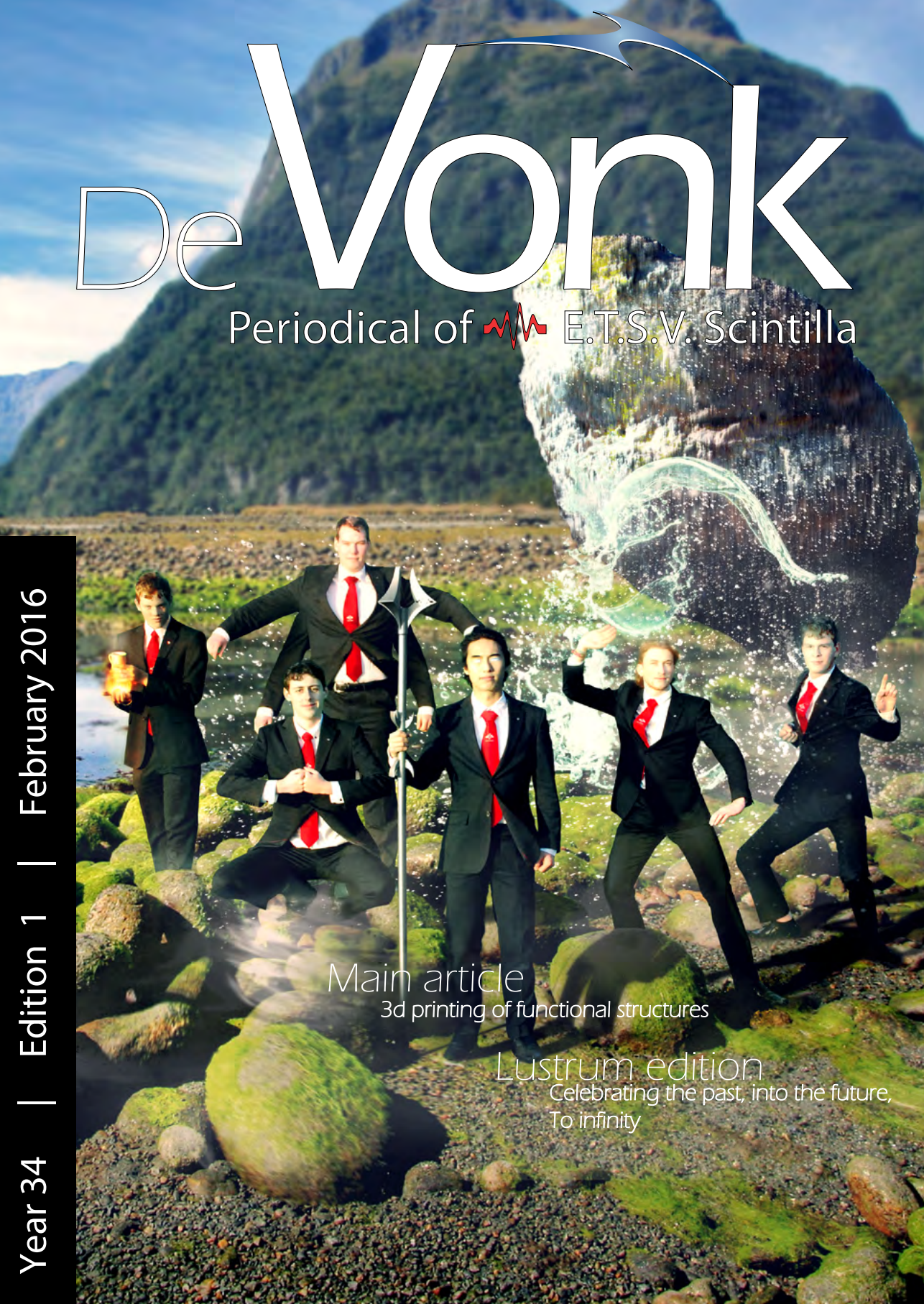


De Vonk

Periodical of E.T.S.V. Scintilla

Year 34 | Edition 1 | February 2016

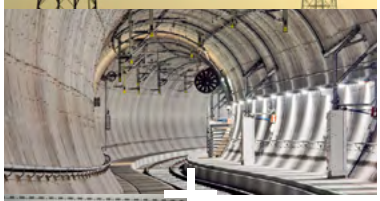
Main article

3d printing of functional structures

Lustrum edition

Celebrating the past, into the future,
To infinity

Witteveen + Bos



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Presidential note

Author: Shing Long Lin

Dear members, as you may have noticed, this first Vonk is a little bit later than usual. This might be partially due to me, as the trees were of a nice Scintilla-red colour when I started writing this presidential note, but now that I am finishing it, there are only a few leaves remaining on the rather bare trees. But as the trees turn bare, my collection of memories and stories from my board year only seem to grow.

When you read this note, I might already be halfway through my board year. The first year students who are building their solar inverter may have noticed that making electronics work also requires some magic. The second years will have almost finished one of the most challenging quarters of our course but will also be working one of the cooler projects we have: building an autonomous hovercraft. The third years, well they will be close finishing whatever adventure they have chosen for their minor and be on their way to wondering about what to do after their bachelor.

Most of us are busy with more than just education though. I myself for example thoroughly enjoyed Scintilla's activities the last couple of months. Once every five year we celebrate a very special birthday with a month of activities and this year I had the pleasure of experiencing this spectacular event. Starting with a visit from the 1st board, followed by a month full of activities and concluded by a magnificent gala, it was a month that will be in my memories for a long time. A good opening note combines a few internal events and some recent events into a nice piece which is interesting, makes one think and elicits a chuckle now and then. Unfortunately, my isolation in the Scintilla room has somewhat dampened my knowledge of any newsworthy items (which, I have to note, is primarily my own fault by the way; I get distracted easily, especially with the abundance of long stretched discussions going on here). I can however report on the status of the things I can see from my comfy desk chair here: a new coffee bar has opened a few meters from here, the pair of scissors has gone missing and for the weather, we don't open the windows as much anymore, so I think it has been getting colder. I guess taking a walk outside now and then would be a good new years resolution.

To the new year!

Dames en heren,
Op de koningin, op Scintilla!

Shing Long Lin
President

11-Bierentocht
woensdag 17 februari
17:30, Abscint

MILFBA
donderdag 18 februari
18:00, Abscint

91st Cantus Scintillae
donderdag 25 februari
20:00, Abscint & Educafé

Scrapheap challenge
vrijdag 15 april
20:00, Educafé

Masthead

De Vonk

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Most people consider 3d printing as a creative hobby. the TST group however see it as a key technology for technological progress in the medical world, robotics and even aeronatuics and astronautics! In this article a nice presentations of the almost endless posibilities of 3d printing will be given.

This year is a lustrum year for Scintilla, and not just any lustrum, but the 50th lustrum! In this Vonk we take a look at some activities organized so far to celebrate this anniversary, like the gala diner and the actual Dies.

Things have changed with the Vonk you are reading right now. To give an impression of how we came to this new format, we made a trip to the press for you! Here we got information about the old fashioned and the digital version of printing and the new way of printing which made this Vonk the way it is.

In this junction Mark Bentum, director of the study electrical engineering, talks about his experience as a student, a teacher, and a director. He also talks about his home life and other interesting and fun things to know.

Editorial

A new year

2016, the year after the Scintilla Lustrum, working on a Vonk with a perfect new design: smaller and better. Whilst writing this article, I sit next to one of my lovely committee members who is swearing on the articles which refuse to adjust to the new lay-out.

But more about last year, and the plans for this year. Last year a lot went on: I studied, broke my ankle and studied less. I tried to give the first years a terrific camp during the Kick-In, created my own type of Puck in the theatre show Midsummer Night's Dream of Shakespeare, and of course did a lot more. As you all know, the Scintilla-lustrum was also in 2015, which meant a lot of activities, with a lot of fun, laughter, and drinks.

After the Lustrum, December started. And we all know of December, the most expensive and stressful month of the year. Sinterklaas, Christmas, and new year. All fun activities, but all costly due to shopping, presents and timewise due to the traveling.

But what about 2016? First off all I would not want to break my ankle again, and I am not going to think of all the stressful days in December at the moment. I am also not the person who makes all kind of new years resolutions, but for this editorial I will try to think of some things I would like to achieve or accomplish. On of the most important things is getting some nice ECTS. Sadly, this has proven to give me some trouble. But who can blame me? I just like to do fun activities with friends.

Guusje

education

Three years into TOM

Author: Niels Leijen

More than three years passed since TOM (Twente Educational Model) started at the university and a lot of education related changes have been made. The main startup implications are resolved and the rest of the still apparent problems are being dealt with. But what is actually still going on behind, apparently, closed doors?

Why TOM?

Three years ago TOM started as a fresh new method of teaching students the materials they needed to know in order to get their bachelor's degree and with that the necessary knowledge that an electrical engineer needs to know. For many the change to TOM was seen as a ridiculous one and one that would make student activism impossible.
Yet the truth may be told why the university actually started to implement TOM.
TOM was mostly advertised as a great new way of teaching students, and as a showpiece for the UT, but getting extra students was not the real reason TOM was invented. The main reason for TOM being that students took too long to finish their studies and the three years that were scheduled for the bachelor became mostly four, five or more years, with only a handful actually getting the degree in time. This was not only a problem for EE but also for other studies at the university. Under pressure of the Dutch government the university had to make drastic changes in order to keep the status of university and so TOM was invented.
Of course it was not that simple and alternatives where discussed, but it seemed that the change that was necessary had to be big and therefore TOM came out as the best option.

What is happening now?

Now that TOM has been here for over two years, to most students it may seem that everything will stay the same. Yet the study is still far from perfect. Therefore there are multiple instances in the university that talk to each other in order to solve any problems that pop up, to keep the study up to par.
Scintilla itself is also a part of this web of instances and has influence by using organs like Scintilla's educational committee, also known as the StOEL. One of the board members is specifically assigned as commissioner of educational affairs. Furthermore there are some members of Scintilla in the URaad, which is the organ which has authority within the university and regularly speaks with the University Board.

What are they and what are they doing?

Let's start by explaining the structure a little bit more, since it's quite complicated. Each module has a module coordinator and has a team of teachers below them, where every teacher is assigned to a different part or subject of the module. This can be the project, math and/or regular EE subjects. The teachers of the subjects then form said part and, assisted by PhDs and student assistants, make sure that it is taught properly.
The educational committee, named the OLC, overlooks if all is going well and tries to steer it into the right direction again if it's not. In order to do this the educational committee comes together about once a month and talks about the problems that pop up. They are also responsible for the education and examination regulations, in short often called the OER. The StOEL, the program director and some more teachers are all part of this group.

What is happening now?

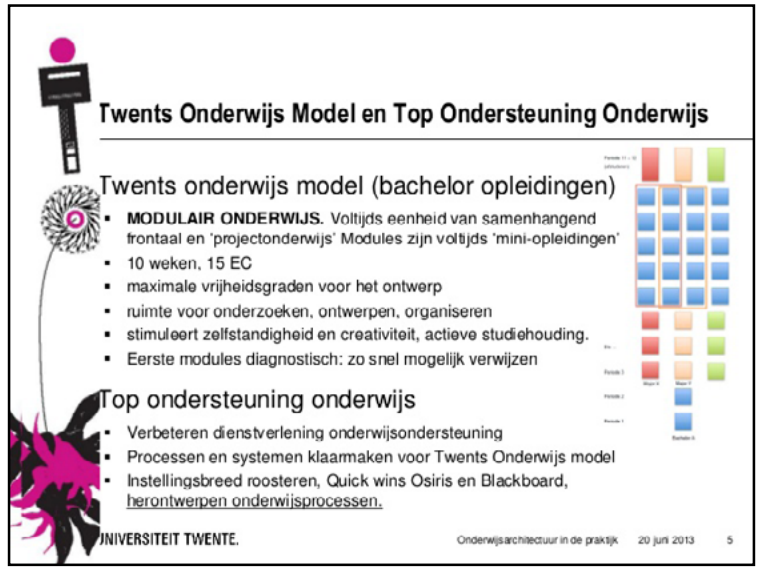
Now that modules 1 and 5 are finished, 2 and 6 have started together with some minors. The 1st and 5th module went pretty smooth, but as long as I have been on this university (and probably even long before), the 6th module has been one of the most difficult modules in the bachelor and therefore always has been giving problems.

What changed?

The things that the educational committee together with the module coordinator, program director, StOEL and staff changed in comparison to last year, and thus differ from this one, are the following:
In module 6 there was a problem with the material and the availability of the teacher of the subject control systems. The StOEL concluded this and passed it on to the teachers first, but this didn't give the result that they were looking for and therefore it was passed further on to the educational committee. Although it could not be fixed in the same year, this subject is now going as smoothly as it should be going.
Furthermore some of the subjects covered in dynamic systems (ESD) are now removed, such that the 3ECs that are given for this subject use 3EC worth of time and not 6EC. Moreover the tests are changed from a multiple-choice to open answer test. This is done so that if one understood the material but made a calculation error, one would still get some points for understanding of the material.

> "Less than 10 percent of the students in the 6th module would pass if nothing was changed.

Although these things have been implemented this year, there are still some problems with this subject. The biggest one seems to be that there are no tutorials and therefore a lack of practical knowledge. The program director asked the teacher about this and the main problem seemed to be a shortage of people who can give these tutorials.
After the first test StOEL concluded that the lack of practical knowledge was so bad that theoretically less than 10 percent of the students in the 6th module would pass if nothing was changed. Therefore the StOEL asked members of Scintilla to organize some extra lectures with tutorials and extra homework problems that can be solved in order to master the material and gain the required knowledge of an electrical engineer.
Because the results of the tests are not known yet as of when I wrote this article, I cannot conclude the effectiveness of this. But it seemed that the students who attended this lecture now at least get the basics of dynamic systems. Now that new lectures are being organized as I write, I am sure that the material will be better understood and with that, the grades of the test will go up and result in a humongous passing rate for this subject.



What to expect later in this year?

Most of the problems that occur during one module can be solved in the same year, but some take a little more time. Therefore evaluations, and a lot of them, are being distributed over the students. These are being used to make the module even better next year.
For example in module 8, which is coming later in this year, the workload for the students (and some teachers) was just way too high. Therefore the educational committee decided that some parts just had to go. Since the rest of the module was quite alright, this will probably be the only big change in this module. The effectiveness of this change will be clear later this year, but I am looking forward to the result.

News for the electrical engineer

In previous editions of the news we searched the internet for interesting information. This time we decided to get news from a lot closer, and asked the various research groups closely related to Electrical Engineering at the University of Twente to send in articles about their own research. In this section you will read about the doings of the research groups which sent in content. A special thanks to them for cooperating in this!

The Kelvin probe as a new type of reference electrode for electrochemical sensing

Author: Yawar Abbas, Researcher at the BIOS lab on a chip group, University of Twente.

For the first time the chloride ion concentration in electrolyte is measured using a Kelvin probe. For a long time now, the Kelvin probe has been used for measuring work function in gas sensing applications and surface potential microscopy. Recently, this instrument has also made its way to electrochemical sensing.

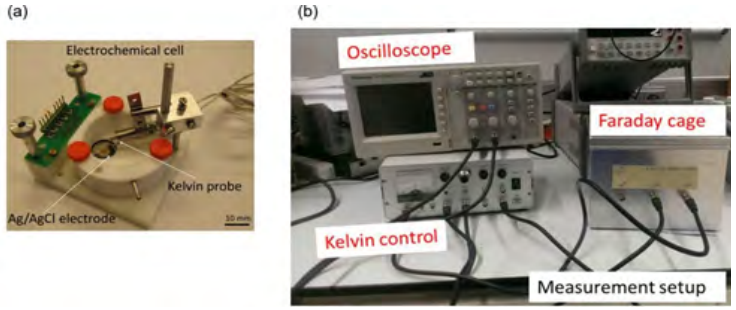


Figure 2: (a) Snapshot of the electrochemical cell along with the Ag/AgCl electrode chip and the Kelvin probe (b) Snapshot of the measurement setup, Kelvin control is used to apply backing potential and signal to vibrating probe, oscilloscope is used to monitor the CPD. For measurements, the electrochemical cell is placed in the Faraday cage.

The Kelvin probe, which is basically a parallel plate capacitor, is well-known for determining the work function of a surface. One plate of the probe (reference plate) vibrates over another plate (sample plate). The distance between the plates changes periodically due to the vibrating plate and thus the capacitance changes repeatedly, generating an alternating current (AC). This current can be reduced by applying a potential in reverse polarity, also called the backing potential, in the circuit. The value of the backing potential, VB, at which the current is completely nullified, is equal to the potential difference between these plates, also known as the contact potential difference (CPD). Now, if the reference plate is in an inert environment, i.e. its work function is stable, and the sample plate is in the electrolyte, the change in CPD is a function of the change in the electrode potential of the sample plate. In this experiment

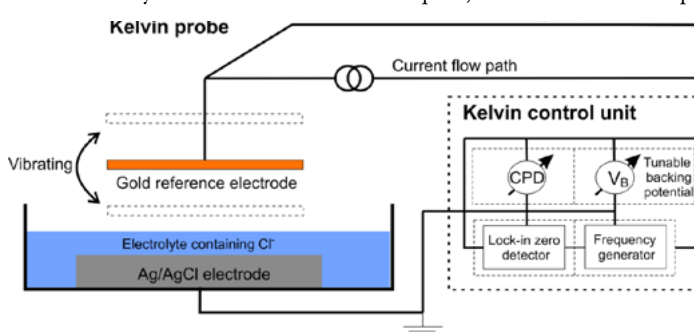


Figure 1: Schematic of the working principle of the potentiometric measurement using a Kelvin probe

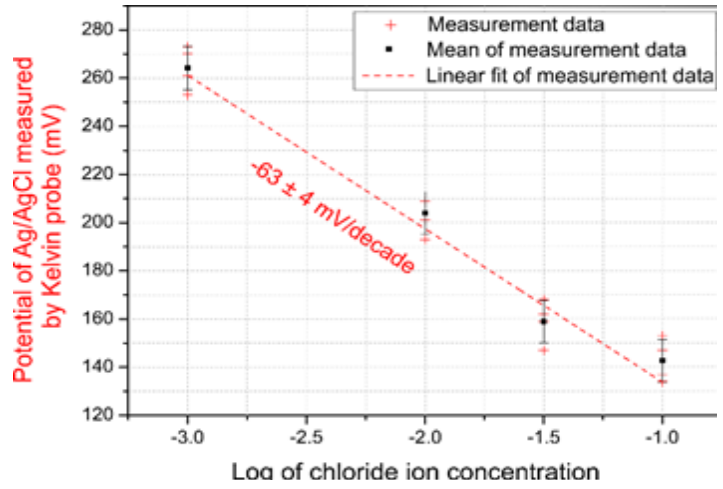


Figure 3: Calibration curve of the standard potentiometric measurement. The open circuit potential of the Ag/AgCl electrode w.r.t to a liquid reference electrode is plotted against the logarithm of the chloride ion concentration.

a silver-silver chloride (Ag/AgCl) electrode, which is a chloride ion selective electrode, is used as a sample plate in the electrolyte and the Kelvin probe is used as a reference plate that is vibrating above the electrolyte, see figure 1. The electrode potential, also called open circuit potential (OCP) of the Ag/AgCl electrode is a function of the Cl^- concentration. The measurement setup is shown in figure 2. There is no contact between the reference plate and the electrolyte. The contact potential difference (CPD), measured by the Kelvin probe, gives the OCP of the Ag/AgCl electrode i.e. measuring the chloride ion concentration in the electrolyte, see figure 3. This approach opens the possibilities for using the Kelvin probe as a contactless reference electrode in electrochemical measurements. Chloride ions are one of the major contributors to degradation of reinforcement-concrete. The presence of these ions initiates pitting corrosion in the reinforcement steel and ultimately results in the failure of the structure/construction. For electrochemical measurement of chloride ion concentration in concrete the limiting factor is the stability of the reference electrode. A solid state contactless reference electrode such as the Kelvin probe can be used for long-term in-situ measurement of chloride ion concentration inside concrete.

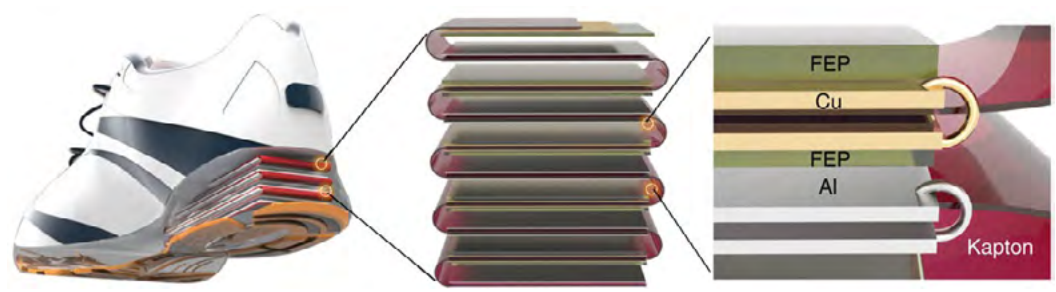
Self-charging biomechanical system

Researchers at the Georgia Institute of Technology, have developed a universal self-charging system to harvest energy from random biomechanical movements. As human biomechanical energy is characterized by fluctuating amplitudes and low frequencies, it is difficult to effectively harvest electrical energy from these movements. This group has developed a system to harvest this energy based on a tribolectric nanogenerator, a system that works by physically manipulating two materials with opposing surface charges, a power management circuit and a energy storage device. This device provides continuous dc energy at 7.34W/m^3.

Source: http://tinyurl.com/vonk3411

Driving on metal

A reserach group based at McGill University have proposed a way to replace fossil fuels with a metal particles.
Prior research at the group showed that metal powders suspended in air allow a flame to be sustained similarly to organing gasses, which results in the metal oxide as waste product. As there is a miriad of techniques to turn metal oxides back into metal powders, this appears to be a sustainable way to transport energy.
The proposal is to create a prototype burner that can burn a stock of metal powder to generate heat for an external combustion engine. The waste oxides can then be collected again and recycled.
Metals might have a lower specific energy (kWh/kg) then fossil fuels (see picture), but they excell in energy density (kWh/l). Combined with the ready availability of Iron oxide, the metal proposed for the prototype, makes metal a better fuel than dinosaurs.
source:http://tinyurl.com/vonk3412



main article

3D printing of functional structures

Author: Gijs Krijnen
TST Group

Transducers Science and Technology

The technology colloquial known as '3D printing' has developed in such diversity in printing technologies and application fields that meanwhile it seems anything is possible. However, clearly the ideal 3D Printer, with high resolution, multi-material capability, fast printing, etc. is yet to be developed. Nevertheless, one can already start to wonder what possibilities for electrical engineering applications will become available in the near future. Here I try to give a brief and balanced overview of current developments and a few examples of the first small steps towards 3D printed transducers.

Introduction

By now, anyone that has some interest in how things are made, and who has not been hibernating in his cave, will have heard something about 3D printing, or more posh 'AdditiveManufacturing'. Actually, the latter term is quite descriptive, especially when put opposite 'Subtractive Manufacturing'. Bluntly put, many classical fabrication methods are characterised by removing material from a given chunk of material, e.g. by milling, eroding, abrading, grinding, etc. In additive manufacturing, on the other hand, parts get shaped by adding tiny amounts of material to a developing form. For example by jetting small clods of material, by solidifying particles by a highly focussed laser beam, by excreting a long, thin wire and dressing it nicely in place, much like a glorified glue pistol, or by using thin sheets ofmaterial (e.g. paper), cutting them in the right shape and putting them on top of each other (much like the 3D post-cards that keep youngsters busy for the better while of a birthday party).

What all 3D printingmethods have in common is that structures are built layer by layer froma digital description of the object. It can be shown mathematically that such a method can built any kind of 3D object, not withstanding gravity and other deal-breakers [1]. The amounts of material added are tiny with respect to the overall scale of the object to be made, but in absolute terms this may mean something completely different when e.g. talking about 3D printed concrete houses [2] or about the sub-micron voxels solidified by two-photon stereo-photolithography in a Nanoscribe 3D printer [3].

The technology behind 3D printing can be classified in 7 main fabrication-types [4], each with numerous members differing somewhat from manufacturer to manufacturer (if not for a difference in quality, then at least to circumvent intellectual property rights). With each of the 7 methods comes a range of printable materials, minimum feature sizes, physical properties, etc. A brief overview of these methods and printable materials can be found in [5]. Some examples of (to be) 3D printed objects are shown in Fig. 1(a)–1(f).

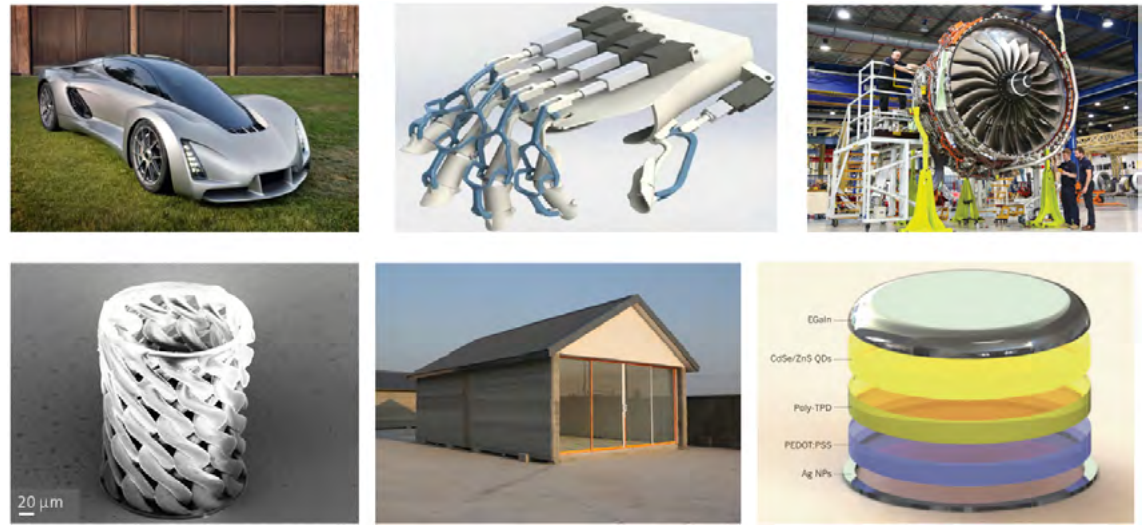


Fig. 1: A few examples of 3D printed objects. (a) The 3D printed car 'Blade' by Divergent Microfactories. (b) CAD drawing of a 3D printed hand exoskeleton for rehabilitation purposes [6]. (c) Rolls Royce uses 3D printing for engine parts [6]. (d) Stent like structure printed by stereophotolithography. Note the scale bar. [3]. (e) House printed by the Chinese company Yingchuang. (f) CAD drawing of a 3D printed LED [7]

3D printed objects everywhere. Really?

With so much press coverage 3D printing is hot, and likely overhyped. So we could safely put it aside and concentrate on other things, e.g. what to do during the European soccer championship this summer, how to found the next internet blockbuster company, etc. But this would be beside the reality as much as assuming that everything will be printed in the near future. Let us look at some of the bare characteristics of 3D printing:

- *Enabling*: things which can't be made by any other method, because of their inherent 3D nature or the range of materials that can be used seamlessly, may in principle be made by 3D printing [1].
- *Limited use of materials*: In 3D printing you only need material to add to the object and virtually there is no waste, like e.g. with milling. Even in powder-bed based printing most often the powder not used in a print can be reused in the next.
- *Integration*: functional and structural parts may bemonolithically integrated.
- *Metamaterials*: like with chemistry and nanotechnology 3D (multi-material) printing may enable new meso-scale material properties. Think of pseudo piezoelectric materials, negative poison ratio materials, anisotropic thermal conducting materials, host loaded printable materials (e.g. with quantumdots [7]), etc.
- *Mass customisation*: objects can be customised on a per device basis, just by design (e.g. 5 different sensors for 5 different robotic fingers...)
- *Adding value*: think of smart packagingwith integrated functionality (sensing, stress-release, overpressure protection, etc. of Si dies, or other components, inside)
- *Prototyping* can be extremely fast.
- *Fabrication can be speeded up* since no tooling is required. This is especially valuable for industries that operate on small series markets (aerospace industries, robotics, medical devices (surgery, prosthetics)) where tooling costs would forma major part of the total costs.
- *Crowd-sourced brainpower*, since AM is based on digital designs they are easy to distribute and share and therefore one can benefit from a large intellectual effort (compare open source software). Also benchmarking materials, processes and equipment is relatively straight forward.
- *On the fly quality control* using camera's or other near-field-metrology produced parts can be directly compared to the geometrical design specs. Material faults can be monitored. Performance testing, of course mostly, requires off-line approaches.

Sure enough the above may sound much like preaching to the choir. And indeed, while the above is true in principle, actual practical fabrication can be hampered by:

- *Lack of resolution.* Although various printing methods can deliver print resolutions from sub-micron

1: Not withstanding the z-weakness, some companies claim really large strengths and even replace metal part by printed carbon fiber and Kevlar [8].

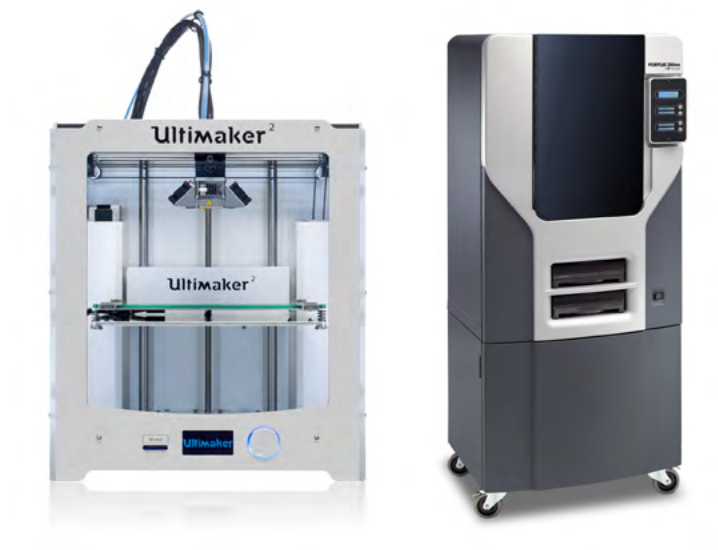


Fig. 2: (a) Affordable desktop 3D FDM printer. (b) Professional 3D FDM printer.

to millimeter size, none have both a high resolution and a large build volume. Limited resolution also may result in large surface roughness, excluding specific applications.

- *Lack of printable materials.* Not all materials can be printed, limiting the range of what can be made for specific purposes (other than the bling-bling and smart-phone covers).
- *Mechanical properties.* The mechanical properties of most printed objects showlarge anisotropy as the layer by layer deposition basically introduces structured inhomogeneities and associated variations in virtually every physical property of the material. Noteworthy is the problem of reduced strength in the z-direction, i.e. the direction perpendicular to the layers, due to limited adhesion between the consecutive layers. [1]
- *Need for support structures.* Although any object can be 3D printed in principle, gravity may require additional internal and/or external supports. These need to be co-printed with the object from a second source and need to be removed afterwards. This removal may pose its own limitations to the printed object.
- *Lack of reproducibility.* Many of the more affordable 3D printers and used materials have limited environmental control leading to limited reproducibility of the printed parts. Good reproducibility is generally only obtained by far more expensive professional machines.
- *High per part cost.* 3D printing is mostly competitive for single or small series products. The advantage is that no tooling is required and lead times can be extremely short. The disadvantage that the time needed to print a product is relatively long, certainly compared to techniques like moulding, spray-casting, punching, etc.,making 3D printing less suitable for large series products.
- *High energy consumption.* The technology has much to offer but this comes at a price of using (far) more energy than for regular fabrication, for example moulding.

Ok, so 3D printing may not be the holy grail, but it certainly has produced some imaginative products and solutions. Let us have a look at some of the developing application fields.

Medical

In the field of medical applications 3D printing has been shown to deliver very attractive solutions for problems that require ultimate customisation: prosthetics. There are plenty of examples of fingers, hands [9], lower and upper limbs that have been printed to be functional, aesthetic and well fitting the body. Also, some of the artificial hip and knee replacements are nowadays 3D printed. Dental applications form another important field where 3D printing forms a cost
effective alternative to hand made artificial tooth for example. The use of 3D printing technology for the fabrication of mock-ups of body parts to allow surgeons to visualise, prepare and train for operations is yet another example.Meanwhile some of these applications havematured quite significantly and lead to large economic activities. E.g. have a look a the medical page of the website of the Belgian additive manufacturing service Materialise [10].
More scientifically driven, 3D printing is investigated as a means to print human tissues [11] or scaffolds on which natural tissues can grow optimally. Think of veins, cartilage, etc. And by extension of the concept of tissue printing one also findswork on printing of entire organs [12,13].
A Stanford group lead by Zhenan Bao [14] has developed artificial skin in the form of thin layers with printed electrodes and organic transistors which transduce pressure signals into frequency modulated digital pulses. It was subsequently shown in vitro that these pulses could optically stimulate optogenetically engineered mouse somatosensory neurons. Obviously, the developed technology would also be interesting for robotic applications.

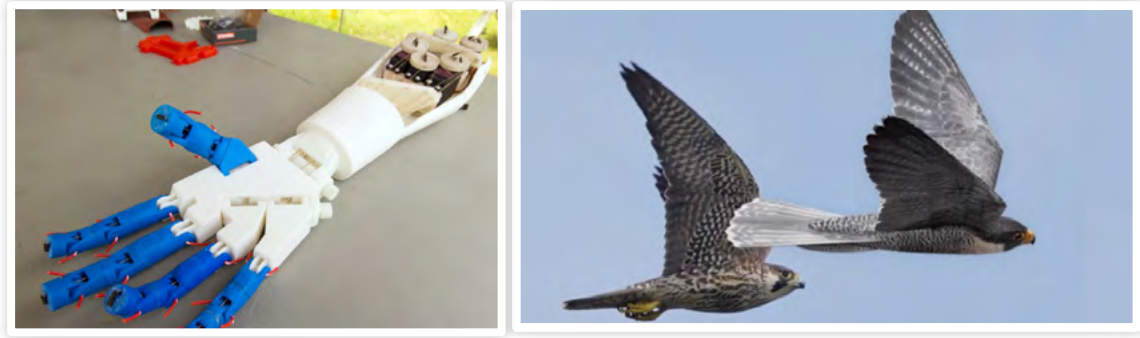


Fig. 3: Left: 3D printed robotic hand, from [15]. Right: 3D printed 'RoBird' from Clear Flight Solutions

Robotics

In robotics 3D printing has been adopted quite well, especially in research environments; just have a look at all things printed in the Robotics And Mechatronics group of our own EE faculty! The technology is interesting since it allows for a sufficient large materials selection for the envisioned purposes, for the free formfabrication of structures, some of which cannot be made otherwise (at least without assembly) and delivers results with very short lead-times. On the transductive side, integration of sensors starts to be addressed increasingly, where medical and robotic applications sometimes almost merge. I.e. an orthosis (exoskeleton) to assist in patient movements may come close to a robotic part as far as function and hardware is concerned, though the required control may differ significantly.
Particularly interesting from a design point of view is that 3D printing allows for a strong degree of biomimetic design. Now, not only can principles from nature be used in robotic designs, but even the used shapes can be virtually recreated. The 'RoBird', developed by Clear Flight Solutions, is a nice example of the latter.

Aeronautics & astronautics

Until recently mostly plastic printed parts, for non flight essential purposes, found their way into airplanes. Think of parts around the windows, seats, etc. The main advantage here is the high strength to weight ratio that can be obtained by freeform structures. Metal printing processes increasingly help to move 3D printing into flight essential parts. Rolls-Royce has developed the XWB-97 engine with some large titanium parts printed by electron beam melting (EBM). The part measures no less than 1.5 m diameter times 0.5 m thickness! New Zealand based Rocket-Lab has developed the 'Electron' and 'Rutherford' rocket engines that contain mostly 3D EBM printed metal parts, amongst them the most essential ones.

Fig. 4: Left: 3D printed bearing housing of a Rolls-Royce XWB-97 engine [6]. Right: the 'Rutherford' rocket engine developed by Rocketlab [16].

The 3D printing hype

So, overrated expectations on the one hand and some tangible demonstration of 3D printing possibilities on the other hand seem to strive for equal attention. Gartner tried to make some sense out of all of this by projecting the technology against a maturity model [17]. In this model some applications of 3D printing are still well before the 'expectations peak' of the hype, to which I happily dedicate the printed transducers of

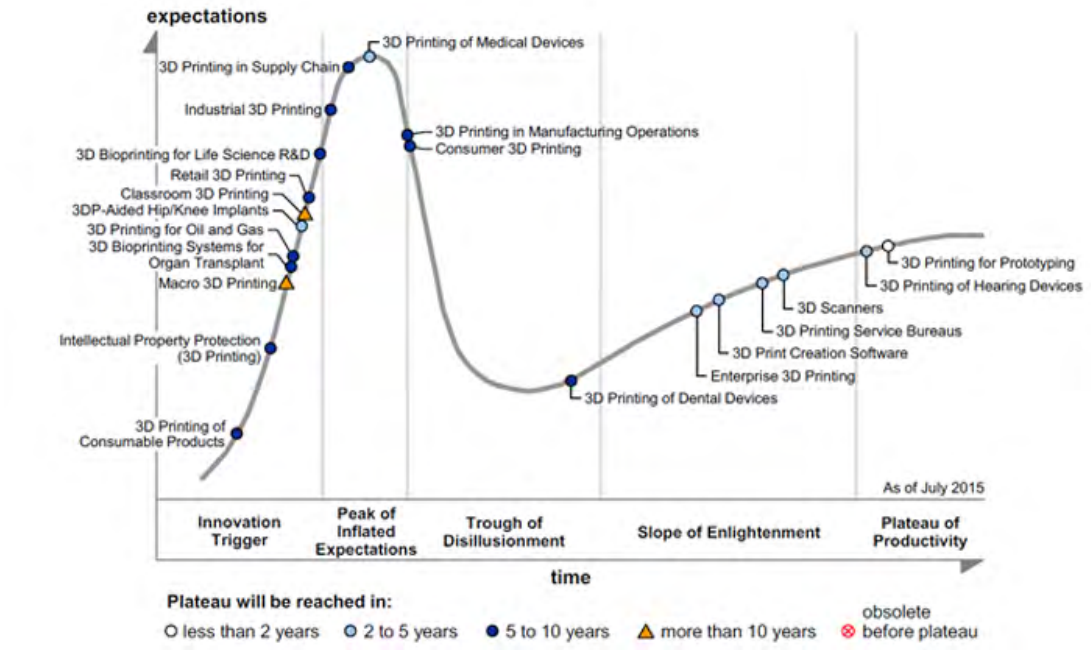


Fig. 5: Maturity model in the analysis of the 3D printing market according to tech research company Gartner [17].

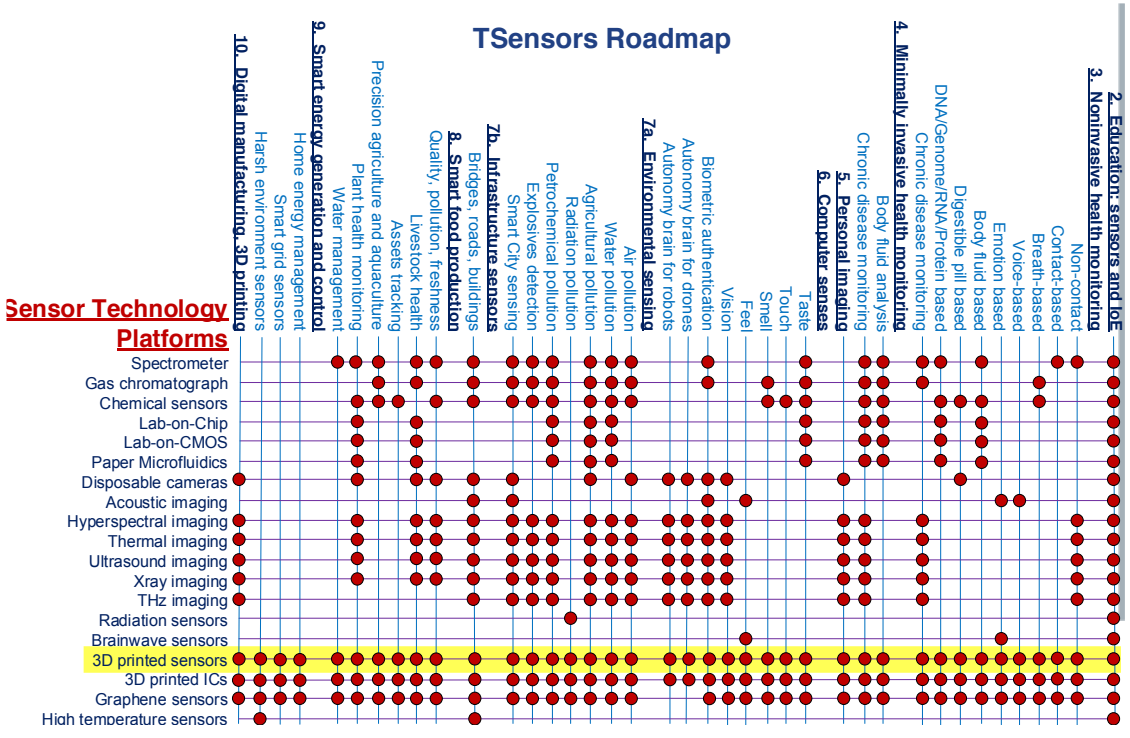


Fig. 6: The sensor needs versus fabrication technologies matrix as produced by the Trillion Sensor Roadmap group, from [18]. Yellow marking by the author.

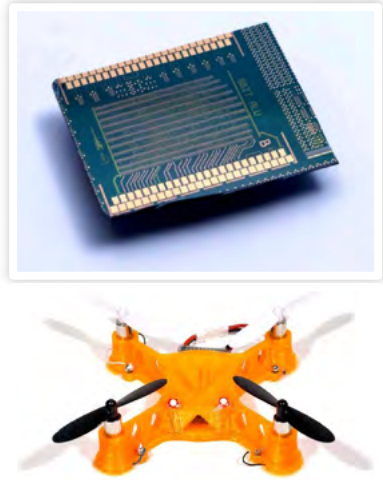


Fig. 7: (a) An 8 bit electronic digital processor with printed-programmable memory by TNO. (b) A quadcopter with included electrical wiring printed by a Voxel8 printer.

this article as well, whereas others have reached a more stable expectation plateau. In the report Gartner emphasises the scale and speed by which 3D printing is being introduced in the medical world, leading to (too) high expectation, but also stresses that the fabrication of customised hearing aids and dental products by 3D printing has already firmly settled. Knee and hip replacements are expected to become mainstream playground for 3D printing due to positive trials and the scale of the market. For a variety of applications the graph indicates the current maturity with respect to 3D printing opportunities. Clearly, some are ahead of the curve andmay be overhyped, but others have become mainstream in their respective markets.

Printed electronics and transducers

The internet of everything & 3D printing

Over the last two decades computing and communication has seen an incredible development. With the internet in the palm of our hands it is hard to believe that it is only 15 years back that Google was founded! And sure enough many more developments are still ahead of us. High expectations about the future connectedworld have been condensed in catchy phrases like The internet of things or even The internet of everything, Industry 4.0 and Real computing[2]. What all these concepts have in common is that they heavily rely on a variety of sensors to obtain information from the environment, machinery, humans, engines, etc. This has led a consortium of people engaged in sensor research and development to think about the future of sensor fabrication. Considering the age of abundance[3] they predict that somewhere between 2020 and a few years later the number of sensors employed in our smartphones, cars, utility devices, environmental sensor networks, medical equipment, etc. will exceed accumulatively a trillion sensors. Hence they have aptly called themselves the Trillion Sensors Roadmap group. Organising various summits on the topic they have drafted a roadmap [18] in order to assess the future needs for sensor as well as to address their fabrication. Interestingly, the resulting matrix shows 3D printing to be thought capable of fabricating sensors for all applications. So this poses the question: 'how will 3Dprinting become a viable technological platform for transducers?'.

A technology preceding 3D printing is, of course, 2D printing. Although this is an entire subject of its own, it is interesting to see howmuch meanwhile has become possible with printed electron ics. Probably one of the most imaginative examples is the work by TNO. They have demonstrated an 8 bit electronic digital processor based on organic transistors with inkjet print-programmable memory [19].

Obviously, 3D printing of electrical and electronic structures is nowhere near as developed as to where silicon technology or even printed circuit board technology is nowadays. However, there is a, for those anticipating, slow, but certain development of technologies for the printing of electrically conductive

Table 1: Overview of resistivities of some conductive (print) materials

Material	*Resistivity* (Ω m)
Copper	16.8×10^{-9}
Graphite	10×10^{-9}
Solder	0.05×10^{-6} to 0.20×10^{-6}
Silver based ink [20]	0.5×10^{-6}
F-electric PLA [22]	7.5×10^{-3}
Blackmagic PLA [23]	10×10^{-3}
Proto pasta PLA [24]	30×10^{-3}
Warwick work PLA [25]	96×10^{-3} to 126×10^{-3}
Conductive ABS [26]	100
Insulators	10×10^{15}

2: Meaning that whatever we have in the shape of digital designs in our computer can take on real shape using digital fabrication methods like additive manufacturing, CNC, etc.
3: Abundance is the termto denote that fabrication of products will become increasingly cost-effective, productivity growing faster than the world populations demand such that all products will become in reach of each person on the planet.

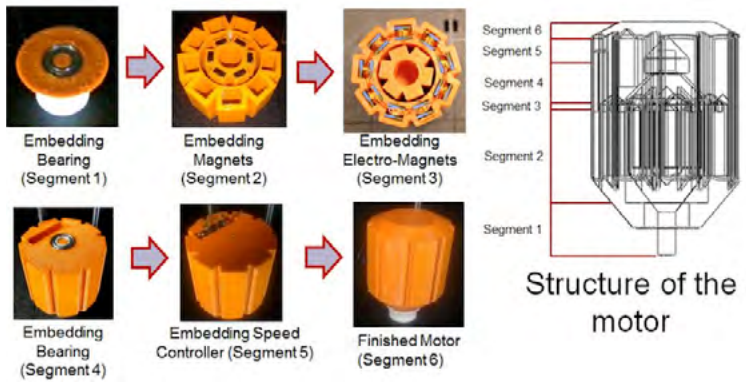


Fig. 8: Various phases in the 3D printing of a motor. After each phase some parts are embedded (from [29])

materials. Some are based on doping of well-known print materials like polylactic acid (PLA, an organic environment friendly and bio-degradable material) or acrylonitrile butadiene styrene (ABS, the stuff that Lego bricks are made from). Other manufacturers design and market printers and materials that are specifically meant to print conductive inks, mostly based on silver particles. E.g. Voxel8 [20] is such a start up. In their commercial material they show how a quadcopter is made by a stop-and-go print process, i.e. the printing is stopped various times to embed electronic components but the electrical wiring is by 3D printing of silver ink.

Recently researchers from Berkeley have devised a process in which they use sacrificial material, i.e. they print with (at least) two materials, one of which is non-destructively and selectively soluble after printing [21]. Once the sacrificial material is dissolved they impregnate the resulting channels with silver particle based ink and let it solidify. They show that it is possible to use this technology to make LC-tank oscillator type sensors for measurement of the dielectric constant of dairy products.

In printing of electrically functional structures one of the important points is the conductivity of the electrodes, see table 1. Obviously, low conductivity does not allow for high current densities since Joule heating will destroy the electrodes. This implies that actuation is going to be hampered. However, sensing generally requires far less power and therefore is still possible. Comparing the different solutions for electrically conductive printing we can observe that the range of conductivities is large.

Clearly standing out is, of course, copper. Reason for theMacDonalds group of the University of El Paso to concentrate on a different approach. In their 3D printed electronics work they use robots to lay down tracks of copper by a robot in a stop-and-go process [27,28]. This way it is even possible to 3D print motors [29], cube sats, electronic dice, etc., admittedly using some assembly as well.

3D printed transducers

In the Transducers Science & Technology group we conduct research on 3D printed sensors. The idea is that to start making sensors one only needs the capability to print structural, dielectric and conductive materials. By allowing structures to be deformable a transductive operation is obtained. This way one can easily envision e.g. piezoresistive, capacitive, magnetic and other sensors.

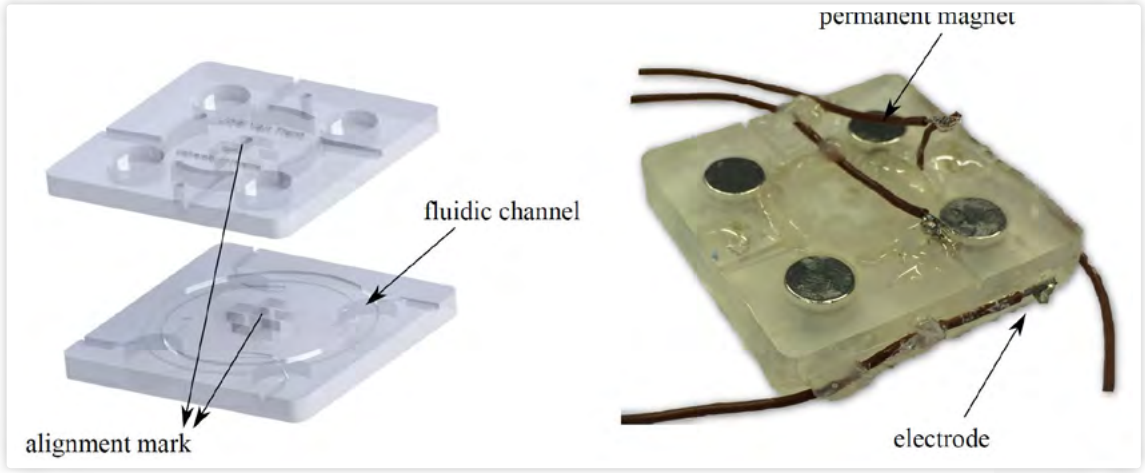
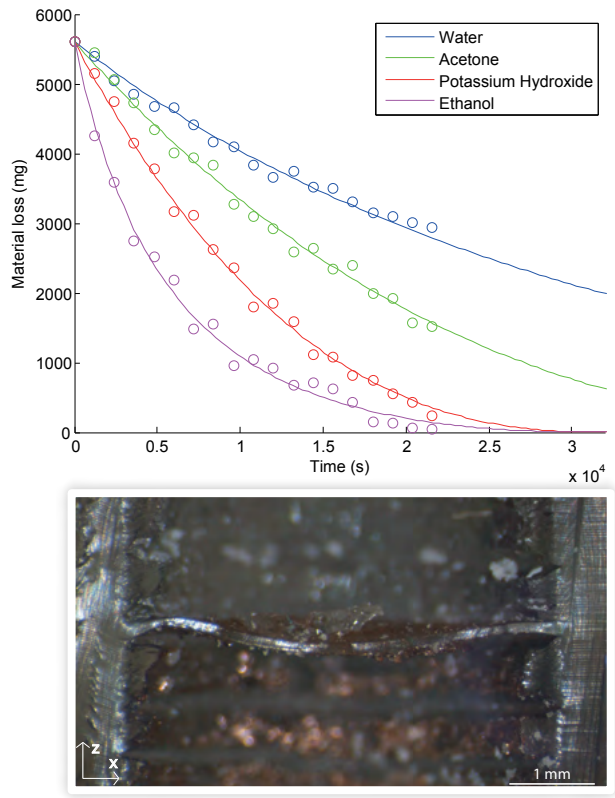


Fig. 9: (a)Design of the two separately 3D printed parts that formthe sensor (left) and the assembled sensor (right). (b) Voltage as a function of angular acceleration.



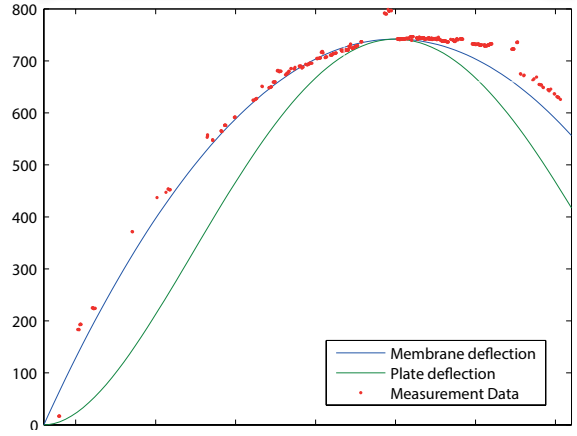


Fig.10: (a)Material loss for Fullcure 705 support material forWater, Acetone, PotassiumHydroxideand Ethanol. The dissolution process can be described using the Noyes-Whitney equation [32]. (b)Cross-section of a 112 &mmembrane under optical microscope after gold deposition and slicing. (c) Measured membrane shape under a uniform load of 300mbar (red dots).

Angular acceleration sensor

In the MSc. work of Joël van Tiem we have investigated a biomimetic angular acceleration sensor inspired by the vestibular system, as found e.g. in mammals and fish [30]. The sensor consist of a fluid filled circular channel. When exposed to angular accelerations the fluid flows relative to the channel. Read-out is based on electromagnetic flowsensing using the pseudoHall effect by means of the ions in the moving fluid in combination with manually assembled magnets. The sensor is made out of two 3D printed parts which, when put together, form a channel and which allow for easy mounting of the permanent magnets and electrodes to measure the flow induced potential difference. Experiments indeed showan acceleration dependent output voltage.However,we find strong contributions from other than electromagnetic sources which, due to their nature and magnitude, are interesting for further research.

Printing of intricate structures

In an another project we have investigated the 3D printing material jetting-process for the fabrication of intricate structures [31]. Normally, any required support material is removed by brute force water jetting. We investigated the chemical dissolution of Fullcure 705 support material
while minimally affecting Fullcure 720 structural material. From several solvents ethanol turned out to be the best with respect to selectivity and dissolution speed. We found that the dissolution process can be theoretically accurately described by the Noyes-Whitney equation, implying that the development of various structures can be predicted quite well. The fabrication process was used to make various 5 mm diameter membranes, ranging in thickness from 112 to 768 μm and their mechanical performance was characterised, see Fig 10(c). The theoretical shapes for membrane (blue) and plate (green) behaviour are compared with the shape of the realised membrane that was pressurised by 300 mbar (red dots). Clearly the structure behaves like a membrane.

2D force sensor

For robotics and rehabilitation purposes, the sensing of interaction forces, torques and pressures on soft materials that

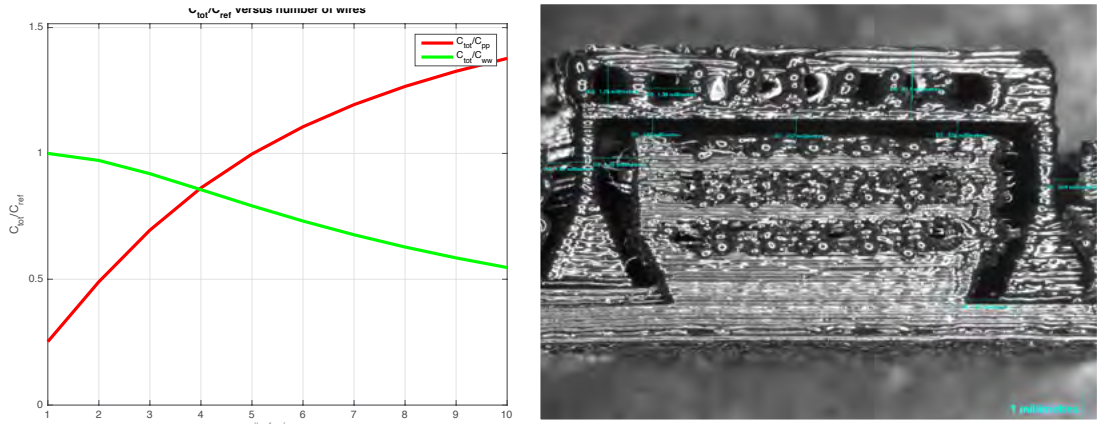


Fig. 11: (a) CAD rendering of a proposed 3D printed 2-DOF force sensing system. (b) Normalised capacitance versus number of wires for a structure of 10mm x 10mm size, a gap of 2mm and a wire diameter of 1mm. (c) Fabricated prototype sensor parts using NinjaFlex FDM material and a MakerBot Replicator 2 3D printer.

stretch on movements are required [33]. To this end, initial investigations are underway for embedded sensing using novel commercial flexible elastomer materials such as NinjaFlex [34]. In order to create normal and shear force sensing with one device, a multiwire structure is investigated, such as that in Fig. 11(a). Using elementary expressions [35], for the electrical fields of pairs of oppositely charged wires, it is possible to calculate the capacitance of collections of wire pairs. The results are shown in Fig. 11(b) and indicate that even for a wire density of only 50%, a capacitance of 85% or more of the fully dense (parallel plate) capacitance can be obtained. This is an important encouraging result for fabrication methods where both high wire density and continuous metal sheet embedding are challenging.

With a fully characterised sensor model (Fig. 11(b)), a multilayer wire capacitive system was designed within a 3D printed structure. Initial proof of concept structures were fabricated from a variety of materials. Materials such as ABS, NinjaFlex, and ULTEM 9085 were used in the fabrication process in order to determine the optimal correct stiffness, filling factor, and printing density. Initial results show a softer material such as NinjaFlex (Fig. 11(c)) may prove to be the most compatible with this sensing system.

Conclusion

If you have made it to here, I hope by now you have a somewhat better overview of sense and nonsense of 3D printing. Hopefully you have gotten excited about future possibilities, meanwhile appreciating the challenges that lie ahead of us in terms of technology that has to be developed, device principles that have to be investigated, etc. To materialise any of the high expectations on 3D printed transducers, much research still has to be done, luckily!, as it provides for ideas for research grants, bachelor and masters projects and exciting future applications. Some of the research that is going to be addressed in the near future in the TST group:

- *Technology*: Selection of the most promising print technologies and materials. Understanding, modelling & application of the various AM technologies for transducers research.
- *Single material printing*: Form-fidelity, adhesion, anisotropy, materials properties, small structures (e.g. membranes), etc. need to be understood, modelled and optimised
- *Multi material printing*: The extension to using multi-material prints implies many additional question regarding form-fidelity, adhesionbetween dissimilar materials, optimisation of printing conditions, differences in layer thicknesses, etc. that will cause undesired topological features, stress, anisotropy etc.
- *Conductive material printing*: How can we get sufficient conductivity while still keeping the conductors small, flexible, etc.? What to do with anisotropic conductivity. With respect to external interfacing we need to sort out how to connect printed conductive materials to e.g. platinum, copper, solder, silver-ink or glue, etc.
- *Printed transducers*: Once the above challenges have sufficiently been addressed we need to use our imagination to optimally use the free-formcapabilities to make new, exciting transducers, characterise them, etc.
- *Systems integration and application*: Of course, one of the promises of 3D printed transducer is to embed them in other structures, RoBirdwings, robotic hands, hand protheses, etc. where they will be exposed to mechanical/thermal loading, fouling, chemical attack, etc.

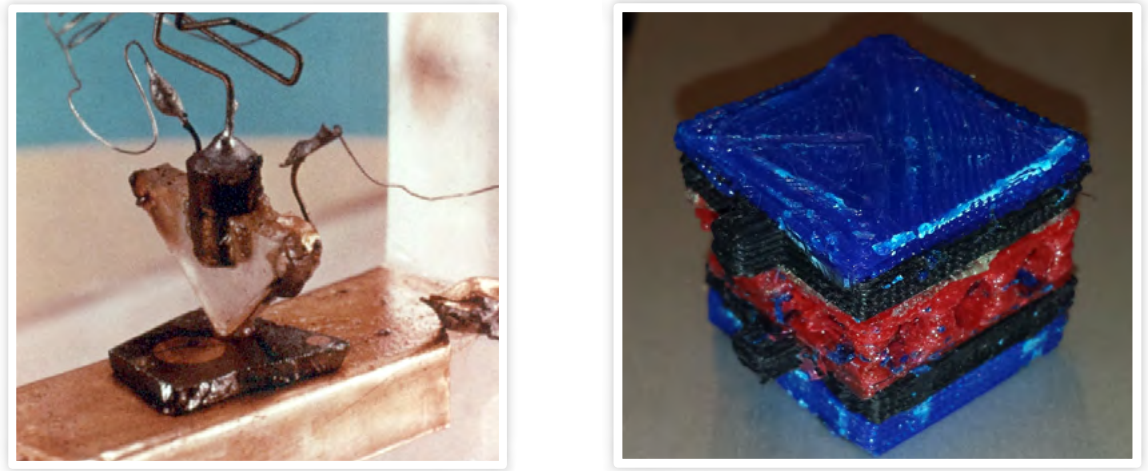


Fig. 12: (a) The first transistor, invented in 1947. (b) A printed, bulky capacitive sensor, 2015.

All in all, it is clear that exciting things become possiblewhen merging 3Dprinting with electronics tomake transducers. At the moment this seems challenging but there are sufficient indications of progress in the 3D printing landscape to start this endeavour now. And, lets face it, who would have been able to predict the course of semiconductor development when confronted with the first transistor?

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Symposium

Author: Jippe Rossen

As part of the festivities concerning our fiftieth birthday, a symposium was organized. On the 15th of September seven companies visited the university of Twente to do a presentation for 130 knowledge hungry electrical engineering students. The symposium committee started organizing this event almost a year before. Six dedicated Scintilla members took up the task to present some food for thought in a month full of fun.

The day started at 8:30 with some coffee and tea with a piece of cake (not to be confused with Scintilla's piece of cake committee, SPOCK). After a word of welcome by our host Mark Bentum, Bruco kicked off the day with a presentation on 'Live streaming on Planes'. In 45 minutes they presented how the data consumption of people increases tremendously and how technology is supposed to keep up with the need for information. They presented an implementation of a high tech antenna system, that would allow for fast WiFi on planes.

After a 5 minute break Nedap continued the day with a presentation on how they could contribute to the information age. They are currently working on a way to identify RFID tags in every possible product. They developed a scanner that could read up to hundreds of tags a second!

Before ASML started their presentation there was some time for some muffins and a discussion on the previous topics during a nice cup of coffee. Then ASML presented their latest technology on creating extreme ultraviolet light, by vaporizing small particles of mercury. The last presentation in the morning was from Astron/IBM, which was about some serious computing power produced by the new generation antenna arrays to scan the universe. Easily reaching the ten exabyte of data every day (!).

During the lunch, some fresh sandwiches were served. As we did not want to waste any time to fill with our guests with information, Arcadis, Dialog and NXP provided them with some gadgets and answers to every question they might have had.

After the lunch there were still presentations from NXP, refreshing some knowledge on die hard electronic subjects such as ADC's and Phase Locked Loops. Technolution explained about their progress on a revolutionary way of designing digital hardware using their own HDL compiler. At last Dialog closed the presentation session with a talk about how their smart sensor fusion is applied in wearable devices such as activity trackers.

After a whole day of inspiring talks, everybody was desperate for some relaxing and set themselves to a nice cold drink. For those who also signed up for dinner, a great meal of spareribs was awaiting for them at the faculty club. Thanks to all the companies involved and other parties who made this day to such a great success.

Dies reception!

Viriday!

Elysium!

Camp!

Gala!

The 86th board

Author: The 86th board

The formation of a new board is an important issue for an association. Selecting a group of candidates filled with enough people capable of and especially willing to run the association for a whole year is not always an easy task. Also getting these people to like each other enough to actually last the whole year is not even possible to do every year. After a long recruitment process during the academic year of 2014/2015, the 85th board of Scintilla invited five people over for a dinner. After this dinner, where only a surprisingly small amount of time had to be spent on serious matters, this set of people had a whole different outlook on their upcoming year. They had found their calling in the running of the new board and they had found the people to complement themselves in running Scintilla for its best year: The 86th board was born.

Shing Long Lin

President

Unlike some of the other board members, I was not seen as an obvious board candidate by many people. After our candidate board presentation, quite a few surprised people noted that they had hardly seen me around before. They were not wrong in that observation however. Although most of my friends were active members, I had not started doing things for Scintilla until I started the skiing committee in my third year (and even still, with only one committee, my committee tally, might be the shortest one among this board). However, I aim to show my face around this year, get to know as many people as possible at Scintilla and fully redeem myself as a true Scintillian with my board year.

Live your life to the fullest; a good phrase to live by. As such, I have tried to keep myself busy during my student life. In my first year I tried rowing in the 'wedstrijdploeg', which, although I gave my all, was not a huge success and soon I traded rowing competitively for pouring my efforts in getting my BSA again. Soon however, I got an itch for doing something extra again. This is when I started teaching students, helping to prepare them for their high school exams at trainings, something I am doing with joy until this day and probably will be doing for several more years. The next year I felt ready for a new challenge again, after I had gotten the now retired propedeuse. Thus I became part of the Greenteam Twente, working on the hydrogen powered UTMotive for the race of 2014. After that I spent my time with more teaching, now at an actual high school for the teaching minor and with my hobby's, playing volleyball and various other sports.

As a board member, my schedule has not exactly become less crowded, but I don't think this is a bad thing. On the contrary, I like being busy all the time and as the president I am able to be just that. Apart from my duties as the commissioner of external affairs, a post shared with my vice-president, I am free to take care of all day-to-day affairs that come up or come by in the Scintilla Room. The post of President was the post I had seen myself fulfilling even before I had met the rest of the board. This is because I often quickly take the lead, but also because I think I am able to have oversight in the many affairs in which Scintilla takes part. Managing the external affairs is something I did not choose at first, but it is a job that I have come to appreciate. The regular contact with all sorts of companies has given me insight in the possible futures for an electrical engineer and it's a nice challenge to create possibilities for companies to present themselves whilst giving the students a nice experience. All in all, it is an experience very different from the normal student life, but I am already very happy for being allowed to do this!

Erik de Groot

Secretary

Of the entire board I may have been the last person to officially decide to join the 86th board of Scintilla. This is mainly due to several setbacks during my second year of study and financial uncertainties. However, I have wanted to be a board member for quite a while despite it costing a year of the study. The main question was whether I would do it this year or next year.

I started studying Electrical Engineering in 2013. The main reason I chose this study is because of how applicable it is, as the thing I enjoy the most about it is being able to make your own electrical system that works. I make my own projects from time to time, such as an amplifier or a stroboscope. The mathematical part of the study I have struggled a lot more with however. Besides the study I have been an active member at Scintilla since the first year, when I was a member of the freshmen-committee, which was a lot of fun. In the second year I helped organize the introduction camp of Scintilla as a member of the kick-in committee and you may find me behind the counter as a member of the STORES.

This year I am the Secretary of the board of Scintilla. I took the opportunity because I wanted to learn other things that the study itself does not offer. These things include being better at organizing, taking responsibility, and writing with more nuance and finesse. And of course I joined the board because it is a great experience where you get to meet a lot of people and the things you do are very rewarding.

Gerolf Meulman

Treasurer

As most of you already know, my name is Gerolf Meulman and I am the treasurer of Scintilla this year. I was born in 1994 in Nieuw-Amsterdam (Drenthe). Since 2012, I study Electrical Engineering here at the University of Twente.
I decided to join the board of Scintilla more than a year ago. First, however, I wanted to finish my Bachelor. So I did, and this year on my birthday, September 11, I received my bachelor degree during the graduation ceremony.
In my first year, I was not an active member at Scintilla. I attended a lot of activities, but did not join any committees. Only in my second year I discovered how awesome it is to become an active member at Scintilla. One of the committees I joined was SKIC. After being a do-group parent for ELco 10, I was asked to join SKIC, which was really fun. In my third year, I joined the BHV committee, which means that sometimes I will be the Emergency Response Officer at an activity. I also became the treasurer of the Lustrum committee.
At this moment, I realize how difficult it is to write something about myself. Writing a huge report about Electrical Engineering related stuff is quite easy compared to writing a tiny piece of text about yourself. Anyhow, let me continue a bit more.
Besides being in the board of Scintilla, I will also be doing some other things this year. For example, in the second quartile I will be a student assistant for the second module (Electric Circuits). At this moment, I am a Master student at the Telecommunication Engineering chair. In the third and fourth quartile I will probably also start actually doing some master courses.
But for now, I will continue doing money related stuff as the treasurer of the 86th board of Scintilla.

Nick te Velde

Internal Affairs

I am Nick te Velde, 20 years old and 3rd year student Electrical Engineering. Now can I start with answering the standard questions, so that those are out of the way. First of all: yes, my favorite color is (of course) PMS185C. Before I joined E.T.S.V. Scintilla it already was red, so it just became more specific. Furthermore, my soldering iron also has a name: Eva.
Now that those two important questions are answered, let me continue with really introducing myself. When I started our great study I of course went to the Kick-In, which I found out to be simply amazing. Especially Scintilla's camp was something I really loved, with the dropping and the cantus. During the Kick-In, I made some good friends, with which I did a lot of stuff in and outside of Scintilla.
During my first year, I joined the Parents day committee, to organize a day for (as the name implies) the parents of all first year students. I really enjoyed it, especially watching the parents trying to measure and calculate an RC-filter, and trying to solder something. Afterwards there was a dinner and drink, where all the parents said we organized a great day. This gave me quite a good feeling, which is probably one of the reasons I decided to continue being active in Scintilla. At the end of the first year, I decided that I really liked the Kick-In the year before and that I wanted to be a do-group parent. No sooner said than done, I became a do-group parent for Elco 11. During this Kick-in I had again a great time, so during my second year I decided to join more committees.
Since I loved the Kick-In for two years in a row, I decided to have another go at it, so I joined the Scintilla's Kick-In committee, also known as the SKIC. Furthermore I joined the Borrel, since I was often at the drinks organized by Scintilla and wanted to try to tap at the bar. With this, my active life at Scintilla has been treated. This is of course not the end of my 'career' at Scintilla, since I am a part of the board now. In the board I have the function of Commissioner of Internal Affairs. This means my responsibility is that all committees are working correctly, our members become active in Scintilla and come to the activities Scintilla organizes. Furthermore I am a part of the SBZ, Stichting Borrelbeheer Zilverling. This means I am responsible for a lot in and around the bars in the Educafe. My task there is purchasing the drinks, beer, cleaning supplies, etc.
As my task is to try and get as much members to our activities, and I am a member of the borrelcommittee, I will probably be found talking to members often, and at Scintilla's amazing acitivites. I hope to see all of you there, so come find me at the borrels of Scintilla and have a drink with me!

Eelco Bussink

Administrator

As an alleged "oude lul", the choice to become an administrator and thereby board member of Scintilla was (maybe) disputed, and not the least by myself. But, since Scintilla has been great to be a member of, a board sided view was an easy enough choice. To finish this already way to long introduction, being an administrator as opposed to a full time board member would impact my desires of finishing my bachelor by a lesser degree. So far, not much has been said. Maybe my efforts for making this easy to read are already futile, after just the first sentence. For which I am not extremely sorry.
Of course, I could write excessively about my history, how I was born (something with my parents having a stork delivery service over), but that is not interesting. Until the time I went to the university, I played soccer, but, after problematic limb structures and driving into a truck, that's off the table. Now, my focus is on lifting weights, putting them down, and mountain biking. Occasionally you will find me training my liver at the Abscint, an activity in which you may always accompany me.
As you can read, the material I am writing about is not that interesting, so maybe a story about Charlie the Unicorn can lighten things up a bit. A trip to candy mountain will be a trip to heaven, for your mind remember all the times you have been up there with Charlie. Perhaps you can take a quick thought about all the hours you have wasted watching Master Movies, which in my mind are very nostalgic. Let's hope at least a few readers of this little introduction are now tempted to watch Charlie the Unicorn or Master Movies again.
I will not limber on with this introduction for much longer. The easiest way of telling who you are or getting to know a person is by, well, meeting in person. If you really want to get to know me, come to have some coffee with me and then we could talk about random stuff like Charlie the Unicorn, Master Movies or some frustrating bureaucratic facts. This concludes my introduction, and as Einstein once said: "The difference between stupidity and genius is that genius has its limits."

Niels Leijen

Vice President

Hello everybody! My name is Niels Leijen and currently in the third year of the study Electrical Engineering. This year I am one of the board members for the 86th board of Scintilla and will fulfill the role of commissioner of educational affairs, so if you have any (study related) problems, feel free to come to me!
Of course I did not join the board by accident (how can you even do that I wonder?). Before joining the board I already was an active member of Scintilla and I joined multiple committees like the Parents day and after that, during the Kick-in, I have been one of the do group parents of the best do group imaginable, aka Elco11. This was so awesome that I decided to join the SKIC, which organized this years intro camp. After a while, probably during one of the so called borrels, I decided that it could be fun if I did a year of board and here I am.
As Commissioner of Educational Affairs, I try to make sure that your study goes smoothly. I do this by attending all kind of meetings (which all have great abbreviations like: OOC, OLC, StOEL, OPEL and more), talk with staff members and other study associations, and all this in order to address all kind of study related problems.
Furthermore the first year students will likely also meet me in the fourth module of this year, since I will probably be one of the student assistants for fields and waves (again...)! Here I will serve, observe and try to help you the best I possibly can to make the best antenna as possible and of course have fun.
Well I think that is in short my life in the 86th board of Scintilla. I hope that this board year will become superdupahcool and finishing on this bombshell, I wish you all farewell and don't forget to have fun during the rest of the year (and after)!

Setting course for a hydrogen-powered victory in 2016

Author: Friso v.d. Boom

Green Team Twente is a student team which develops and builds a fuel-efficient hydrogen car. They have been competing in the Shell Eco Marathon since 2011. The first race was a great success, and the team went home with the first prize. Since then the competition has ramped up rapidly, forcing the students to push the limits of innovation.

Starting point for 2016

Pushing these boundaries can lead to difficult problems, especially with regards to system reliability. This has cost the team, due to technical difficulties (and sometimes just a little too much bad luck), the chance to complete any attempt at the Shell Eco Marathon for two years in a row. The goal for this year is to build on the knowledge of previous years to make a more robust system, whilst still innovating enough to stay ahead of the competition in terms of fuel efficiency.

Team photo of the 2016 Green Team

The new team

Stepping up to the challenge is a group of 16 students. The team consists of five electrical engineers, four mechanical engineers, three industrial designers, a chemical engineer, an advanced technology student, a creative technology student, and an international business administration student. This list quite clearly illustrates the multidisciplinary approach of green team. This approach not only helps bring in a great deal of knowledge, but also expands Green Team Twente into a university-wide effort.

The team will also work together with the members of the previous team to transfer previously gained knowledge, and ensure previous mistakes will not be repeated.

The new challenge: London 2016

This will definitely be necessary, since the Shell Eco Marathon Europe 2016 will be held in London, and the new track will feature tighter corners and steeper inclines than previous tracks. Furthermore, there is a raised viaduct leading up to the paddock. This means that not only things like the suspension and steering will need to be improved, but the electrical systems need to be more efficient as well.

The new car: H2.Zero

So, the development of a car that is up to these challenges has begun. This car will be the younger brother of the last car: the H2Zero. It will be an improved design based on the last car, however, it will be lighter, faster, more powerful, more reliable and more efficient.

> "It will be lighter, faster, more powerful, more reliable and more efficient."

One of the systems that will be improved this year is the capacitor bank that is used to buffer the energy from the fuel cell, which enables us to use more power in the motors, without drawing too much current from the fuel cell. Because of the higher viaduct in the track this buffer will be very important, as it needs to store enough energy to get to the top of the hill. Therefore, the capacitance of the buffer is upgraded from 17.5 Farad to 35 Farad.

The Boost converter that is used to charge the buffer will also be completely revised. The boost converter that was designed last year had pretty poor reliability, and one revision even caught fire during testing. This forced the team to implement the system designed in 2013, which only has an efficiency of around 96%. The goal of this year is to make a reliable boost converter which has an efficiency of 98.5%. To achieve an efficiency this high, without compromising reliability, the boost converter will use a custom made solution, controlled by an FPGA instead of an IC.

The London track map

Furthermore, the motor controller will also be redesigned, since there were problems last year which caused the GaNFETs in the H bridge to short. Eventually, a working motorcontroller was made using an off-the-shelf solution from Maxon Motor. The goal this year is to give the GaN approach another try, and achieve an efficiency of around 99.5%. This motorcontroller will also enable the car to apply regenerative braking. This can be of great significance regarding the overall efficiency, since the track features tight corners in combination with steep descents, where decelerating is necessary to prevent crashing.

The H2.Zero will also feature an all-new lighting system, new rims, a more lightweight carbon body, and a gullwing-like door design. More on the design of the new car will be revealed at the design presentation, and at the car presentation the H2Zero will be shown to the public for the first time.

No more excuses

As shown in the last two years, system reliability is quite important when attempting to set records. It is about time for Green Team Twente to set a good attempt for first place. The H2.Zero will be our new platform which will hopefully be able to achieve first place in London. The team is determined to actually complete an attempt; no more excuses.

Green Team Twente is a project where you can step up to challenges not only of technical nature, but also related to management and public relations. Are you interested in working in a project like this, or are you just interested in the developments of the team? Like us on facebook (facebook.com/greenteamtwente) or look at our site (greenteamtwente.nl) for more information.

Lustrumactivities

Celebrating our past into the future: To infinity!

Author: Jippe Rossen

As many of you know (or don't know, and from now on will never forget), Scintilla was founded on the 9th of September. In a time before any significant digital computing was possible, the groundwork of a flourishing association was born.

Now, 50 years later, it is a great time to reflect upon the past and to look forward to the future. This, however, sounds way too civilized and is quite opposed to what electrical engineering students would rather do. We therefore decided that it would be best to keep the 'thought pondering' to a minimum and do what we do best: have an awesome time together!
Scintilla therefore declared the period between the 9th of September till the 9th of October to be a month of celebrating. This month we organized loads of activities that would let a smile appear upon the face of any electrical engineering student. Activities ranging from eating pie on the actual Dies Natalis, to 'how to tie your bow tie'.

> Activities ranging from eating pie on the actual Dies Natalis, to 'how to tie your bow tie'.

There was a camp organized and a reunion day for former electrical engineering students. Also a symposium was organized with the subject the subject 'To Infinity', featuring no less than 7 companies presenting how they contribute to the world, which was the theme for our entire lustrum.
Needless to say it was a very busy but rewarding month. Everybody had loads of fun, while also some additional acquired skills and knowledge were not passed by. In the following pages some of the activities will be recaptured in some more detail, to once more relive the 50 years existence of our wondrous association!

> A symposium was organized where no less than 7 companies shared their view on the topic of the day: 'More Moore'.

Actief sinds 1965
E.T.S.V. Scintilla

50th Dies

Author: Nick te Velde

As many of you know, the birthday of Scintilla is 9 September 1965. That is quite a while ago and a very special while: already 50 years! Of course, such a happy occasion could not have passed without some memorable events, which includes the birthday itself. Hereby I would like to tell you a bit about this event, which had quite some memorable moments for me.

Of course, such an event needed some preparation. As one of the members of the board, which organized the event, I helped with the organization quite a lot. We played a lot of birthday music during the day, got lots of decorations for the event and for the Scintilla Room, and bought a lot of other things necessary for a successful birthday.

One of the most important parts of a birthday is of course the cake, and so we decided that this would not be a good birthday without at least multiple cakes. In total, we had 15 cakes. During the event, even though we thought this was an adequate amount, we barely managed to let every member present have their own piece. Luckily, by estimating how many people were there and were yet to come, we got everyone their own piece and divided all the cakes, without making the pieces too small. However, of those 15 cakes, one was quite special: the glazing on top of the cake was, quite well made, Scintilla's logo and a congratulations with our 10th Lustrum.
This special cake was of course held back for an even more special event during the evening. During the preparation of the event, we heard some interesting news: the first board of E.T.S.V. Scintilla wanted to join us on the dies of the association they founded! We immediately responded that we would be honored. Since we did not want our members to miss such important people, we decided it would be fun to let our current president and one of the present members of the first board hold a speech, followed by the toast of Scintilla and the first board cutting the special cake.
Unfortunately, by this time all the plates were already used. Luckily, as true engineers, we immediately found a solution and repurposed boxes of the cakes as extra plates. Fortunately, by this time only the special cake was left and so the cake was cut and eaten without much trouble.
Obviously, while eating cake is always nice, it is not enough to fill your stomach for an entire evening. Since the first board had to go back to their homes later that evening, we invited them to have dinner with us at the faculty club. After promising the members present at the borrel to come back after dinner was finished, both boards went to the faculty club to have dinner. There, we had a nice meal, some more alcohol and a nice talk about the time back when the university and Scintilla were just founded. During this talk we found out that a lot had changed over time, but also a lot had stayed the same. Back then, the members of Scintilla were also very fond of the taste of Grolsch and also held a lot of activities for members of Scintilla. A lot of experiences were shared, about the fun activities each of us had and about the people we studied with.
After the dinner, the first board unfortunately had to go home, but we returned to the Abscint to continue celebrating this special day. However, by that time the members that were present during the event were also hungry and the activity was almost over. With the last few members we finished this celebration and then went on to prepare for the next activities during the lustrum.

> Luckily, as true engineers, we immediately found a solution and repurposed the boxes of the cakes as extra plates.

> Back then, the members of Scintilla were also very fond of the taste of Grolsch.

Kind regards,

Nick te Velde
Commissioner of Internal Affairs

An evening never to forget...

Author: Dieuwertje ten Berg

Once upon a time there was a little girl. This little girl lived in the east of a beautiful country. And the little girl had a dream. It was something she had seen in different places, but not yet in her hometown. Luckily for the little girl she met another little girl with the same dream. They talked about their dream, but it did not yet seem to be possible to fulfil their dream.

A few years later the hometown of the two girls was celebrating their 50th anniversary. This was going to be celebrated in the biggest, most festive way the city had ever seen. So when the city was looking for people who wanted to organise these festivities, both girls decided to join. Together they were with ten boys and girls who were going to organize the parties and celebrations. And for the two girls, this was the perfect opportunity to make their dream come true. Their dream was to organize a grand gala for all the members of the city.

The rest of the committee still needed a little bit more of convincing. The last time there was a gala in the city it was not really a great success. But the girls were determined that their gala would be a great success, that they would make it a success. So eventually the committee was convinced and the gala became a part of the festivities. But it would not be just one the festivities, it would be the grand closure. So the pressure was on for the two girls to make it a great success.

But these girls were not crazy, it would be a lot of work for just two persons. But luckily for them they knew that there were three other girls that would want to help. So the five of them sat together and started making plans. They wanted everyone to come and make it lovely for everyone. So the search for a location begun. The whole region was searched. All possible locations were considered and contacted. In the end the girls found a location that measured up to all the wishes of the girls and needs of the town. The girls had multiple conversations with the manager of the location to plan the grand gala. So the date and the location were set, all the plans were there. There was only one thing left for the girls. And that was making sure that the gala was all the town could talk about and letting everybody join.

So the girls started promoting the event. They made sure that everybody knew about it and would get an invitation. Most people were really enthusiastic about the gala, and as always a few people needed some more persuasion. But the girls did not let it get to them. And in the end their enthusiasm worked and a larger part of the city's inhabitants joined the gala to make it a night to never forget.

And after almost a year of preparations, the big night was there. The night of the gala, the last night of the celebrations. One more event to make a success. It would become a night to never forget for the people of the town. And of course a night for everyone to dress up in their most fancy clothes. It was an excellent chance for the girls to plan a girls-afternoon full of dressing up, doing hair and make-up and getting excited for the evening. All dolled up they went to the location 'The Jaargetijden' at the start of the evening. They had a preview of the location that was all dressed up according to the infinity theme and looking very pretty.

From seven in the evening the guests started arriving and they were welcomed with a Scroppino. The rest of the evening went by very quickly. There was a photographer and a dinner buffet. People were laughing, talking, eating, taking pictures together and enjoying themselves. Unfortunately it could not last forever and the magic of the fairy tale like night was over at midnight. For some people the rest of the night was spend dreaming about the wonderful evening, some other people continued in the city's bars for a little bit longer. Not willing to let the magic go just jet.

It was a wonderful evening and I (and judging by the overload of positive reactions and happy faces) and everyone else enjoyed it tremendously. It was really a dream for me to have a gala with our beautiful association Scintilla. It brought making the impossible possible to a whole new level and as I may say, with great success. I think Vera, Lynn, Tara, Karin and myself put together a perfect finale of the lustrum and we proved that Scintilla and a gala can definitely be a match made in heaven. Thinking back is still making me smile and I'm sure it will take some time before I forget the 9th of October 2015. I hope everybody enjoyed themselves and thank you for coming. All our hard work would have gone wasted if you would not have come and made the evening the success that it was! So, if you wasn't there, (poor you) you now know, next time, you definitely want to be there!

Love,
The gala committee
By Dieuwertje ten Berg

What is this? it's smaller!

Author: De Vonk

Yes, that is correct, from this point on the Vonk will be smaller. No longer the big A4 Vonk of which you never know where you should keep it. Now this problem will be gone, because now there is a nice, beautiful and fancy-looking (semi-)B5 format Vonk. How and why did this happen, and what do we do with this?

At Gildeprint

As Vonk was discussing our now revealed new format, we were invited to learn the process of how Scintilla's favourite magazine travels from our hard disk to your doormat. A tour was given by none other than Freddie Drijsen, the account manager of printing office "Gildeprint Drukkerijen". After a warm welcome with tea and coffee, a first look was taken at the communications part of the company.

Obviously, the first step in creating a book, magazine, or anything else that requires a press is to receive an order for one from a customer. The company helps the customer in their choices and has a large collection of books and magazines in all shapes and sizes to give the customer an idea of what their final product will look like. After the first step, two ways of printing can be chosen.

The first method is the older one of the two. Aluminium plates are printed, each large enough to fit 4 pages. For every four pages, four aluminium plates need to be printed for the four colours the printer uses: cyan, magenta, yellow and key (CMYK). If needed, an additional plate can be added for a glossy layer. These plates go into a second machine, an offset printer, which consists of five towers; four for the four colours (CMYK) and one extra for the glossy layer. On the sides of the printed papers, calibration colours are printed. These colours are there to find out whether the right amounts of ink are used. The allowed difference in colour intensity is as low as 0.05%. The print also contains registration marks, which are able to show whether a plate is not slightly turned or tilted. If the registration marks of one of the four or five plates does not overlap, one of the plates must have been inserted incorrectly. This method has a high quality, but is a long-winded process. Usually this process is used for small orders, such as magazines ranging from 10 to 1000 copies.

The second way of printing is with the use of a digital printer. Gildeprint has two digital printers; a bigger one and a smaller one. A digital printer has a value of about half a million euros. These digital printers are able to produce 200

sheets an hour, with a sheet containing 4 pages on both sides. This, in comparison to the offset printer which is able to produce Vonks for everyone in Scintilla in a mere 1.5 days, is a much better option for larger assignments. For example, the Moteq notebooks have been printed using this machine.

> "These digital printers are able to produce 200 sheets an hour, with a sheet containing 4 pages on both sides."

After these two machines, the last optional steps are taken. Most orders are books, notebooks or magazines, which means that the large amount of printed pages need to be put into the right order and stuck together. This can be done via stapling, sewing or gluing. Only the latter two are done at Gildeprint. The sewing is done in one quick action with a large sewing machine, while gluing the pages is done with a substance called 'pur'. This method is the easiest and one of the cheaper options, but it means that the pages need to dry for four hours before going to the next step. Gildeprint has many extra machines of which all have their own purpose. Whether it is laminating, packing or cutting; everything is possible.

Changes

> "Which is slightly comparable with printing as we do on printers like Zirma"

So what changed for us? With this new method of printing, it is made possible for us to make more choices. For instance, we could use glossy covers; use different kind of papers and even have less care about the amount of papers we use. It also happens to be cheaper to have this cooler looking Vonk. Due to the new way of printing, which is slightly comparable with printing as we do on printers like Zirma, it goes a lot quicker and easier. Some of the possibilities we gained were already named before, but there is more. We cannot show all the possibilities in one go, but it might occur that some day there is a rip-out page within the Vonk, just because we can now.
The more technical changes are the layout changes. Since we went from A4 to (semi-)B5, we had to adjust some layout features, such as borders, marges and font size. Since we do not want to deliver a magnifying glass with every Vonk we produce, the font size could not just be scaled along with the measurements, so they needed to be adjusted. We also did not want it to be that big that the amount of information on a page would become smaller, such that articles would need more pages. Because we all know that if an article looks to long, some people might get scared, even though the amount of text would be the same. We also moved the marges around a bit and shifted with some standard layout features like our page numbers and the nice-looking Scintilla-squiggle.

More information?

This new format could not have been possible without the help of Gildeprint Drukkerijen. You can visit their website www.gildeprint.nl or take a look on www.promoveren.nl, where they offer 30 years of experience and help with the layout and production of your thesis. If you are interested in the process of printing and want to see it with your own eyes, then go quickly to their YouTube channel. A quick search for Gildeprint Drukkerijen should do the trick.

The Vonk editor team hopes you enjoy this new format and wishes you lots of fun reading this new edition of the Vonk.

Junction

Authors: Maarten Thoonen, Mark van Holland

Mark Bentum is the director of Electrical Engineering, and a teacher at the university. On the 17th of December He was interviewed by the Vonk, about his life as a student, and his experiences with the university as a student, and later on as a teacher / director of Electrical Engineering.

Where and what did you study?

I studied Electrical Engineering at the HTS (Hoge Technische School) in Groningen which was a four year study. After that I started to study Electrical Engineering at the university of Twente, here I studied the course medical signal processing which took me three years to finish. After I had finished my study I started to work at Astron.

Why did you study Electrical Engineering?

I already made this choice early on. When I was young, I met a group of radio-amateurs. This group was part of the organizers of a camp I went to. I liked what they did there and wanted to learn more about it. Then there was this one time where we were going to make a radio, back then I was like twelve years old, and we made this radio using a germanium diode, this way we could receive some high frequency signals, without using much voltage. Because this peaked my interest I went on to make my own transmitters, and so when it was time to choose a study I chose EE. I first went to the HTS because I came from the HAVO, and because this went easy I went to the university afterwards.

Did you immediately start your master when coming to the UT?

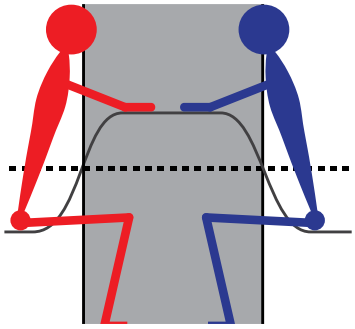
Back then there was no bachelor master system. When finishing the HTS one could just start to get his propedeuse, and afterwards his PhD. I did not have to get the propedeuse except for a few subjects. After that I went for my PhD in the field of signal processing. I did this in the area of the medical signal processing.

Did you have an internship?

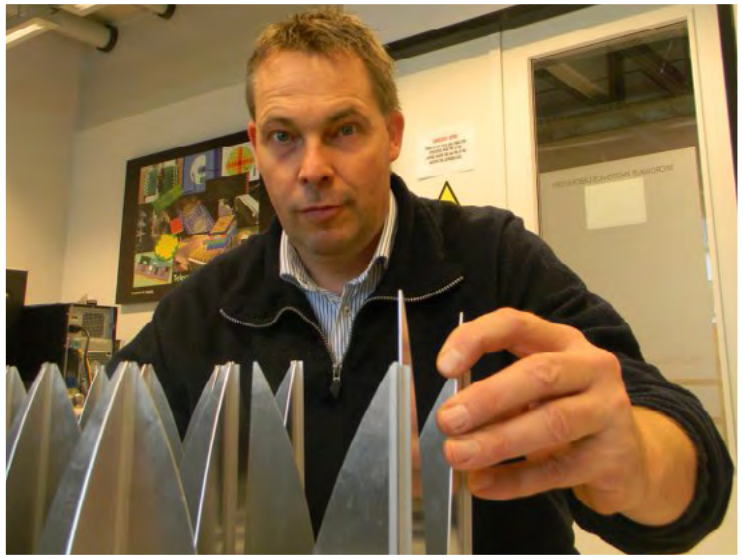
Yes, at the HTS I did my internship at Philips data systems in Hilversum, at Philips in Hoogeveen, and at the Dutch cable manufacturer NFK in Delfzijl. Because I already did my internships at the HTS I did not have to do them at the UT, but because I found that I lacked foreign experience, I did my PhD assignment in America.

What did you do for your PhD assignment?

In America I worked on a medical system to be used in hospitals. When a lung photo is made, a photo is made from the chest and on this photo they



look for nodules. These nodules can be spotted on an x-ray, but from here it can not be determined if the nodule is cancerous or not. It is perfectly possible for these nodules to be just calcified material, which is not cancerous, this is just a thing that happens in the lungs. So we made two pictures instead of one, at the same time. So then we had a film. We placed a nonlinear material and then made another film. After which we had two pictures with two unknowns, the two unknowns in this case are the calcium, and the soft tissue, so the harmful tissue and the harmless tissue respectfully. With these two pictures we could solve the equation with two unknowns. This way we could make a picture of the lungs, where these nodules could be seen and in which of the two categories the nodules belonged. When it was soft tissue the doctors could do tests to determine if it was really cancerous or not. So this is what I developed, tested, and build in the hospital. We then made photos of people who had lung cancer, and eventually that was the system. Our trip was sponsored by Philips medical systems, who later used the product we made.



Marinus Jan Bentum

Age	48
Birth place	Smilde
Favorite Color	Red
Favorite Drink	Bok Beer

How were you as a student?

I was a student who did many things besides my study. I was a student for three years here at the university, in that time I participated in sports like: ice-hockey, table tennis, and rowing. Besides that I also was a teacher's assistant. I guided the subjects of Electronics, and non-linear Electronics for a few years. Besides that I did not have much time left to do other side activities. So I have always been active, in the sport associations, and as a teacher's assistant.

> "I have always been active: mostly in the sport associations and as a teacher's assistant."

What subjects do you teach?

I teach in the bachelor phase: communication systems, which is in module 8. I am module coordinator of module 12, which is the bachelor thesis.
In the master phase I teach: modern communication systems, mobile radio communication, and smart antennas and propagation. Besides that I am also the director of Electrical Engineering.

What do you think about the Twents Education Model?

I do believe in the Twents Education Model. I think it is good that multiple subjects get brought together in modules. That way you can better see the whole picture, instead of having one subject in the first year and then needing that knowledge as prior knowledge for a subject in the third year when you have long forgotten it, now you have everything together. I also think it motivates students to work, as you get everything or nothing. If you pass the module, you get 15EC, but if you fail just one subject, you get nothing. It used to be the case that you had about 4 or 5 subjects, and if you wanted to do something else next to your studies it was no problem to drop a subject. Nowadays that is just impossible. The government requires that 70% of everyone who re-enrolls for the second year finishes his or her bachelor in a total of 4 years. That percentage used to be 15% before TOM. We got a yellow card from the visitation committee because of that, so something had to change. TOM and also the BSA helps us reaching 70%. Students are working harder because of those two things, and I think that is a good thing.

Are there differences between the original idea for TOM and the way it is executed now?

Not really. I was in the curriculum committee when TOM was created. We designed the first two years of the bachelor, as in those years the basics had to be taught. In the third year the students have more freedom: they do their minor and their graduation projects. You do two graduation projects: a design project and a research project. After your education, you also either work as a designer or as a researcher. You can for example work at Philips and design the next electronic shaver or invert a new supersonic localization system, or you can do research. The projects help you find out what you like most.

> "If I want to change something, I just do that, as I am the program director."

Telescopes at Westerbork

If you could change anything in the current system, what would that be?

If I want to change something, I just do that, as I am the program director. I am continually working on improving the program. But those are mostly small things, to make the curriculum more studiable. If a module coordinator thinks something should be removed from a module or something is missing, I started looking into that. I think that if you spend a lot of time designing a new curriculum, there will be some mistakes and those have to be corrected, but other than that I think the new curriculum should just be studied for a while. So there are constant changes, but they are nowhere near as big as the introduction of TOM.

Did you already know during your studies you wanted to become a teacher at the university?

No. After I finished university, I went to work at ASTRON in Dwingeloo. ASTRON is the organization that manages the large radio telescope by Westerbork. I worked there for over 10 years. After a while I wanted to start teaching again and have contact with students. I always remained in contact with the UT, so when I was asked to create a new chair by the UT, I did that. So since 2008 or 2009 I'm working here.

> "At the university, you have a lot of freedom in how you teach a subject."

What do you think of teaching at the UT?

I really like doing it. I also like experimenting with different ways of teaching. For example, I once gave the subject Cosmology. In that course were students from many different studies, like Electrical Engineering, Applied Physics and Industrial design, but also psychology. Psychology students have other prior

OLFAR satellite

knowledge than physicists, so the teaching had to be adapted to that. I made groups of people who each had to study one aspect of the course, make a talk about it and then give a lecture about it. At the university, you have a lot of freedom in how you teach a subject. The curriculum committee formulates what you have to learn in each module. This is called the 'eindtermen'. The only requirement is that the students have the right amount of knowledge at the end of the module, but how they acquire that knowledge is left to the teachers. One way of teaching students is by giving lectures, but you could also use problem based learning, like in module 4.

> "Enjoy your life, do stuff you like. I think you're not living your life right if you don't do what you like."

What kind of research do you do?

Most of the time I am busy with my chair, telecommunication engineering. Personally, I work on radio systems for many different applications. For example, at the moment I'm working with ASTRON and the TU Delft on OLFAR, the Orbiting Low Frequency Array. The plan is to launch 50 to 100 little satellites in an orbit around the moon, and those satellites together form the array. All these satellites have to communicate with each other and with the earth, and the array itself is one large antenna. My research department researches all these kinds of things.
Another subject my research department works on are sensors in the internet of things. There are sensors everywhere, and all those sensors have to send their data somewhere. We try to make those transmitters as energy efficient as possible, so every device lasts as long as possible.

Do you have a family at home?

Yes, I have a wife and two sons, of 14 and 16 years old.

What are your hobbies?

In my free time I like to drive my 4x4 car off-road, working on my house and I'm still with the scouting.

What do you want to do in the future?

I just want to stay working at the university and do research. My dream is that one day I can look at the moon and imagine the OLFAR satellites orbiting around it, and that we can discover the origin of the universe with it.

Do you have a piece of advice for the students?

Enjoy your life, do stuff you like. I think you're not living your life right if you don't do what you like.

Red One Go

Author: Fieke Hillerström
Photo's: Gijs Versteeg

"Probleem? Poar Neem'n, Red One Go!" The whole team is yelling and partying in the fountain in Adelaide. We made it, 3000 kilometers through the Australian outback, a unique experience. Proud of our performance during the race, all we could do was smile.

Amazing Australia

In September we arrived in Darwin, one month before the race. Why so early? To be able to test our car in the Australian conditions, to acclimate to the weather and to finalize the Red One. During our time in Darwin we stayed in a scout hall, a big room filled with stretchers. Our workshop was located at the Charles Darwin University, only a few hundred meters from the scout hall. The transport box with the Solar Car had a few days delay, which gave us the opportunity to discover Darwin; visit national parks, watch crocodiles and barbecue on the beach.

Get back to work in Darwin

When the car arrived, we had to focus again and the hard work began. We had to finalize the solar panel and SABINE

> "Probleem? Poar Neem'n, Red One Go!"

(Solar Array Balancing Interface Not Expected). SABINE is one of our electrical improvements of this edition. It increases the solar arrays' efficiency by better tracking the maximum power points of single solar cells. This is done by balancing the output current of solar cells, instead of using the traditional bypass diodes which dissipate the energy. The Australian sun gave us the opportunity to characterize our solar array and measure the benefits of SABINE. We also had to test whether we reached our temperature limits, especially the battery pack and MPPTs can become very hot.

Control stop

Check, check, double check!

We were allowed to test our car on the Australian road for about two weeks. Before you are able to drive on the public road, the Australian road authorities have to issue a roadworthiness certificate. They check your belts, horn and lights, for example. After the testing period, our car had to go through the scrutineering. During the scrutineering, the organization checks whether your car meets all the regulations. We also had to hand in documentation with the schematics of the electrical system. During the scrutineering itself, the organization focuses especially on the battery pack and the solar array. A seal was being placed inside the battery pack, which we were allowed to remove at the end of the race. This, to

Service car

make sure the teams do not change cells inside the battery pack, for energy gains. I found it more symbolic, because no team will break those rules.

Ready, set, Red One GO!

The qualification took place in combination with the dynamic scrutineering on Hidden Valley. The team with the fastest round time starts first at the beginning of the race. A high qualification does not only result in a time advantage at the beginning, it also reduces the amount of cars you have to overtake. Overtaking is not that easy, especially when the road becomes single way. We qualified twelfth, in the same range as our main competitors in the Challenger Class.

> "We were standby to fix problems, which could occur during the race."

During the race I was part of the service team and together with Robin Lohuis, Elmar Peters and Tom Vocke, we drove the Electrical service car. The service team is responsible for Red One during the race and has only one focus; optimizing the car performance. We were standby to fix problems, which could occur during the race. Besides this, we were responsible to run the control stops and the charging in the morning and evening. We customized our service car to fit in all the service-boxes, for quick service possibilities. About one hour before the control stop, we started driving forward, to prepare the stop. At control stops the solar car has to wait for 30 minutes. The solar panel is reconfigured towards the sun for higher energy gain. We spray the solar panel with demineralized water to clean the dust and increase the performance. Watch out, before you cause shadow on the panel. After the 30 minutes the solar car leaves. After this, we had to clean up the place and drive back into the convoy. With the high speed of this year, the service cars had to drive speed limit to arrive at the next stop in time. At 5 o'clock we finished for the day and set up our camp in the outback.

The end of an amazing challenge

After four and a half day the rush of the race ends and we finish in Adelaide, only a few minutes after the number one. Traditionally we make our way towards the Adelaide fountain and take our first 'shower' in four days. We are proud of our achievements and the exciting race we drove. Time for party and holiday!
At the moment of writing, my holiday has finished and we are working on the completion of the project. I had an amazing time in Australia, preparing and driving the race and a nice holiday afterwards. Together with two teammates, I drove in a campervan from Adelaide to Cairns in five weeks. We have seen and done a lot of crazy things.
During this last month we work out the possible improvements for the electrical design of our solar car. Improvements on the current systems, such as motor efficiency and the SABINE project, but also some new ideas/projects came up.

Become a Solar Team Twente team member yourself!

Do you have ideas for improving our solar car? Do you want to have a more practical year? Do you want to be part of a highly motivated engineering team? Do you want to participate in a World Championship? Watch our after movie, to get a feeling of the outback experience.

> "With the high speed of this year, the service cars had to drive speed limit to arrive at the next stop in time."

Are you interested in Solar Team Twente? Don't hesitate and apply for the new edition of Solar Team Twente, which will start around September 2016 and participate in the World Solar Challenge 2017.For more information about Solar Team Twente 2017, contact sollicitatie@solarteam.nl

Being part of Solar Team Twente, an experience to never forget.

Impressions of a freshman

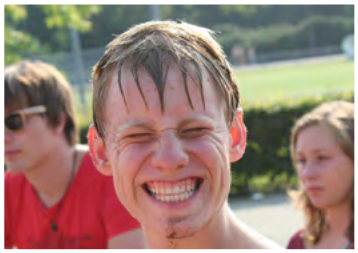
Author: Robert Brouwer

At the moment I wrote this down, I could declare myself a student for three months and six days. Thinking by myself, this is a long time and although I know that the road ahead is far longer, I still remember how the road started.

Coming from Enschede, the terrain of the university was already well-known to me. Still, seeing all those people who all came here was overwhelming, but also exciting.

> "Seeing all those people who all came here was overwhelming, but also exciting."

I was even getting more excited when I met the first two people. Their names are not known to me and after that moment, we never met again. The only thing I still remember is that they were in the same class as my cousin.
When later being added to the group of students of Electrical engineering, they were all people I hadn't spoken to before. Still, these are the people I eat with every Wednesday.
Shortly after the Kick-In, the first lessons started. Telling about the first lessons and the impression would fit great over here, if I was there. Starting the first day without the right timetable doesn't leave a good impression, but after that I have almost always been on time. The first lessons were easy, but got more difficult quickly. For a subject like math I knew already everything, because I had had the subject before. I even won a price for answering most quiz questions correctly. This however changed when starting with the next topic, which was in the beginning not too difficult, but over time got tough so I had to start practicing. The subject I liked most, and still think is the best of all subjects, is the laboratory. Working in groups of two on a small experiment, you feel like a real scientist, although the outcome is predetermined. I'm very lucky with my lab partner, who is someone who already knew a lot about Electrical Engineering before starting with this study. Although he's is not that punctual, with his knowledge and me being present we made every lab journal a piece of art.
Luckily, life is not only work. There are also lots of other things, like the eating on Wednesday mentioned before, Scintilla also organizes activities which are really fun. An example is the Lustrum gala, which was the first real gala I've been to. Sitting at one of the most famous places in Enschede, de Jaargetijden, we could enjoy food and drinks for free, as long as you had paid. The only thing I missed was a dancefloor to do some ballroom dancing. Maybe it's better that it wasn't there, because just like gala's, I have no experience with dancing. Still it was a night to remember.



The best improvement from going to the university is the people, and although I liked my high school class, the group I'm now in is far more enjoyable.

> "Although I liked my high school class, the group I'm now in is far more enjoyable."

They are people that think in the same way as me, and not only here in college, but also outside college with the Christian student association Alpha. There you are with people of all educations. This takes a lot of your time, but it is worth it.
If I would give any advice to anyone, it is to join also some kind of sport or other kind of group with activities next to scintilla. When I finished writing this down, I could declare myself a student for three months and seven days, because being a student takes a lot of time.

What next?

Author: Dieuwertje ten Berg

"Hey, long time no see! How are you doing?" "You good, you?" "Yeah, also good, how's study going, almost done?" "Yeah, I'm writing my master thesis at the moment. Oh nice, what do you want to do after graduation?"

The conversation above is a conversation that, in some kind of form, keep's occurring the last couple of weeks/ months. When people hear that I'm busy with my final project the next question is always 'what do you want to do next?' The other option is them asking when will you be finished (like that's a fixed date that does not move around – hell no, that'd be easy).

> "Like that's a fixed date that does not move around – hell no, that'd be easy."

The point is, I do not know what I want to do next. How am I supposed to know what I want to do next? So the general answer that I give is that I want to find a job. And people nod understandingly. There are a few things I don't understand about the question. People always ask it in a way like you have a wide arrange of choices. Which I do not really see, because after six year of studying there is this thing called a study debt that wants to get paid. And because of that, I want to get paid. But in order to get paid, one must have a job. So what are my options other than finding a job? Of course I would want to travel the world, but that won't pay for itself.

But maybe I'm interpreting the question wrong, maybe people want to know what kind of work I want to do. What kind of company or type of job. But how am I supposed to know that?

Apparently at certain times in life you are supposed to know what you want in life. As a child, adults ask what you want to be when you grow up. My answers than ranged from hairdresser, to dentist and a violinmaker (yes, really, I wanted to be a violinmaker when I was a child). Then again in high school, you have to decide what you want to study. Some people already knew this since they were 12. I really had no clue. When I was freshman in high school, those seniors always looked so grown up and they must know what they wanted in life.

> "Apparently at certain times in life you are supposed to know what you want in life."

A part of me always kept hoping that I would magically know what I wanted when I would become a senior. Like a lightbulb that would go on. You might guess, that didn't happen. And now during the last stage of my studies, I am again supposed to know what I want. And I still do not know.

To all the people who always have known what they wanted to do in life, how do you know that? What made you so sure? Why not something else? Maybe it is just not for everyone to know it like that. Or perhaps everybody knows it at some point during their life. Until I hear an answer that will help me, I'll just keep experiencing and perhaps that lightbulb will magically go on. And if it doesn't, that's okay. I'll follow the wisdom of the Aussies and the kiwi's; no worries. Because knowing everything won't make me happy either.

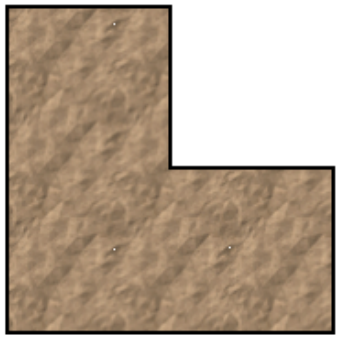
Dieuwertje

Puuzle

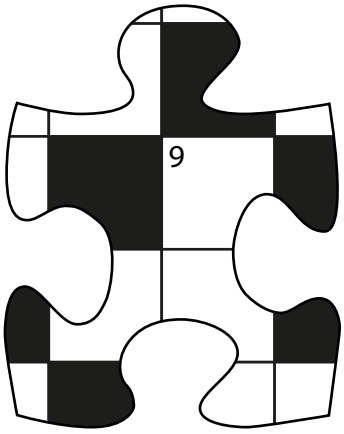
Author: Truusje

During the last edition nobody answered all the questions in full or correctly. Therefore the prize goes to the one who was closest to the correct answers, congratulations Rik de Sain!
For this edition Truusje has some problems for you to ponder on. The first person to help her find the answers to the following puzzles will be rewarded with a home baked pie! Mail your answers to truusje@scintilla.utwente.nl.

A chip designer, specialized in routing, wants to layout a chip consisting of eight individual modules. The surface that is available on the chip is L shaped like in the figure below. He wants to divide the available space into eight sections of identical shape and size. Unfortunately he was not taught how to do so during his masters degree, can you help him out?



Truusje is feeling generous and wants to give away 45 Xilinx FPGA's to three electrical engineering students. She promised 1/2 of the FPGA's to the first student, 1/4 to the second student, and 1/6 to the third student. She then called Mr Mu for advice, after thinking a while he came with a solution, and as thanks she gave mr Mu 1 FPGA', what was mr Mu's solution ?



Five electrical engineers have acquired government funds of €20,000 for their research. To divide this money they decided on the following system: The engineers get to make a proposal for the division one by one, starting with the oldest and ending with the youngest. If a proposal is accepted by at least 50% of the engineers, the proposal is passed. Elsewise the engineer who made the proposal is brutally electrocuted. All living engineers are allowed to vote, and all engineers will try to get the largest possible funds, without moral objections.

The question: Which division should the oldest engineer propose, in order to get most funds, and stay alive.

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