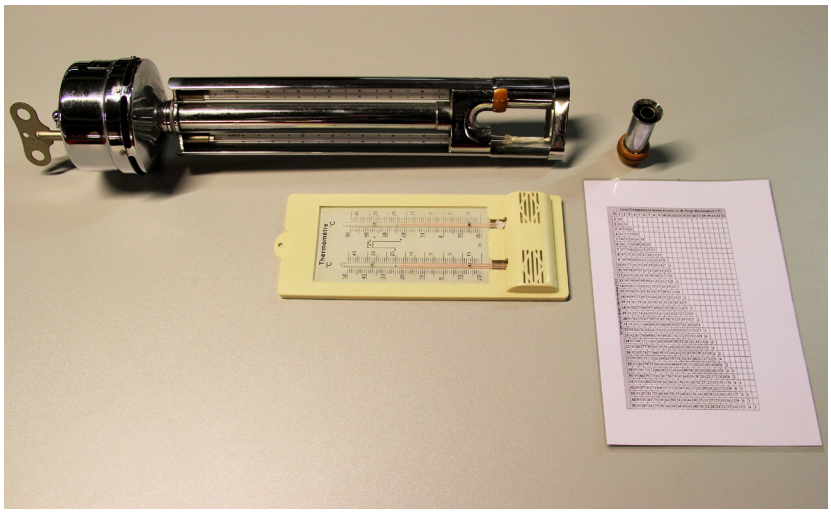
De psychrometer

P.J. Trimp

Een psychrometer is een instrument waarmee de luchtvochtigheid kan worden gemeten. Vóór de intrede van het elektronika tijdperk bestond zo'n instrument in feite uit twee identieke kwikthermometers welke in een robuuste behuizing waren ondergebracht. Op de foto is een zo'n psychrometer (in liggende toestand) afgebeeld. De metalen behuizing is verchroomd om externe ongewenste warmtestraling (zon, lichaamswarmte, verlichting e.d.) weinig tot geen invloed te laten uitoefenen op de temperatuurmetingen van beide kwikthermometers. De ene thermometer meet de omgevingstemperatuur "de zgn drogebol temperatuur" terwijl het kwikreservoir van de andere thermometer is voorzien van een katoenen kousje (op de foto is het dubbele stralingsscherm weggenomen om het kousje zichtbaar te maken voor de lezer) dat van te voren met zuiverwater is bevochtigd. Dit wordt ook wel aangeduid als de nattebol temperatuur. Als er een luchtstroom (0,5 tot 2 m/s) over het kousje wordt geleid dan zal de temperatuur van deze thermometer gaan dalen. Immers het vocht in het kousje zal gaan verdampen. Deze verdampingswarmte wordt onttrokken aan het kwikreservoir van de thermometer. Voor het uitvoeren van een vochtigheidsmeting is de omgevingstemperatuur en het temperatuurverschil tussen beide thermometers "het z.g.n. psychrometrisch temperatuurverschil" van belang. M.b.v. van een tabel, diagram of rekenschuif die bij de psychrometer meestal wordt meegeleverd, kan men op eenvoudige wijze de relatieve luchtvochtigheid van de lucht waarin de psychrometer is opgesteld bepalen.

Onder de relatieve luchtvochtigheid wordt verstaan het percentage van de verhouding van de hoeveelheid waterdamp in een gegeven hoeveelheid lucht tot de maximale hoeveelheid waterdamp die diezelfde hoeveelheid lucht kan bevatten.

De luchtstroom wordt overigens bij de afgebeelde psychrometer opgewekt met een ventilator die boven in de behuizing is ondergebracht. De afgebeelde psychrometer dient, integenstelling tot wat wordt getoond op de foto, normaal in vertikale stand opgehangen te worden. De lucht wordt van beneden naar boven over de beide thermometers geleid; immers als de lucht van boven naar beneden zou gaan dan komt er beneden vochtige lucht vrij waardoor lokaal de luchtvochtigheid ongewenst wordt verhoogd en daardoor wordt nauwkeurigheid de meting nadelig beinvloed.



De ventilator wordt bij de afgebeelde psychrometer mechanisch aangedreven door een veermechanisme. Het veermechanisme dient net als bij "de wekker thuis" te worden opgewonden. Nadeel is dat de ventilatorveer iedere keer weer opnieuw moet worden opgewonden. Latere uitvoeringen kregen een elektrische ventilator ingebouwd.
Het kousje wordt niet continu bevochtigd en is derhalve na verloop van tijd opgedroogd. De tijd waarin men vochtigheidsmetingen kan uitvoeren hangt overigens niet alleen af van de tijd waarin de ventilator afloopt maar óók van de toestand van de lucht. Bij een hoge omgevingstemperatuur en een lage luchtvochtigheid kan het kousje heel snel zijn vocht verliezen. Onder zulke omstandigheden kan dit een praktisch probleem geven om het kousje voldoende lang vochtig te

houden om überhaupt een meting uit te voeren.

Het bevochtigen van het kousje wordt gedaan met een eveneens meegeleverd dun glazenbuisje. Er wordt vanuit gegaan dat de psychrometer vertikaal is opgehangen. Dit buisje wordt tot de helft (om morsen te voorkomen tijdens het onderdompelen van het kousje) met water gevuld en daarna voorzichtig van onderaf over het kousje gebracht zodat het weer volledig is verzadigd met water.

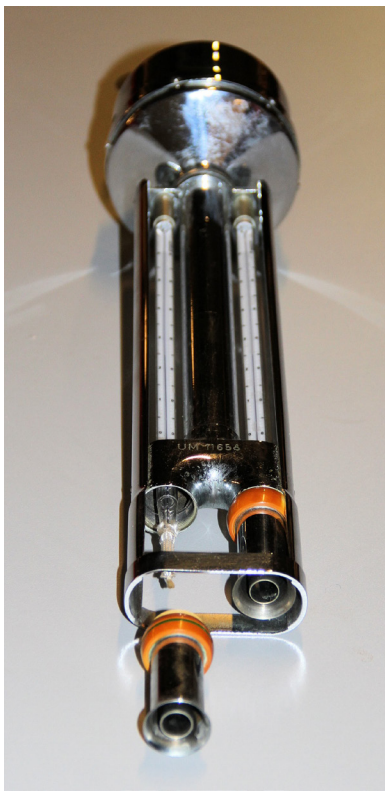
Het is goed om te weten dat er zich twee meetsituaties kunnen voordoen waarbij de beide thermometers dezelfde temperatuur zullen aangeven:

1. De luchtvochtigheid is 100%; er zal geen verdamping plaatsvinden en derhalve zal het temperatuur verschil nul bedragen.

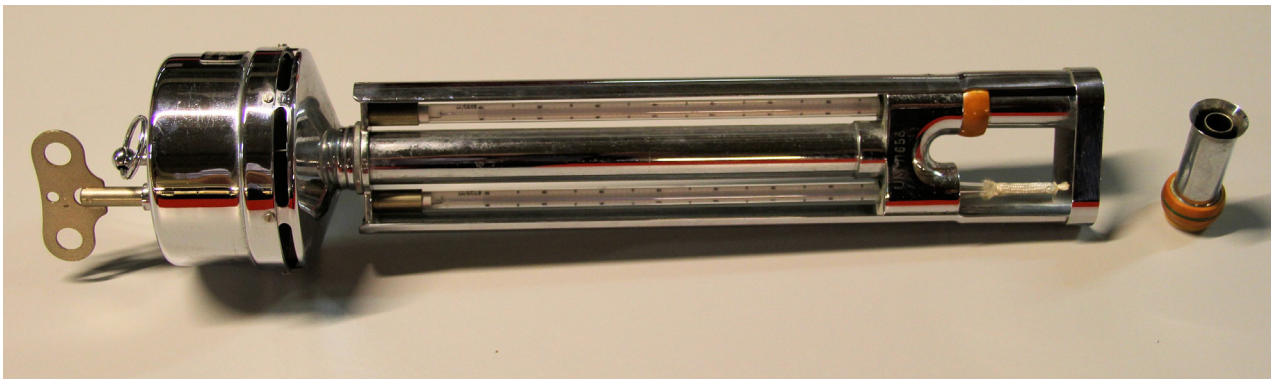
2. Wanneer het kousje droog is; men is vergeten om het kousje te bevochtigen.

Bij het aflezen van de thermometers moet men overigens letterlijk een blad voor de mond én neus nemen of tijdelijk de adem inhouden. Immers de uitgeademde lucht van de degene die de aflezing verricht bevat veel vocht en kan ongemerkt de meting beinvloeden. Overigens zijn de beide kwikreservoirs voorzien van een dubbel warmtestralingsscherm. Dit laatste kan men zien door de onderste delen van de behuizing ter hoogte van de kwikreservoirs af te schroeven. Men ziet dan dat deze onderste delen dubbelwandig zijn uitgevoerd. Op de foto is het afschroefbare stralingsscherm van de natte thermometer te zien.

Het meetprincipe is al heel oud, maar het wordt nog steeds toegepast. De kwikthermometers zijn inmiddels vervangen door b.v. Pt100 weerstanden. Pt staat in de scheikunde voor Platina. De platina weerstand doet hier dus dienst als een nauwkeurige temperatuur gevoelige weerstand. Van platina kan men héél dunne draden trekken. Men wikkelt het dunne platinadraad op b.v. een glazen drager net zo lang tot de weerstand 100,00 Ohm is bij 0 °C. Door een nauwkeurige maar heel kleine stroom (om elektrische opwarming in de weerstand heel klein te houden) door deze weerstanden te sturen kan men via een spanningsmeting van beide weerstanden de droge- en nattebol temperatuur bepalen. Het psychrometer principe wordt nog steeds toegepast in b.v. industriele klimaatkasten. Eén van de twee Pt100 weerstanden is dan wederom van een katoenen



kousje voorzien. Dit kousje wordt nu echter wél continu bevochtigd. In een moderne klimaatkast is zelfs een redelijk grote container (gevuld met demi-water = gedemineraliseerd water) van 10 liter geplaatst alleen maar om het kousje voor héél lange tijd te kunnen blijven bevochtigen. Immers in de praktijk worden bijvoorbeeld steeds vaker elektronika componenten voor meer dan een jaar continu getest in een klimaatkast. ■



Advertorial

ASML

ASML Internship: a memorable experience in cutting-edge technology and teamwork.

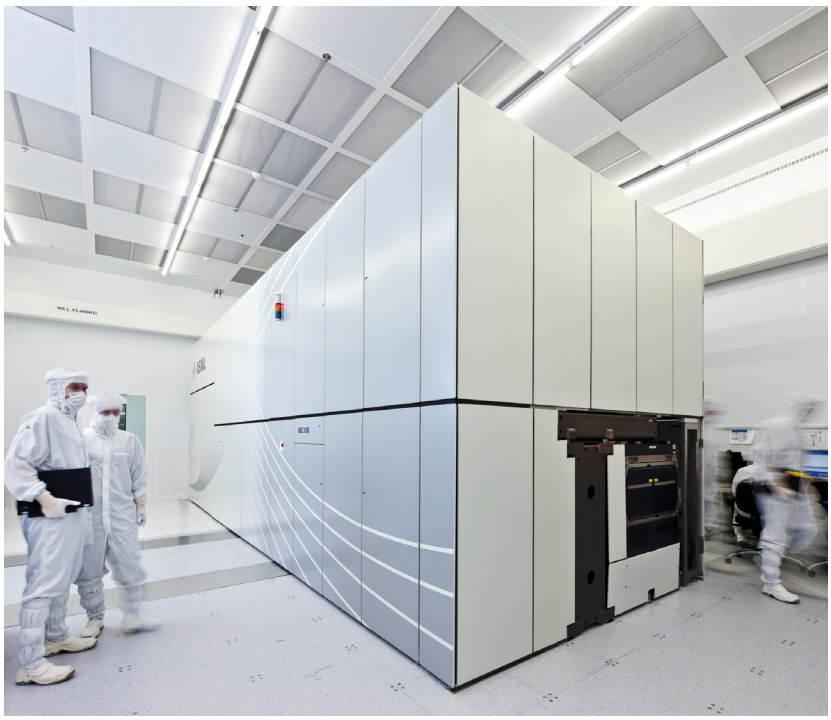
Nowadays, you can find 16 GB USB sticks on supermarket shelves for as little as €10. This probably isn't something you think about much, but it actually represents quite a significant milestone. Let's revisit the world of Moore's Law for just one moment. It's a highly complex world in which companies everywhere are doubling the capacity of their chips on an annual basis, but not without a high degree of effort. It's a world in which major breakthroughs measure only a few nanometres in size. It's a world in which one of the leading players is located in the Netherlands, or to be more precise, Veldhoven.

Crucial Step

Welcome to ASML, a manufacturer of lithography systems for producing computer chips. ASML supplies equipment to all the world's major chip manufacturers including Samsung, Intel and TSMC. There are dozens of steps along the path to producing a chip. ASML helps manufacturers take just one of these steps, but it's a very crucial step. Lithography involves exposing and chemically etching the wafers used to 'print' a chip's components. The degree of miniaturization achievable is fully dependent on the accuracy of the lithography process.

With ASML's latest generation of machines, it's possible to print lines on chips measuring only about 20 nm in thickness. To put this into perspective... that's like printing the contents of a 500-page novel onto a centimetre-long strand of human hair!

You probably think ASML's machines are incredibly complex. You'd be right. Every day, thousands of engineers and researchers dedicate themselves to refining its machines still further. And we are always looking for interns or graduates that want to join them.



Internships

If you are a technical student, you can apply for an ASML internship – and if we can find the right assignment for you, you'll get a memorable experience in cutting-edge technology and teamwork. As long as you are bright, eager to learn, and can work in a team, we will be pleased to consider placing you in our technologically diverse organization. What's more, your technical skills will be strengthened, enriched and stretched – whatever your specialty is. That's because we build machines that are amongst the most complex systems ever conceived. And machines like these require an extremely wide variety of technologies.

Niels Hooger, Electrical Engineering, did a Board Diagnostics intern project: "When applying for an internship at ASML I noted my interests and skills and the assignment I received fitted my wishes. During my work, the assignment changed, but I was able to retain focus on the parts that interested me most. My best memory of ASML will be

the people I met and all the things they taught me. I have never before been surrounded by so much knowledge and experience as I was at ASML."

As an intern, you are part of this cutting-edge technology and work in a multidisciplinary team. You will also experience an international environment and have the opportunity to learn from many different technical specialists. It can therefore be the starting point for building your own professional network.

We offer a wide range of internships and graduation projects, but you can also work with an ASML engineer and formulate your own unique assignment. One that is built around your area of expertise and interest. We have found that a little creative thinking and a touch of flexibility goes a long way in making an internship rewarding, relevant and enjoyable – for both sides.

The facts:

- ASML offers more than 160 internships per year in Veldhoven
- We host interns from 20 different countries
- Internship periods range from 3 to 12 months
- The number of days per week is open for discussion
- Allowance of up to 500 euros per month
- If you meet the requirements, it's possible to receive an additional housing allowance of 250 euros per month as well as a travel allowance if you don't qualify for a student travel card
- Twice a year we host an Intern Day with a variety of informal activities

How to apply for an internship

Simply visit www.asml.com/students and check out the current opportunities. If you see one that interests you, upload your CV and motivation letter via the website. If you do not find an assignment that matches your interest, then feel free to send an open application. There is always an opportunity to formulate one based on your background and/or interests. We appreciate initiative and support innovative plans and ideas!

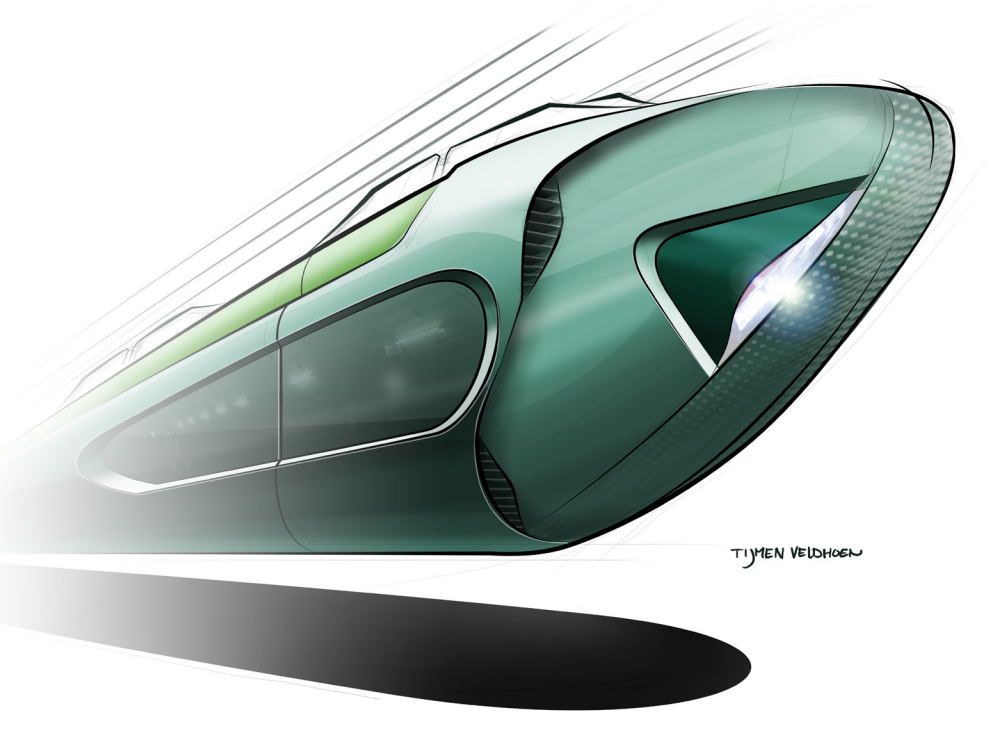
Hyperloop

Delft Hyperloop: van Amsterdam naar Parijs binnen een half uur!

Door Marleen van de Kerkhof

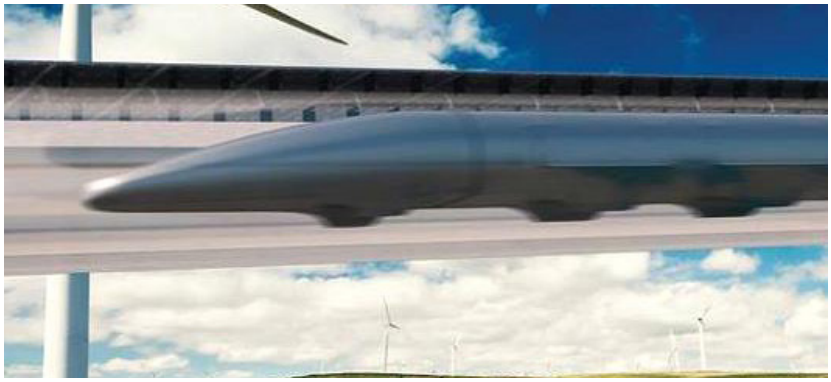
De Hyperloop is een revolutionair nieuw concept, dat mensen in staat stelt om te reizen met de snelheid van vliegtuigen, maar met het comfort van een trein. Bovendien gebruikt de Hyperloop slechts een fractie van de energie die wordt gebruikt door hogesnelheidstreinen en andere conventionele transportmiddelen. Het is bijna geluidloos en de Hyperloop brengt je in no-time naar een bestemming honderden kilometers verderop.

In het kort is de Hyperloop een conceptueel high-speed transport systeem met buizen die onder lage druk staan waarin capsules met passagiers en bagage reizen. Hierdoor is de luchtweerstand zo laag dat er bijna met de snelheid van het geluid kan worden gereisd. Echter is de Hyperloop ook een stuk goedkoper, efficiënter en handiger dan vliegtuigen. Daarnaast is de Hyperloop immuun voor alle weersomstandigheden en is het ontwerp bestand tegen aardbevingen. Het concept van de Hyperloop werd voor het eerst voorgesteld als een vaag sciencefiction idee in de jaren '70. In 2013 tilde SpaceX dit concept naar een hoger plan en Elon Musk publiceerde een whitepaper over de Hyperloop. Sindsdien is er wereldwijd enorm veel aandacht voor de Hyperloop. Om de ontwikkeling van een werkend prototype te stimuleren, lanceerde Elon Musk in 2015 de "Hyperloop Pod Competition". Het idee is simpel: Studententeams van over de hele wereld ontwerpen, bouwen en testen hun eigen Hyperloop capsule die door de testbaan zal lopen. Deze testbaan van 1,6 kilometer wordt door SpaceX naast hun hoofdkantoor in Calfornië gebouwd. De Hyperloop competitie is een internationale engineering design wedstrijd met meer dan 1200 deelnemers uit de hele wereld. De wedstrijd vindt plaats in juni 2016 in Hawthorne, Californië. De capsules worden door experts van Tesla Motors, SpaceX en de bijbehorende hoogleraren beoordeeld op het ontwerp en de prestaties. Enkele duizenden ingenieurs zijn aanwezig, samen met meer dan duizend bezoekers en bedrijven.



In juni 2015, direct na de lancering van de competitie, is het team Delft Hyperloop gestart met kleine groep van 6 gemotiveerde en ervaren studenten. Deze studenten kenden elkaar al van Formula Student, waar zij recordbrekende elektrische raceauto's hebben gebouwd die de felste studentenwedstrijd in de wereld hebben gewonnen. Vanwege deze ervaring kan Delft Hyperloop dit project tot een groot succes brengen. Momenteel is het team uitgebreid naar 36 leden om dit succes te realiseren. Deze studenten behoren tot de bovenste gelederen want ze zijn geselecteerd uit bijna 200 kandidaten. Met dit team kan Delft Hyperloop verder kijken, verder reiken, harder werken en het beter doen dan alle andere teams die concurreren in de Hyperloop competitie. Iedereen in het team vindt het extreem leuk wat we doen omdat we de wereld schoner en efficiënter willen maken en mensen zo snel mogelijk bij elkaar willen brengen. Het doel van Delft Hyperloop is duidelijk: Het winnen van deze wedstrijd! Delft Hyperloop wil de technische en commerciële haalbaarheid van de Hyperloop bewijzen door de wedstrijd te winnen met een veilige, snelle en betaalbare capsule.

Volgens Elon Musk is het Hyperloop concept een voertuig met aan de voorkant een grote compressor om de lucht op te zuigen waardoor de luchtweerstand nog lager wordt. Deze lucht wordt onder het voertuig uitgeblazen zodat het voertuig op een luchtkussen zweeft. Hierdoor is er dus geen mechanisch contact waardoor er ook geen slijtage is en er dus veel minder onderhoud nodig is. Het voertuig wordt op het station geaccelereerd, waarna deze zonder verdere aandrijving naar het volgende station zweeft en daar weer wordt afgeremd. Dit is mogelijk omdat de luchtdruk in de buis zo laag is dat er heel weinig luchtweerstand is. Bij het afremmen wordt ook weer energie teruggewonnen. Dit concept heeft Delft Hyperloop nog eens onder de (hyper) loep genomen en er is gebleken dat de luchtlagers en de compressor nog wel de nodige nadelen hebben. Een compressor is erg duur, zwaar, en het bleek dat wat luchtweerstand betreft het verschil niet significant was of er een compressor in de capsule zat of niet. Om de luchtlagers nog enigszins efficiënt te houden moet de luchtlaag waar de capsule op zweeft 0.5 mm dik zijn. Hierdoor moeten de bouwtoleranties van de buis heel erg nauwkeurig zijn wat weer heel veel kosten met zich meebrengt. Het Delft Hyperloop team heeft ervoor gekozen om dit concept te vernieuwen. Wij gaan de wedstrijd winnen met het ontwerp van een capsule met een aerodynamische vorm die door regelbare elektromagneten wordt

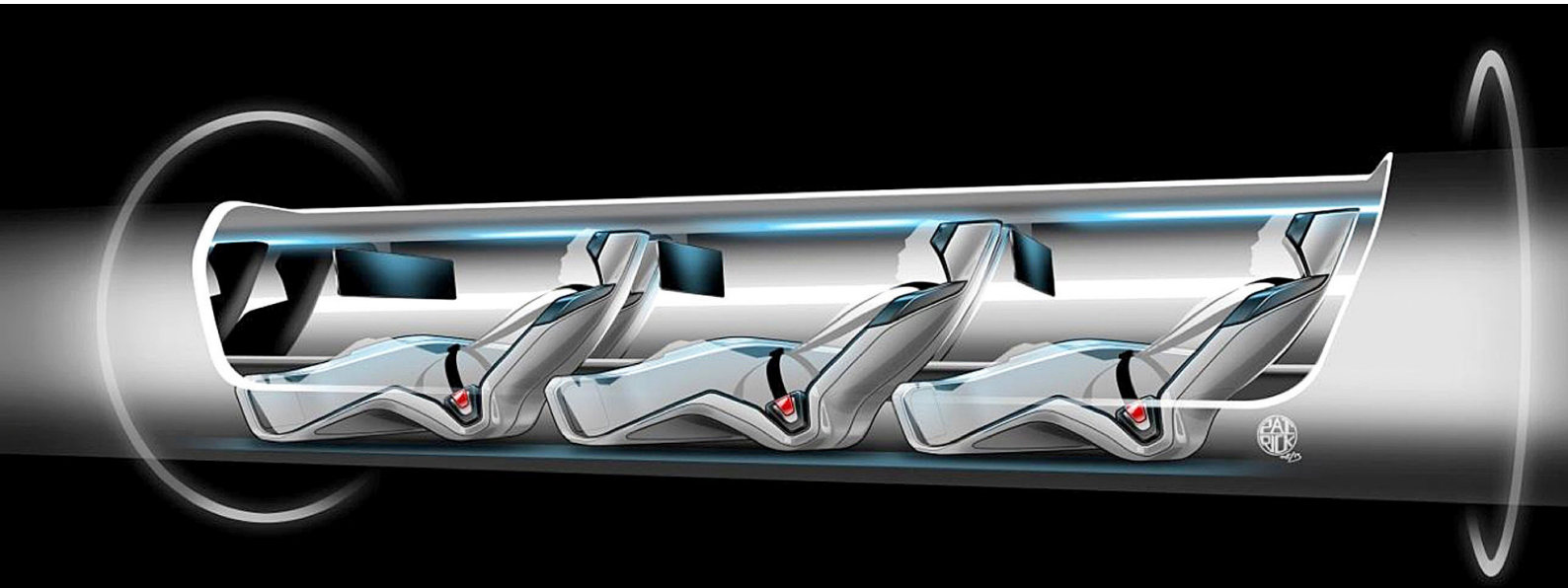


opgehangen. De elektromagneten worden van energie voorzien door accu's. Deze accu's krijgen hun energie van zonnepanelen bovenop de tunnel als de capsule bij het station staat. Om de capsule op te hangen in de tunnel is in plaats van wielen en luchtlagers dus gekozen voor elektromagneten. Hierdoor is er wederom geen mechanisch contact wat slijtage en onderhoud minimaliseert. Het gebruik van elektromagneten geniet vele voordelen ten opzichte van luchtlagers. Zo is de luchtlaag tussen de capsule en de tunnel gemakkelijk op 4 cm te houden, waardoor de toleranties veel groter worden wat weer de kosten reduceert. Verder zijn magneten goedkoper dan een grote compressor. Het stroomverbruik wat nodig zou zijn om de compressor aan te drijven is ook vele malen hoger dan het stroomverbruik van de magneten voor levitatie. Verder kun je je voorstellen dat als je op luchtlagers wilt zweven, je wel lucht nodig hebt. Omdat de luchtdruk zo laag is, moet je heel snel gaan om genoeg lucht op te zuigen. Hierdoor is er ook nog een secundair ophangingsysteem vereist voor op lage snelheden. Met een magnetische ophanging is dit niet nodig, want als je dit goed uitvoert, werkt het ook op lage snelheden en zelfs bij stilstand. Verder is een magnetische ophanging al uitgebreid getest en succesvol commercieel toegepast.

Met dit vernieuwde ontwerp heeft het Delft Hyperloop team een voorsprong op de andere concurrerende teams en dit zorgt voor veel exposure in de media. In Nederland heeft de NOS, NRC en de Volkskrant al bericht over de Hyperloop en in de USA CNN, Business Insider en Forbes. Kortom: de Hyperloop is een project dat wereldwijd in de spotlights staat.

Volg de vorderingen van het Delft Hyperloop team op Facebook: Delft Hyperloop.

Check de website: delfthyperloop.com



High bit rate audio sampling

Why 24/192 makes no sense

Monty Montgomery

Over the past couple of years, there has been much discussion on how to best distribute digital music. Apple has made claims of delivering 'uncompromised studio quality' music. Much of the press and user commentary was particularly enthousiastic about the propspect of uncompressed 24 bit 192 kHz downloads.

Unfortunately, there is no point to distributing music in 24 bit/192 kHz format. Its playback fidelity is slightly inferior to 16/44.1 or 16/48, and it takes up 6 times the space.

There are a few real problems with the audio quality and 'experience' of digitally distributed music today. 24/192 solves none of them. While everyone fixates on 24/192 as a magic bullet, we're not going to see any actual improvement.

I've had conversations with intelligent, scientifically minded individuals who believe in 24/192 downloads and want to know how anyone could possibly disagree. They asked good questions that deserve detailed answers.

I was also interested in what motivated high-rate digital audio advocacy. Responses indicate that few people understand basic signal theory or the sampling theorem, which is hardly surprising. Misunderstandings of th mathematics, technology, and physiology arose in most of the conversations, often asserted by professionals who otherwise possessed significant audio expertise. Some even argued that the sampling theorem doesn't really explain how digital audio actually works.

Physiology

Misinformation and superstition only serve charlatans. So, let's cover some of the basics of why 24/192 distribution makes no sense before suggesting some improvements that actually do.

The ear hears via hair cells that sit on the resonant basilar membrane in the cochlea (see fig. 1). Each hair cell is effectively tuned to a narrow frequency band determined by its position on the membrane. Sensitivity peaks in the middle of the band and falls off to either side in a lopsided cone shape overlapping the bands of other nearby hair cells. A sound is inaudible if there are no hair cells tuned to hear it.

This is similar to an analog radio that picks up the frequency of a strong station near where the tuner is actually set. The farther off the station's frequency is, the weaker and more distorted it gets until it disappears completely, no matter how strong. There is an upper (and lower) audible frequency limit, past which the sensitivity of the last hair cells drops to zero, and hearing ends.

Sampling rate and the audible spectrum

I'm sure you've heard this many, many times: The human hearing range spans 20 Hz to 20 kHz. It's important to know how researchers arrive at those specific numbers.

First, we measure the `absolute threshold of hearing' across the entire audio range for a group of listeners (see fig. 2). This gives us a curve representing the very quietest sound the human ear can perceive for any given frequency as measured in ideal circumstances on healthy ears. Anechoic surroundings, precision calibrated playback equipment, and rigorous statistical analysis are the easy part. Ears and auditory concentration both fatigue quickly, so

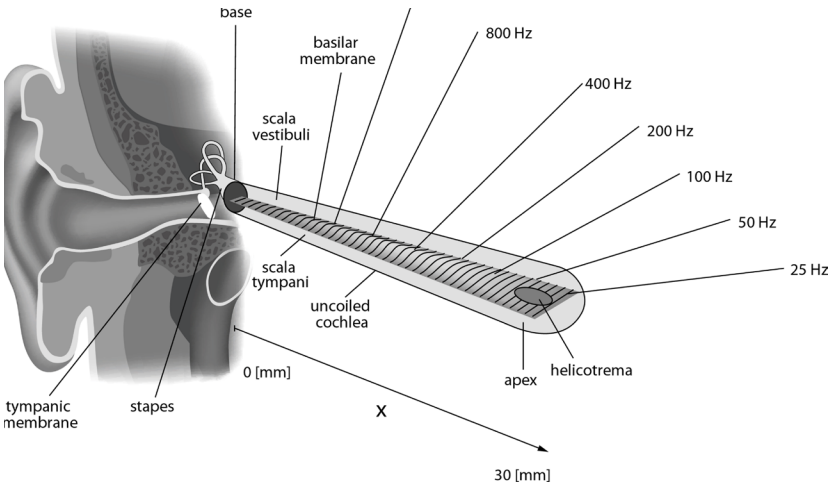


Figure 1: The membrane is tuned to resonate at different frequencies along its length, with higher frequencies near the base and lower frequencies at the apex. Approximate locations of several frequencies are marked.

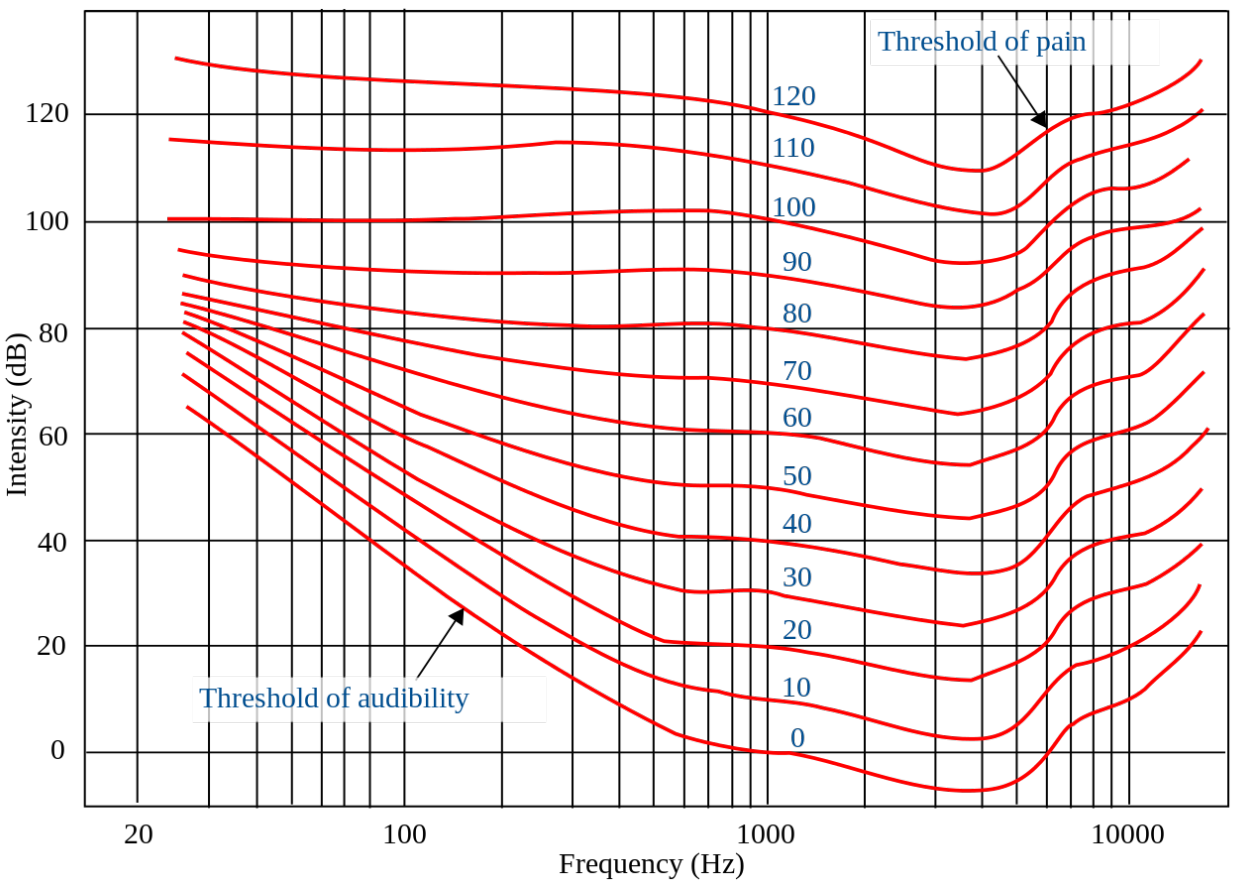


Figure 2: Approximate equal loudness curves derived from Fletcher and Munson (1933) plus modern sources for frequencies above 16 kHz. The absolute threshold of hearing and threshold of pain curves are marked red. Subsequent researchers refined these readings, culminating in the Phon scale and the ISO 226 standard equal loudness curves. Modern data indicates that the ear is significantly less sensitive to low frequencies than Fletcher and Munson's results.

testing must be done when a listener is fresh. That means lots of breaks and pauses. Testing takes anywhere from many hours to many days depending on the methodology.

Then we collect data for the opposite extreme, the 'threshold of pain'. This is the point where the audio amplitude is so high that the ear's physical and neural hardware is not only completely overwhelmed by the input, but experiences physical pain. Collecting this data is trickier. You don't want to permanently damage anyone's hearing in the process.

The upper limit of the human audio range is defined to be where the absolute threshold of hearing curve crosses the threshold of pain. To even faintly perceive the audio at that point (or beyond), it must simultaneously be unbearably loud.

At low frequencies, the cochlea works like a bass reflex cabinet. The helicotrema is an opening at the apex of the basilar membrane that acts as a port tuned to somewhere between 40 Hz to 65 Hz depending on the individual. Response rolls off steeply below this frequency.

Thus, 20 Hz - 20 kHz is a generous range. It thoroughly covers the audible spectrum, an assertion backed by nearly a century of experimental data.

Genetic gifts and golden ears

Based on my correspondences, many people believe in individuals with extraordinary gifts of hearing. Do such 'golden ears' really exist? It depends on what you call a golden ear.

Young, healthy ears hear better than

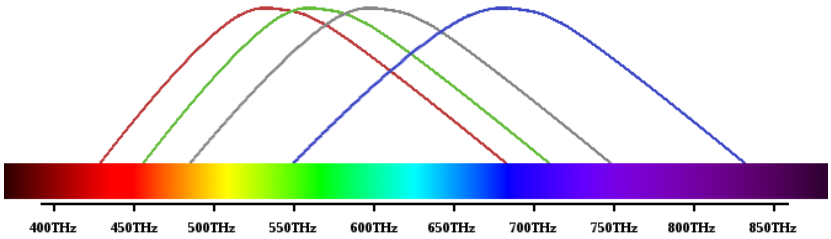


Figure 3: The approximate log scale response of the human eye's rods and cones, superimposed on the visible spectrum. These sensory organs respond to light in overlapping spectral bands, just as the ear's hair cells are tuned to respond to overlapping bands of sound frequencies.

old or damaged ears. Some people are exceptionally well trained to hear nuances in sound and music most people don't even know exist. There was a time in the 1990's when I could identify every major MP3 encoder by sound (back when they were all pretty bad), and could demonstrate this reliably in double-blind testing.

When healthy ears combine with highly trained discrimination abilities, I would call that person a golden ear. Even so, below-average hearing can also be trained to notice details that escape untrained listeners. Golden ears are more about training than hearing beyond the physical ability of average mortals.

Auditory researchers would love to find, test, and document individuals with truly exceptional hearing, such as a greatly extended hearing range. Normal people are nice and all, but everyone wants to find a genetic freak for a really juicy paper. We haven't found any such people in the past 100 years of testing, so they probably don't exist. Sorry. We'll keep looking.

Spectrophiles

Perhaps you're skeptical about everything I've just written; it certainly goes against most marketing material. Instead, let's consider a hypothetical Wide Spectrum Video craze that doesn't carry preexisting audiophile baggage.

The human eye sees a limited range of frequencies of light, aka, the visible spectrum (see fig. 3). This is directly analogous to the audible spectrum of sound waves. Like the ear, the eye has sensory cells (rods and cones) that detect light in different but overlapping frequency bands.

The visible spectrum extends from about 400 THz (deep red) to 850 THz (deep violet). Perception falls off steeply at the edges. Beyond these approximate limits, the light power needed for the slightest perception can fry your retinas. Thus, this is a generous span even for young, healthy, genetically gifted individuals, analogous to the generous limits of the audible spectrum.

In our hypothetical Wide Spectrum Video craze, consider a fervent group of Spectrophiles who believe these limits aren't generous enough. They propose that video represent not only the visible spectrum, but also infrared and ultraviolet. Continuing the comparison, there's an even more hardcore (and proud of it!) faction that insists this expanded range is yet insufficient, and that video feels so much more natural when it also includes microwaves and some of the X-ray spectrum. To a Golden Eye, they insist, the difference is night and day!

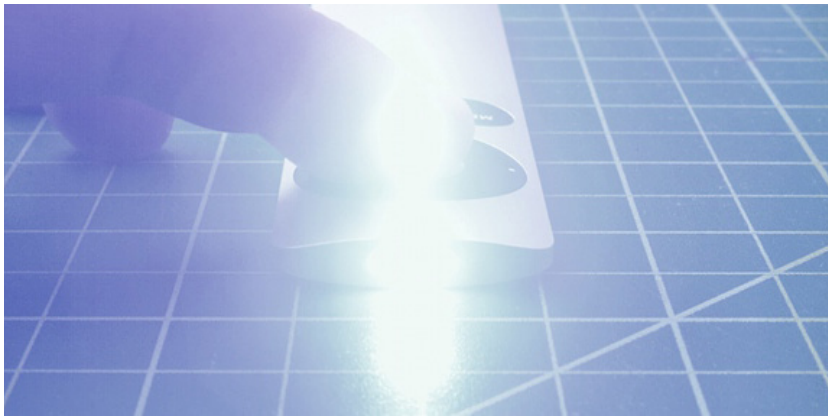


Figure 4: Apple IR remote photographed using a digital camera. Though the emitter is quite bright and the frequency emitted is not far past the red portion of the visible spectrum, it's completely invisible to the eye.

Of course this is ludicrous.

No one can see X-rays (or infrared, or ultraviolet, or microwaves). It doesn't matter how much a person believes he can. Retinas simply don't have the sensory hardware.

Here's an experiment anyone can do: Go get an Apple IR remote. The LED emits at 980 nm, or about 306 THz, in the near-IR spectrum. This is not far outside of the visible range. Take the remote into the basement, or the darkest room in your house, in the middle of the night, with the lights off. Let your eyes adjust to the blackness. Can you see the Apple Remote's LED flash when you press a button? No? Not even the tiniest amount? Try a few other IR remotes; many use an IR wavelength a bit closer to the visible band, around 310-350 THz. You won't be able to see them either. The rest emit right at the edge of visibility from 350-380 THz and may be just barely visible in complete blackness with dark-adjusted eyes. All would be blindingly, painfully bright if they were well inside the visible spectrum (see \cref{fig:apple-ir}).

These near-IR LEDs emit from the visible boundary to at most 20% beyond the visible frequency limit. 192 kHz audio extends to 400% of the audible limit. Lest I be accused of comparing apples and oranges, auditory and visual perception drop off similarly toward the edges.

192 kHz considered harmful

192 kHz digital music files offer no benefits. They're not quite neutral either; practical fidelity is slightly worse. The ultrasonics are a liability during play-

back (see fig. 5).

Neither audio transducers nor power amplifiers are free of distortion, and distortion tends to increase rapidly at the lowest and highest frequencies. If the same transducer reproduces ultrasonics along with audible content, any nonlinearity will shift some of the ultrasonic content down into the audible range as an uncontrolled spray of intermodulation distortion products covering the entire audible spectrum. Nonlinearity in a power amplifier will produce the same effect. The effect is very slight, but listening tests have confirmed that both effects can be audible.

There are a dew ways to avoid the extra distortion: There are a dew ways to avoid the extra distortion:

1. A dedicated ultrasonic-only speaker, amplifier, and crossover stage to separate and independently reproduce the ultrasonics you can't hear, just so they don't mess up the sounds you can.

2. Amplifiers and transducers designed for wider frequency reproduction, so ultrasonics don't cause audible intermodulation. Given equal expense and complexity, this additional frequency range must come at the cost of some performance reduction in the audible portion of the spectrum.

3. Speakers and amplifiers carefully designed not to reproduce ultrasonics anyway.

4. Not encoding such a wide frequency range to begin with. You can't and won't have ultrasonic intermodulation distortion in the audible band if there's no ultrasonic content.

They all amount to the same thing, but only 4 makes any sense.

If you're curious about the performance of your own system, try playing audio containing only frequencies above 24 kHz. There are plenty of resources for this on the internet. Alternatively, use a software synthesizer to generate some noises or shift an existing song up by 24 kHz.

If your system is actually capable of full 96 kHz playback, the everything should be completely silent with no audible noises, tones, whistles, clicks, or other sounds. If you hear anything, your system has a nonlinearity causing audible intermodulation of the ultrasonics. Be careful when increasing volume; running into digital or analog clipping, even soft clipping, will suddenly cause loud intermodulation tones.

In summary, it's not certain that intermodulation from ultrasonics will be audible on a given system. The added distortion could be insignificant or it could be noticeable. Either way, ultrasonic content is never a benefit, and on plenty of systems it will audibly hurt fidelity. On the systems it doesn't hurt, the cost and complexity of handling ultrasonics could have been saved, or spent on improved audible range performance instead. ■

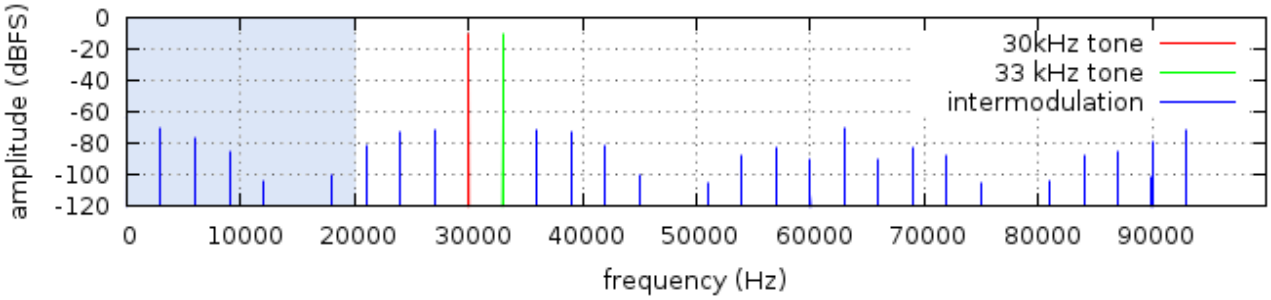


Figure 5: Illustration of distortion products resulting from intermodulation of a 30kHz and a 33kHz tone in a theoretical amplifier with a non-varying total harmonic distortion (THD) of about 0.09\%. Distortion products appear throughout the spectrum, including at frequencies lower than either tone.

Inaudible ultrasonics contribute to intermodulation distortion in the audible range (light blue area). Systems not designed to reproduce ultrasonics typically have much higher levels of distortion above 20 kHz, further contributing to intermodulation. Widening a design's frequency range to account for ultrasonics requires compromises that decrease noise and distortion performance within the audible spectrum. Either way, unnecessary reproduction of ultrasonic content diminishes performance.

To be continued in the next issue

Sterkstroomdispuut

Rik Wilmer

What you are reading here will already be the last words of the current board of the SSD. In 2016, our successors will take our place and organise nice events. We have already started looking for suitable candidates who could replace us. If you are from the Electrical Sustainable Energy (ESE) master track and feel that you would be a good candidate, do not hesitate to contact us!

For those of you who don't know what the Sterkstroomdispuut (SSD) is: The Sterkstroomdispuut is founded on the 10th of December 1964 and it is the student association for students of the department of ESE, part of the faculty of EEMCS from the Delft University of Technology. The board is made up from four students of the MSc program Electrical Sustainable Energy (previously Electrical Power Engineering). Every year, new candidates are selected and then officially installed in January. Working for SSD is not the easiest part-time job as a Master student. It requires commitment from all the members and we have to set aside some time from our busy schedules. Every year, the board is officially changed through a special meeting conducted by ETV, where only old and new board members of the SSD and the current board members of the ETV are present. Here, the new members receive the recognisable SSD-ties and are now ready to represent the Sterkstroomdispuut proudly on all occasions. The board organises two events per quarter; one excursion (or a technical event) to a company in power engineering and one social drink (or another social event like a barbecue), where students and professors meet each other outside the lecture halls. We are planning to also have lunch lectures and board meetings with professors more regularly.

SSD organises excursions for all the students and staff members from the Electrical Sustainable Energy (ESE) department; usually we take a group of 20-30 participants with a bus to a company (lunch provided), who will then arrange a nice tour of the company, which is always a treat. Last year, we went to the 380 kV substation in bleiswijk from TenneT, Smit transformers Nijmegen and DNV-GL Arnhem. These excursions are organised with an aim to improve

The SSD Board

the technical knowledge of students following the master course from ESE department, as well as making the gap between studying and the world of companies smaller.

Through the events the Sterkstroomdispuut organises, ESE students & staff get informed about the latest innovations in technology and the kind of problems being tackled by companies on a daily basis. As electrical power engineers it is essential for us to keep track on the latest innovations in the fields of Power Electronics, Power Systems, DC & Smart grids, Renewable energy and High Voltage engineering. It should be kept in mind that we fall into multiple categories and form a part of one of the fastest growing sectors in the world. Therefore finding interesting topics or companies for our students will not be a problem any time soon. It becomes simpler for us to organise such events with the support from our professors, faculty & old SSD members. Companies like TenneT, DNV GL and SMIT have also been very supportive & cooperative in organising the events with them. Without our helping hands, none of the events would have been as successful as they were. Hopefully they would also encourage the future SSD board members to organise similar events.

To make sure that our students don't get overstressed, as well as improving

About the SSD

The Sterkstroomdispuut is the student association for students of the department of Electrical Sustainable Energy. The department is part of the faculty of Electrical Engineering, Mathematics and Computer Science from the Delft University of Technology.

The board consists of students from the MSc program Electrical Power Engineering, which is a track of Electrical Engineering. Every year the SSD arranges several excursions to companies in the field of Electrical Power Engineering, and every quarter a social drink in the /Pub of the faculty EEMCS.

Besides that, there is an annual Christmas Lunch for the department, several seminars, lunch lectures and almost every year an excursion to a company outside the Netherlands.

The current board

Remco van der Plaats - President
Nishant Save - Secretary
Rik wilmer - Treasurer
Deesh Dileep - Commissioner

contact between teachers and students, the board organises social drinks or BBQ events for all students and staff of the department. By organising social events we also aim to give a platform for students and staff to interact with each other, and to discuss freely on topics of their choice. Here we can see a more informal contact between professors and students, under the enjoyment of a drink – which are fully sponsored by the Sterkstroomdispuut. These events are always well-visited and are a great addition to the master's student's life here in Delft, in our perspective. Most of the students benefit from such events and give a positive feedback which encourages us to organise these events every quarter.

Every year a few days before Christmas, the high-voltage lab of the university changes its purpose of existence; all equipment is set aside and nicely covered tables fill the centre. These preparations are all made for the annual Christmas lunch; all staff and students of the ESE department are invited for a nice lunch, with an inspiring speech, to inspire all attendees for the coming year of electrical power engineering.

Our year as a board is coming to an end but I can conclude that it has been a wonderful experience, collaborating with Dutch and International students, companies and professors, learning new skills and exploiting previously learned skills. I can speak for the rest of my board as I say we enjoyed the time we have spent together organising events and helping our ESE students at their study – during and after studying hours. I really hope my successors will continue the great tradition that is called Sterkstroomdispuut, an association we have tried to make bigger with our efforts.

We hope to see you soon at one of our activities!

On behalf of the board of the Sterkstroomdispuut,

Rik Wilmer
Treasurer of the SSD board 2015

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KERSTBAL VERSIEREN 10:30 - ETV

WO 16 DEC
VLEXCURSIE 9:30 - ETV

DO 17 DEC
LINKEDIN WORKSHOP 10:45 - Zaal J
/PUBQUIZ 19:00 - /Pub

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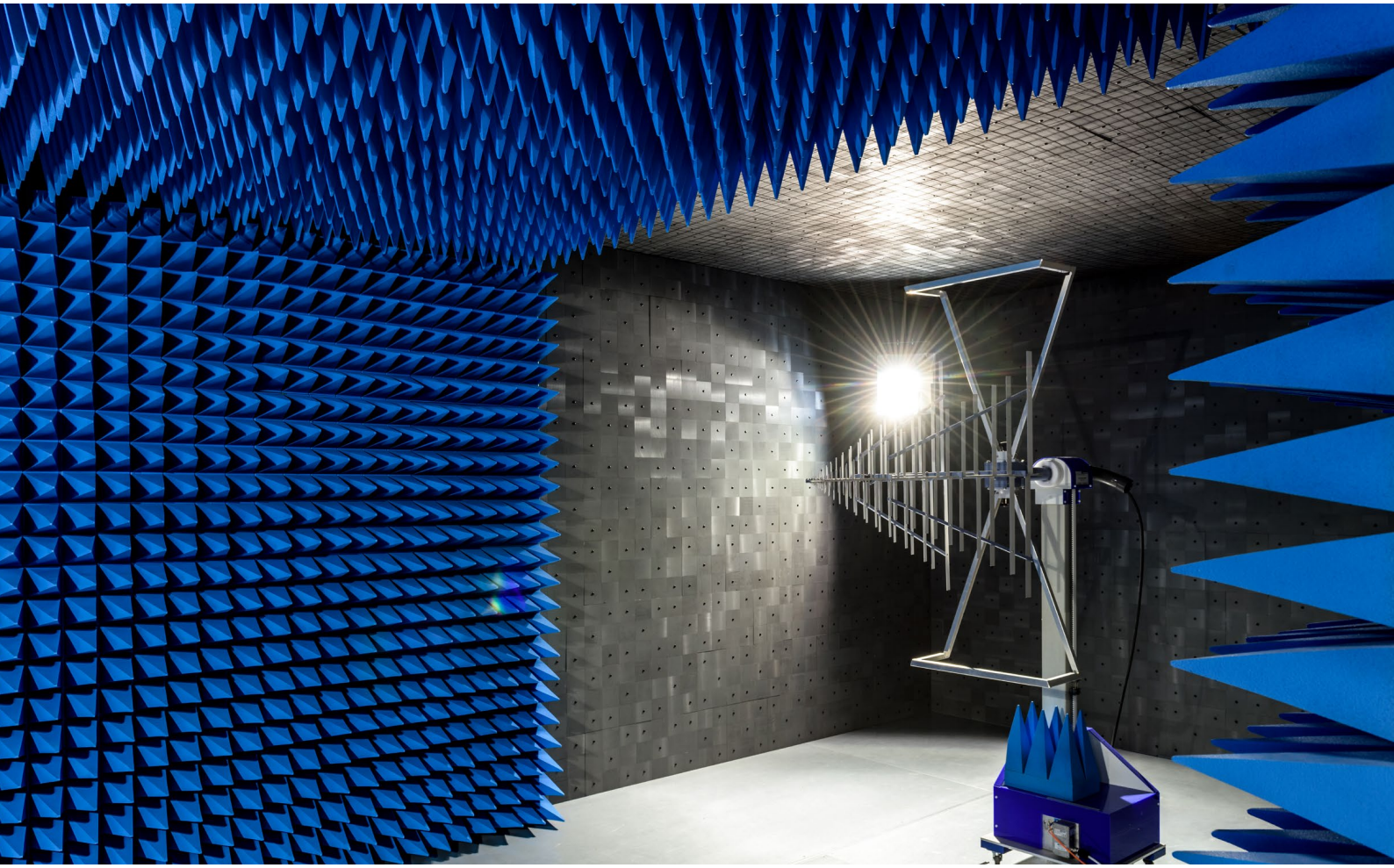

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Faculty Student Council

Facultaire Studentenraad

Ludo van den Buijs

Every academic year a new Faculty Student Council (FSR) is elected by the students of EEMCS to represent them within the faculty. On of the means to keep students informed of the activities of the FSR are articles in the Maxwell. This edition we'll discuss several key points of what we'll be discussing the coming year.

Contact with students

In order to effectively represent students it is important for us to keep in touch with the students themselves. This entails that we keep students informed, e.g. via the Maxwell, but also that we ask you for your opinions. We'd like to pursue this via organised feedback moments, for example with coffee outside of the lecture halls.

Motivation

Studying at the TU Delft is challenging and requires a strong motivation. For many students staying motivated is a challenge. The FSR wants to look into this problem, together with the educational board, and see what the cause of the problem is, and what possible solutions could be.

Grading deadline

It is important for students to receive proper feedback on their work within a reasonable amount of time. A limit has been set on the time a teacher is allowed to take. Though setting this limit is a good step, it isn't properly upheld. The FSR wants to pursue a stricter regulation of this deadline, while making sure the quality of tests isn't affected.

Evaluation student assistants

Projects form an important part of our educational programs. The proper guidance of student assistants is important for the quality of these projects. The quality of the assistants frequently varies, with various student assistants delivering subpar guidance. The FSR wants to look into this problem and set up an evaluation system for these assistens in the coming year.

Naturally, these subjects don't cover the entirety of the subject we will cover the coming year as FSR. Furthermore, we find it important to look into problems students run into themselves. Please don't hesitate to contact as at fsr-etv@tudelft.nl or by talking to us directly when you see us.

ETV Activities

Elektro Ontvangst Weekend

By Merlijn Stokvis

The EOW : the best start of your student career anyone could wish for! Let's start with the plain and simple, the EOW is amazing! It's like a cruiseship heading for an unforgettable start of your student career while in an ocean of new interesting people. Or an evening full of intoxicating music fused with beer from the piano beer tap that opened 10 a.m.* Music that was made by great stories from awesome activities. Activities like building the EWI with all the electronic crap people want to trade you, or running over inflatable obstacle courses while crashing into the ground because people couldn't handle all the hair gel they had to twist there hands in.

***Disclaimer:** During the EOW no brain cells were harmed. Quite a lot were instantaneously killed though. To be honest, when I enrolled for the EOW I hadn't the slightest clue of what to expect, but I think that's the beauty of it! When everybody goes in open-minded it's quite easy to meet new people. And because everyone wants to have a good time you make it a good time together. Overall, The EOW equals a jolly good time and now I've done it and actually know what it's like to go to the EOW, I wouldn't want to miss it, or my new friends, for anything in the world.

Eerstejaarsexcursie kernreactor

Door Karen van der Werff

Woensdag 7 oktober stapten we met zo'n 20 eerstejaars op de fiets voor een interessant bezoekje – we gingen op excursie naar een kerncentrale! Deze centrale is onderdeel van de TU en wordt alleen gebruikt voor onderzoek – hij is dus wat kleiner dan normale centrales, maar dat was eigenlijk alleen maar fijn. Dat betekende namelijk dat we veel meer konden zien! Na een presentatie over de werking van de reactor, de verschillende onderzoeken die er gedaan worden en de veiligheidsmaatregelen, werden we in groepjes rondgeleid door de centrale. Naast een hoop onderzoeksopstellingen en ingewikkelde apparatuur, kregen we ook de reactor zelf te zien, terwijl deze in werking was! Op hele charmante sloffen stonden we naast de reactor, die zich in een diep zwembad bevond. De laag van 20 meter water die ons van het radioactieve materiaal scheidde, was genoeg om de straling tot een acceptabel niveau te beperken. We konden dus veilig de reactor bewonderen, en dat zag er heel gaaf uit! De Tsjerenkovstraling die vrij kwam gaf het ezen echte sci-fi look – voor de geeks: het leek op Marvel's Tesseract! Het was heel interessant om te zien hoe het er in zo'n centrale aan toe gaat en we hebben een leuke ochtend gehad. Na een check op eventuele contaminaties konden we daarna genieten van een warme kop chocomel – het was een geslaagd tripje!

Lustrum Activities

This year the ETV celebrates her 22nd Lustrum. A variety of activities are planned this year. Every quarter the ETV will organize a week full of excursions, parties and workshops. This Lustrumyear wouldn't be the same without the spectaculair opening of the year. In collaboration with the faculty the new Tellegen hall is officially opened with a talk from dean Rob Fastenau, a barbecue and a party with live music from ETV-members. In the first Lustrumweek a few activities were organized such as bubblesoccer, a CV workshop and the next activities:

Groot dictee der ETV

By Declan Buist

On the Thursday evening of the first Lustrum week, the most important evening for any ETV'er, "het Groot dictee der ETV" took place. A spelling contest for engineers, success was inevitable. There were some nerves here and there before the start of the event and people already started creating excuses.

Under guidance of the calming voice of Bart Kölling participants struggled with words like: 'spring-in-'t-veld' and 'brogues'. Luckily, when the doubts of where to place hyphens or whether to write words together became a bit too much, Ralph was always there to discretely refill your glass of wine, a much appreciated help.

When the examination had finished, everybody was relieved and assessed their performance. Even more excuses than before could be heard. While everyone was making sure the excess wine would not go wasted, the jury retreated to correct the participant's work. Anxiously the participants left to the /Pub to await their fate.

Then the jury returned with their final results. As much as >60 errors were made by the worst performer (he did not receive a consolation price for this), but more surprisingly there were 2 candidates for the top spot, myself and Sjors Nijhuis. After 5 nerve-wracking elimination words, I was happy to come out on top to claim my price, a beautiful pen and the title of "ETV dictee winner".

I think this evening taught us that despite we are in Delft and study to become engineers, a little more attention to our linguistics skills can't hurt.

Duinrell weekend

By Lotte Zwart

On the 9th of October began what was to be the final activity of the first lustrum week of the ETV; the long anticipated " Duinrell " weekend. Starting from around six in the evening on Friday, members started arriving and all the 'gezelligheid' was on. The planning that evening was joining the karaoke to present our impeccable singing capabilities, but unfortunately the Duinrell pub had already closed around 11 pm. The next few days we got to enjoy every part that the park had to offer. We had a go in almost every ride, and yes that is including the kiddie rides, and to top it all off we also had free passes for the Tikibad. Whereas the park mainly focusses on small children, the Tikibad offers slides for people with a child-like mentality but a physical body that is somewhat disproportional to their mentality i.e. students. On the second evening (Saturday) we re-attempted to participate in the activities organized by the Duinrell pub. After having a few beers in the pub, we learned that the activity of the evening was bingo. However, after receiving the news that in order to join in a bingo card had to be purchased for 10 euro, we as poor/greedy students decided it would be more fun to gather in our rented cabins and hold our own game night. This resulted in a snug evening filled with card games. All in all, the board has outdone itself organizing this weekend and it was a great success. Onwards to the next three activity filled lustrum weeks!

Microelectronics Caseday

By Fjola Osp Snaevarsdöttir

To begin with, the last Caseday of Microelectronics was held on the October 7th, 2015. Some weeks before the event hangouts and advertisements were visible on campus. Sign up for FREE and win a drone it said. Undoubtedly not the main cause of attending, but also was it the exciting lecture and possibility to do something different with the theoretical knowledge.

At first we attended guest lecture from both Intel, Intel Imaging and Camera Technologies Group, and ASML. Very informative lectures about their companies and goals but also the research and projects going on, giving information about future opportunities and possibilities. Lectures about imaging processors, multicore, 5G and Lithographic machines just to mention a few.

Finally the cases were then presented. Giving two different projects for the Bachelor and Masters students. The Master case consisted of coming up with a new solution to clean wafer tables. Different from the current technology, which uses stone. After lunch working on solution to our case with guidelines from ASML employees.

So to conclude, at the end of the day, after some exciting lectures, problem solving time and presentation the Caseday had come to an end. Closing off with anaward ceremony with drinks. The Caseday gave a experience which unquestionably be of use in the future, wether it is research work or in our careers. Therefore hopefully more opportunities for attending Casedays, connected to our study, will be presented.

Promotion flyer

2nd Period

Sintlunch - *Friday December 4th*
Saint Nicolas will come to the Netherlands and will bring a visit to the ETV during the lunch. A special lunch will be provided.

Christmas lunch - *Friday December 18th*
The day before the Christmas holiday Santa Claus will visit the /Pub and tell a Christmas story during a special provided lunch.

2nd Lustrumweek - *week 2.6*
The second Lustrumweek with a few activities is organized in the week of December 14th.

Motibo - *Monday February 8th*
The third period will start with a drink in the /Pub to review the second period and the winter holiday.

Excursions
During the second quarter of this academic year, the following excursions are planned:

- TenneT - *Friday December 4th*
- TNO - *Tuesday December 15th*
- Tata Steel - *Monday February 8th*

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