



**DELFT** | NO. 4 | DEC 2019 | YEAR 36  
**OUTLOOK** |  **TU Delft**

**All family  
Generations  
at TU Delft**

**WASTE GLASS**  
Infinitely reusable

**Best teacher  
Joris Melkert  
'Active participation  
earns you points'**

**THEME**  
**Education**

Cover:  
"Children and grandchildren of Delft alumni often also end up in Delft. Klaas and Maartje met each other while studying in Delft, grandson Simon is now studying there. An old-fashioned blackboard seemed like a suitable background." (Photographer: Sam Rentmeester)

Foreword  
*Tim van der Hagen*

## Renewal

This issue puts the spotlight on education, a topic that is probably close to your hearts. A lot has changed over the years, as you will read in an interview with a current student and his grandparents.

In these times of technological progress, in which many of today's workers can never stop learning and developing, educational renewal is more urgent than ever.

Fortunately, the same technology also makes lifelong learning possible. We are sharing our knowledge with the world through our Extension School, which is about to enter a new phase.

This renewal is also visible on campus. Although chalk may never completely disappear, digital smart boards are gaining ground. This is a step towards the lecture hall of the future, where online and campus students may soon be following the same degree programme.

At the moment, though, teacher workload is putting pressure on primary and secondary schools. Through our Master's degree in

Science Education, we are playing our part to address the shortage of science teachers. Water levels are also a cause for concern. In the Delta Futures Lab, students from various programmes learn how they can work together to solve the complex problem of rising sea levels.

And this brings us to the biggest challenge of this century: climate change. This is an important theme in our education and research, and by making our own campus more sustainable, we want to put our money where our mouth is. When it comes to such topics, we live in a glass house; society scrutinises what we do. Fortunately, these glass houses are now very safe and comfortable, thanks to glass "bricks" made of waste glass. You can't get much more sustainable than that.

*Professor Tim van der Hagen,  
President Executive Board*

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Joris Melkert

Joris Melkert, lecturer and Educational Fellow at the Faculty of Aerospace Engineering, was voted TU Delft's Best Teacher of 2019. How does he keep students engaged?



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Sustainable campus in 2030

Very ambitious: TU Delft wants a carbon-neutral campus by 2030. In a recently published report, researchers outline how the university can achieve this ambition. Here's a hint: lots of trees are needed!



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Colourful waste glass

They made their breakthrough with a solid glass façade in a chic shopping street. Now, three years later, the thick glass of doctoral candidates Faidra Oikonomopoulou and Telesilla Bristogianni has been given colour, curves and circularity. Their motto: 'Thick glass is our baby'.





# DELFT IN BRIEF



Photo: Sam Rantmeester

## Talking robots

Social robots can teach children to better manage their diabetes, but balancing ambitions and opportunities remains a difficult task, says Dr Rosemarijn Looije. For example, social chitchat (how are you?) with a robot creates a bond, but robots are not very good at it. Emotional expressivity makes interaction livelier, but... the expressions mustn't become predictable. And a robot with arms and legs is more appealing than a tablet, but its appearance raises expectations. In other words: a humanoid robot should do more than just sit and talk.



Photo: RVD

## Open sewer in Delhi

The extremely polluted Barapullah creek is one of the largest open sewers in New Delhi. Researchers from TU Delft (CEG), in collaboration with Indian colleagues, have been developing water treatment technologies here for several years now. Last October, they scaled up their treatment capacity from 100 litres per day to 10,000 litres

per day. The new wastewater treatment pilot was opened by King Willem-Alexander and Queen Máxima. Every day, sewage of three million households flows untreated through the Barapullah, which also serves as a water supply for irrigation and industry.



## Gas reservoir

When pressure drops in a gas reservoir, accumulating water may stop the flow of gas. Putting a pipe deep into the borehole can help to restart production. The Netherlands has more than 200 gas wells in the North Sea with a lifespan of 20 to 30 years. A velocity string can restart and extend production by 10%, says Prof. Ruud Henkes. The measure may be economically feasible, but the effect is not guaranteed. Gas companies want more certainty about this in advance. Measurements by graduating student Piotr Muis and his supervisor Arnoud Greidanus are the first steps in the development of a predictive mathematical model.



Photo: Sam Rantmeester

## Artificial cell division

Cell division is one of the challenges involved in making artificial life. Nanobiologist Elisa Godino recreated the cell-division mechanism of bacteria in artificial cells. When a cell divides, it divides into two equal halves. Nanobiologists have long wondered how cells actually achieve that. Researchers in Prof. Christophe Danelon's lab have imitated the bacterial cell-division mechanism in artificial cells. The whole process starts automatically as soon as the cell is warm enough. Elisa Godino and her colleagues describe these experiments in a recent article in Nature Communications.



Photo: Sam Rantmeester

## TU Delft continues to grow

TU Delft is bigger than ever before. At the start of this month there were 25,106 registered students, 959 more than last October (about a 4% increase in the student population). Thanks to the introduction of numeri fixi, the intake of Bachelor's students has remained the same. Degrees with a numerus fixus (Architecture, Urbanism and Building Sciences 400, Industrial Design Engineering 350, Aerospace Engineering 440, Nanobiology 100, Computer Science and Engineering 500 and Clinical Technology 100) are almost completely filled or even oversubscribed.





## Help for surgeons

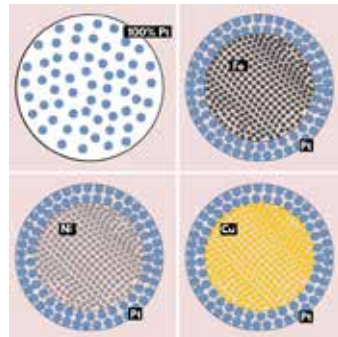
Master's student Alexander Sendrowicz helped to design a tool that makes brain surgery safer, faster and easier. This is the NeuroPunch, a device that is inserted and can rotate in the nose. Until now, it was only possible to insert a similar tool in the nose in a linear fashion, so there was a risk of damage. DEAM is conducting further tests on the device and plans to launch it on the market in about two years' time. Scan the QR code to see how it works.



Photo: Sam Bentmeester

## Fuel cells with less platinum?

Hydrogen cars are powered by fuel cells that contain platinum. Researchers think that fuel cells can also function with less platinum. Platinum is still the best catalyst, but Dr Emma Westsson wanted to reduce the amount by developing Smartie-like catalyst particles. The outside of the particles (23 nanometres wide) is still platinum but the core is another metal. Her supervisor, Dr Ger Koper (Faculty of Applied Sciences), estimates 50% less platinum is needed. According to Westsson, the catalytic activity for iron, nickel and copper cores is the same or better than pure platinum nanospheres.



## High-tech in the Stone Age

Neanderthals used complex technology to make tools. This is the conclusion reached by researchers from TU Delft, the universities in Leiden, Utrecht and Groningen, the Stone Foundation, the Dutch National Museum of Antiquities and the North Sea Stone Age research group. In the scientific journal PNAS, they describe a flint tool found in 2016 by an amateur archaeologist on the Sand Motor, the artificially constructed beach near The Hague. The flint tool is encased in a tar-like substance and is one of the few examples of glue used by Neanderthals. The pitch was probably meant to make it easier to hold the tool firmly in the hand. The chemical composition was examined using gas chromatography and the constituents point to birch pitch.



Photo: RMO

## 4TU research collaborations



Photo: 4TU Federation

At the end of October, the 4TU.Federation presented five new research programmes in The Hague, for which €22 million has been made available. TU Delft, Eindhoven University of Technology, the University of Twente and Wageningen University & Research will be conducting research into personalised medicine, disease prevention and treatment, smart industry, more resilient societies and global food demand. The four universities are working together on each of the programmes. With the appointment of 44 tenure tracker staff, 4TU is investing in research for the long term. The objective is for the researchers to set up their own research projects within the themes, to secure funding and to take on doctoral candidates.

# THEME Education

In this theme, grandparents who started their engineering degrees at TU Delft 60 years ago, are talking with their grandson, a current TU Delft student, about how teaching has changed over the years. Back then, professors used to write formulas on the board in chalk; now, more and more lecture halls are equipped with digital boards, students can follow lectures on line and interactive resources and audio-visual technology are used to disseminate course material. And there are many more students today, from all over the world. There is also a growing demand for skills such as cooperation, communication and being able to deal with unexpected and unknown situations. To overcome these challenges, TU Delft will start using different teaching methods.



PHOTO: SAM BENTMEESTER



# Say goodbye to chalk!

TU Delft's lecture halls are getting an upgrade. More and more of them are being equipped with digital boards. "We have to prepare for the digital world of the future."

Hundreds of first-year students are gathered in lecture halls A, B and C at 3mE. They are learning about jumping trolleys. The lecture is the official kick-off of a design project. Part of the faculty building will be transformed into a racetrack featuring an obstacle over which the trolleys, designed by students, jump like kangaroos. In the Leonardo da Vinci hall (hall A), lecturer Anton van Beek is explaining how to design a reliable transmission for the trolley. Students can also watch his lecture in the other two halls, on large projection screens. To the familiar ticking sound of chalk on a blackboard, he writes down a series of mathematical equations. Yet there is no chalk dust, while students are spared the gut-wrenching noise of chalk-on-blackboard. Van Beek is writing on a digital board. The digital board, or smartboard, is becoming increasingly popular. The first ones arrived at TU Delft eight years ago. Now there are 47 of them scattered all over campus. "Smartboards are used in most lectures," says student Lynn de Lange, who is taking Van Beek's course. She's very excited about them. "The subject matter is often easier to read than on a blackboard, and you can save it for later reading."

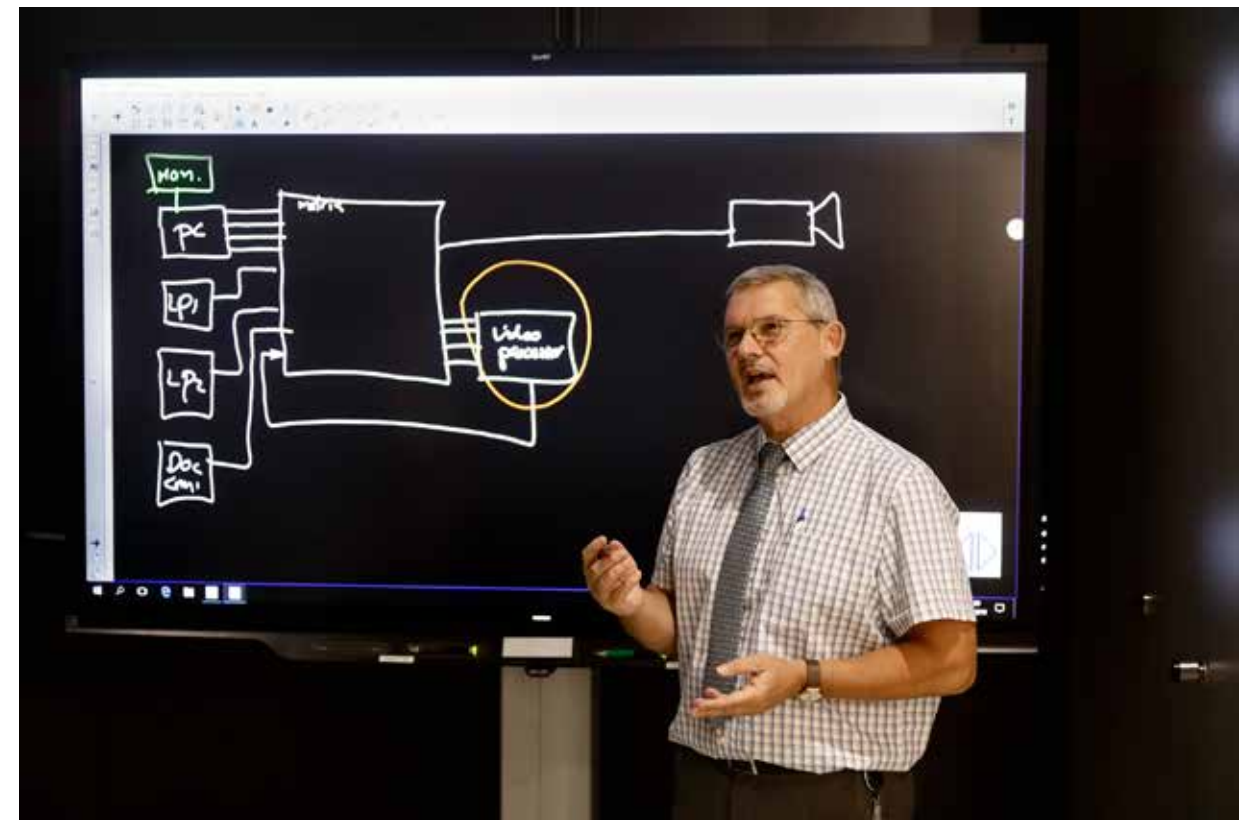
## WRITE, COPY, SAVE

If you can write with chalk, then you can write formulas just as easily on a touch screen. That's the idea. You use one of the special pens that stick to the bottom of the board with magnets. And you can use your finger to copy, save or move a formula. You use your palm to erase.

"It's easy to use," says lecturer of mechanical engineering Anton van Beek in between all the work. "If the connections are working properly, that is," he adds quickly. "I was here 30 minutes before class to make sure everything was in working order. Occasionally, the computer fails to connect to the smartboard. Things like this may cause a bit of stress going into the lesson." A few halls further on, Peter Naaijen, a lecturer in ship hydrodynamics, is cleaning a whiteboard. He's just finished his lecture. "I'd rather use a real pen or chalk," says Naaijen, "I went to an introductory session a few years ago to learn how to work with these boards. But it takes some fiddling with the connections. I'm not an early adopter. But in the long run I'll have to get used to it."

Piet van der Zanden agrees. He works at ICT & Facility Management and specialises in the application of audio-visual technology in education. He is one of the driving forces behind the modernisation of lecture halls. "In 2011, we and a large group of lecturers – including mathematicians, mechanics and physicists – started looking for an alternative to the chalkboard," says Van der Zanden.

According to Van der Zanden, the chalkboard is ideal for what he calls 'chalk-writing didactics'. "If you just present a calculation in PowerPoint, the students won't understand it. You have to slowly build up to something like that by writing out the sum on a board, step by step. But then again, all that chalk dust... Something had to be done about that. After all, it's bad for your health, while cleaners are spending too much time cleaning up all the mess. Whiteboards became popular some 20 years ago, but they weren't much of a success. The contrast was



IT specialist Piet van der Zanden went looking for an alternative to the chalkboard.

poor, and the pens dried out quickly." Smartboards are designed to solve these problems. "And more importantly," adds Van der Zanden, "these smart boards help lecturers to prepare themselves for the digital world of the future. Digital writing skills are

*'You can use a smartboard to present a whole body of evidence in a logical and easy-to-follow sequence'*

essential for methods that involve both physical and virtual students, for example MOOCs, blended learning and hybrid classes."

"The image on the smartboard is enlarged and projected onto a screen," continues Van der Zanden. "The lecturer can divide this central image into four quadrants to project something different on each of them. For example, you can add a proposition to the top left, then

substantiate this proposition with a series of formulas on two other screens, and on the last screen you can display an animation of the formula and create a graph. You can use a smartboard to present a whole body of evidence in a logical and easy-to-follow sequence." This may sound promising, but plenty of lecturers still have cold feet. In one of the halls at 3mE, we came across a mobile chalkboard covered in formulas – despite the fact that it is actually only there as a back-up in case of a power cut.

## METAMORPHOSIS

The modernisation of lecture halls is in full swing. It is part of the so-called transformation plan launched in 2015. In that year, it was decided that the majority of the faculties' lecture halls (180 in total) would become part of a large, centrally managed pool of rooms, meaning that the available space could be used more efficiently. As such, lecturers and students are no longer tied to their own faculty building.

[Read more on page 10](#)





A modern lecture hall at the Faculty of Industrial Design Engineering.

Swarming around campus, they are assigned rooms to match group size and teaching method.

This means that lecturers have to get used to teaching in different rooms all the time. How do you turn the light on and off? And how do you hook up your laptop? It's different everywhere. All the rooms are therefore being redesigned according to a standard plan. This transformation plan is due to be completed in 2024. Last summer, it was CEG's turn. Themara Bogerd from Education Logistics and Paul Uiterdijk from CRE Strategic Campus Management were closely involved in the metamorphosis. We caught up with them in hall A at CEG.

#### TRAINING


The first thing we noticed are the new chairs, which offer just a little more leg room and all have power sockets. Felt wall lining provides better acoustics. The control panel is also new. It is exactly the same as the control panel used in other lecture halls that have already been revamped. In the corner there's a

smartboard. But, surprisingly, the chalkboards haven't disappeared.

"Never force people to use new technology, expecting someone who has always used chalk to start using a smart board overnight," says Uiterdijk. "We set up a programme to help lecturers who want to make the switch," adds Bogerd. "At the start of each new quarter, we find out which lecturers haven't been assigned to a room before. We offer them training, which covers both the technical side of using digital tools as well as teaching skills. But they can still use chalk if they want. Some lecturers will always prefer to fill an entire chalkboard with notes and formulas." <<

# Graduating student Rens de Graaf

On average, Dutch people have to deal with the legal system at least once in their lives. "For many, this is a complicated and sometimes even scary situation", knows Rens de Graaf (Industrial Design Engineering). For his graduation project, he researched this process. "For example, a summons is full of jargon and it is often unclear where you can go to get help."

On behalf of the district court of Noord-Holland, he therefore developed a new process for the subdistrict court. "The summons is now accompanied by a leaflet with visual explanations of the rules of play and the next steps in the process. Together with the district court of Noord-Holland I'm now working on a pilot." He received a ten for his graduation project. 





# Multidisciplinary engineers needed to tackle rising sea levels

In the Delta Futures Lab, forty Master's students from different programmes work together on hydraulic engineering and spatial issues.

When the Delta Works were under construction, it was hydraulic engineers who decided which structures needed to be built where and how. Half a century later, we are preparing ourselves for rising sea levels – but engineers no longer have the final say. Measures also need to be multi-purpose: a dyke is not just a sea defence, it also has to fit in with the landscape, have public support, and contribute to a richer ecology. “Complex issues are no longer monodisciplinary,” says lecturer Dr Martine Rutten of the Delta Futures Lab (CEG). “Employers are looking for people who can connect various disciplines.”

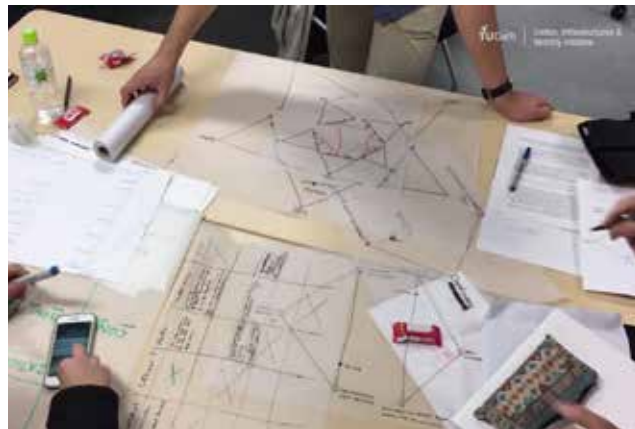
## OTHER WAY OF THINKING

This need is at the heart of the multidisciplinary network Delta Futures lab, in which the faculties of Civil Engineering and Geosciences, Architecture and the Built Environment, and Technology, Policy and Management work together. The forty students who started this Master's programme in July come from these faculties, although the network is open to students from other faculties and from other educational institutions. “Interfaculty collaborations are becoming more common during the Bachelor's phase,” says Dr Jos Timmermans (TPM), “but no one has yet integrated various

*'No one has integrated various disciplines during the Master's yet'*

disciplines during the Master's.” To ensure that engineers don't “lose depth of knowledge”, participants bring their own thesis supervisor with them. Lecturers at the Delta Futures lab allow students to choose from various hydraulic and spatial issues, and they ensure that different disciplines are represented in each group.

Students are introduced to other ways of thinking and working, and they learn to define their own role in this process. Architecture students like to create beautiful designs, but they might not always consider the feasibility of their design. Civil engineering and TPM students have more of an eye for that. Conversely, civil engineering



Students at work. (Photo: Delta Futures Lab)

students sometimes lapse into the design mindset of their predecessors. They come up with a sound design and call it ‘the solution’ without considering social or ecological wishes or requirements. TPM students are happy if the process was good. They share the architect's holistic view and the civil engineer's solution-oriented approach. “At first, they are often reluctant to express themselves because they miss the background knowledge.” After a while, they discover that they can actually add value when different disciplines work together, says Timmermans.

The people at the Delta Futures lab call this overarching approach ‘Research by Design’. The designs by architecture students have a strong communicative function. A good design can open up new perspectives and involve people in the great changes that await us,” says Timmermans. For students, taking part in this Master's is more than an eye-opening experience. The Delta Futures lab introduces them to consultancies and dredgers from the field, they build up a network with people from different areas of expertise, and they learn to play their part in a diverse team. These are all valuable qualities for engineers who want to protect the delta against rising sea levels. 

More information at:  
[tudelft.nl/deltafutureslab](http://tudelft.nl/deltafutureslab)

# Learning to teach

Every year, dozens of TU Delft students train to become secondary school teachers on the Master's in Science Education.

Secondary schools have great difficulty finding teachers for a number of key subjects such as mathematics, chemistry and physics. No one really knows the scale of the teacher shortage. But if nothing is done to tackle the problem, there will be a shortage of 700 FTEs in 2022 and 1200 FTEs by 2027, according to the Ministry of Education.

TU Delft is doing its bit to reduce this deficit with its Master's degree in Science Education. The programme trains students to teach computer science, physics, chemistry, mathematics and design and research. Universities of technology are the main suppliers of STEM teachers.

However, according to Maartje van den Bogaard, Director of Studies for Science Education & Communication, that's not very many. “Each year, we deliver around thirty Master's graduates, qualified to teach at upper secondary level (HAVO/VWO, ed.). We also offer a minor and an education module to get as many qualified teachers as possible into the classroom. Both tracks last six months and train students to become lower secondary school teachers (HAVO/VWO/VMBO-t).”

## CURIOSITY

However, these students don't


always go on to forge a career in education. “Research by my colleagues Begüm Coskun and Alma Kuijpers shows, for example, that students often choose the minor because they are curious about education and the teaching profession. Some students want to improve their presentation and communication skills or think it looks good on their CV.” According to Van den Bogaard, the fact that many students don't go into teaching is due to the poor reputation of the profession. “If we want more teachers, we really need to work on that. But we can't solve this social problem on our own.

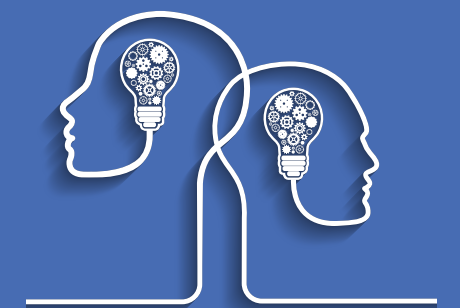
*'Each year, we deliver around thirty Master's graduates, qualified to teach at upper secondary level'*

What we can do and do indeed do, is make sure that students enjoy teaching. To do that, we work with schools that have an induction period for newly-qualified teachers. So starters have fewer teaching hours and more support.” For now, Van de Bogaard is focusing on expanding the education programme in Delft. “A second intake was introduced for the Master's in February 2019 and we have the full support of the Executive Board.” We are the only TU Delft programme that's allowed to grow.” 

# JIP is more than a course

It is a teaching method which, according to Vice-President for Education Rob Mudde, should become a permanent feature of modern engineering programmes. This is JIP, or the Joint Interdisciplinary Project, in which four groups participated last year, 10 this year, and 40 will take part in next year. Each group consists of five Master's students from different disciplines who tackle an issue from the business community. Last year (presentation on 8 November 2019) the students worked on issues such as the corrosion of pipes in geothermal energy, an app against the devastating impact of climate change on cocoa cultivation, and how to make cities better able to withstand rising sea levels.

Aldert Kamp, director of education at the Faculty of Aerospace Engineering and initiator of the JIP, said during the presentation: “This is more than a course, more than an internship. It prepares students for a changing labour market in which engineers increasingly work in small multidisciplinary teams.” Hans Hellendoorn, his colleague at 3mE, adds: “The world had already changed. It was high time that TU Delft changed with it.” 



# Online education is booming

Following the example of Harvard University, in 2014 TU Delft set up its Extension School. This is where all open and online education is offered to the whole world. Vice-president for Education Rob Mudde and his team explore how they can offer entire online programmes to professionals.



Online education has given a real boost to TU Delft's international reputation.

“In the last few years, around 2.5 million people from all over the world have registered for one of our massive open online courses (MOOCs), of which there are more than 100, that we offer through the EdX platform. Most international students know us through these online courses. Last year, we were awarded the title of ‘world leader in innovative engineering education’ as part of a MIT benchmark study. Online education has given a real boost to our international reputation. It also had a positive impact on campus-based teaching. A lot of online material is reused for blended learning, where students do the preparatory work

online so that there is more time for deepening and discussion during the lectures.”

## ENTIRE DEGREE PROGRAMMES OFFERED ONLINE

“In the meantime, the larger institutions that instigated the online movement – such as MIT, Harvard, Berkeley and TU Delft – are exploring which steps to take next. Georgia Tech, for example, offers an online version of their IT programme, which has more than 8,500 students. They pay \$6,700, while the campus-based version costs more than \$45,000. This means that large-scale, high-quality and affordable online education is now being offered on the market by institutions with

an international reputation. We are in an excellent position to explore whether we want to participate in that by offering entire degree programmes online in certain topic areas. Our target group for this is older people already in work: professionals over thirty, who want to study part-time to give their career a boost or to head in a different direction.”

## RETRAINING

“This is also a huge theme at a political level, both in the Netherlands and abroad. Robotisation, large-scale 3D printing, the Internet of Things: the fourth industrial revolution will radically change the economy. Many people will have to retrain in the coming decades. We certainly see this as a task for

‘Our target group for this is older people already in work: professionals over thirty’

our university, but it remains to be seen which part of that problem we can solve. Of course, we want to do this in a way that strengthens our current education and research, rather than just increasing the workload. Here too, the example of Georgia Tech is particularly useful. There, they recruited 100 PhD students and postdocs to spend one day a week supervising students as online tutors; the rest of the time, they can be used for research.”

## INVESTMENT NEEDED

“It’s likely that only a handful of institutions will provide a large-scale online programme range. So we must learn to understand exactly how this market works:



Rob Mudde: “If you develop the degree programmes in collaboration with industry, the degrees will be better suited to the needs of the employees.”

How will demand develop? Who is the target group? Where is the competition? Another challenge is that good online education requires a lot of pre-investment. The development of an entire online degree programme alone costs a few million euros and a lot of time. So you don’t want to choose a theme that other institutions have already started on.”

## COLLABORATING WITH ALUMNI AND INDUSTRY

“We would prefer to work on this in consultation with other parties, such as alumni or market players. All kinds of sectors will have to change their infrastructures and their services. As such, lots of people will need to acquire new skills. If you develop the degree programmes in collaboration with the industry, the degrees will be better suited to the needs of the employees who will have to go through the transition.”

## SHORTER AND MORE FLEXIBLE PROGRAMMES

“That will involve a considerable transition process. We currently have a lot of experience in training young students who are studying an academic discipline for the

first time and in preparing them for a job as an engineer. This new development will focus on people who are already much further in their careers. They have other commitments and can’t just take two years off to go and study. Such degree programmes will, therefore, have to be shorter. At the same time, they already have a basis, so the programmes will also have to be far more flexible. Sometimes participants will be able to spend more time studying, sometimes less. You can issue ‘stackable’ certificates for the completed modules, that together ultimately lead to a degree certificate.”

## GLOBAL IMPACT

“This is a really interesting development in the world of education. As in other industries, digitisation raises fundamental questions about what we should continue doing in the traditional way. I think that campus-based education is extremely valuable and will continue, but you also see something new emerging that will also be big. I would like to explore how we can offer the best of both worlds and thus make education even more accessible to those who do not have access to it now. That’s what I liked about the initial programme: sharing knowledge with the whole world. We must now look for new business models so that we can continue to do this sustainably. This will enable us to have an impact on people and societies all over the world, by helping them keep up with all these new developments.” <<



# Following in his grandparents' footsteps

Sixty years after Klaas Hoogendoorn and Maartje van Asperen started their engineering degrees in Delft, grandson Simon Gebraad enrolled at the university. We talk to two generations about the university, then and now.

**M**r Hoogendoorn never would have thought that they'd be sitting here together after all these years. "On one of our first days at the Delft Institute of Technology there was a meeting at the Westerkerk. I saw her in the distance, talking to a classmate of mine. The weather was great, it was sunny. But she hadn't noticed me!" he jokes. Yet they found each other, got married and had three daughters, all of whom graduated from TU Delft. Grandson Simon Gebraad is carrying on the

family tradition. He is in his second year of Industrial Design Engineering and is a member of Civitas Studiosorum Reformatorium (C.S.R.), the association that his grandparents helped set up. "My wife and I were both members of S.S.R. Delft, but we were unhappy about what was going on there," says grandpa Klaas. "Thirty of us got together and founded C.S.R. We had twice as many members in the second year!" Now there are over three hundred, according to Simon. Besides C.S.R., grandma Maartje was also a member of the Delftsche Vrouwelijke Studenten Vereeniging (DVSF), the female branch of the

Delftsch Studenten Corps. "We often ate there together, because self-catering wasn't an option then. You lived with a landlady and had no kitchen." At DVSF she had a lot of contact with national and international students. "There were girls from present-day Indonesia, the only international students I knew." Things are different now, says grandson Simon. "It varies per course, but I think there are international students on about three quarters of the courses." In those days, the number of female students could also be counted on two hands. Grandpa: "No girls did electrical engineering. There were

very few of them at all in Delft. There were six girls in the entire year group." Grandma: "One in civil engineering, two in physics and three in architecture." She smiles. "That never bothered me. The lectures were enjoyable and I never had a problem. In those days it was unusual for girls to study. But now, in some faculties, women are even in the majority." Simon nods. "On my programme it's 50-50, but I think architecture has more women than men." Whereas his grandparents were still taught in barracks on Jaffalaan, Simon is taught in large lecture halls where

professors share their knowledge using PowerPoint presentations. You can ask questions in between or during the breaks. "We didn't do that in our day," says grandma. "During class, you listened and copied whatever was written on the board." With chalk. So you had to write everything down before it was all erased. Luckily, Simon's grandma was very disciplined, says grandpa Klaas. He borrowed her lecture notes. "She was very good at taking notes." Grandma starts to blush. "Someone had to copy what was on the board." But one thing never changes: the

tension when lecturers announce exam results. Simon looks up all his marks online; his grandparents used to find them on lists hung up in the faculty. "At my department on Mijnbouwplein, the small hallway next to the receptionist was packed with students," says grandma. "I couldn't get near the list. Professor Druyvesteyn – an exceptional professor, according to Klaas – saw that I couldn't see it and said: 'Miss Van Asperen has a seven.'" She still seems proud of it today. <<



# Lifelong learning is a great idea

Vanida Salgado Ismodes obtained her Master's degree in Water Management in 2016. After graduation, she started working as a policies engineer at the Superintendencia de Servicios Sanitarios, a Chilean governmental institution that regulates water service providers.

**Last year, she followed the online paid course Nanofiltration and Reverse Osmosis in Water Treatment. Why did you choose this online paid course?**

"After graduation, I felt that I was really up-to-date with technologies for water treatment and sanitary engineering. I wanted to keep learning to stay abreast of new developments. Also, Chile is currently experiencing large droughts; we've had an uninterrupted period of dry years since 2010. With our long coastline, using reverse osmosis to turn seawater into drinking water could be a solution. That is still relatively new, but some companies are already building reverse osmosis treatment plants. As one of my tasks as a policies engineer is to participate in the study and review of environmental guidelines, it is important to have a better understanding of reverse osmosis and its implications."



(Photo: Vanida Salgado Ismodes)

water, but also healthy minerals like calcium and magnesium. You have to remineralise the water to make it fit for consumption.

**How was your online learning experience?**

"The course was well set up. It included an online virtual 3D lab that you could use to simulate running a small reverse osmosis plant on your computer – that was very innovative. All aspects of the technology were addressed. For example: reverse osmosis not only removes contaminants from

*'This interaction with your fellow students is another important part of the experience'*

The online forum where you could ask questions was also useful. Since I followed the course at night after work, I would sometimes only get an answer the next day because of the time difference. At other times, I would get a reply from another student, so I wouldn't have to wait for an answer from the course organisers. This interaction with your fellow students is another important part of the experience."

**Do you agree lifelong learning is a good idea?**

"Lifelong learning is a great idea. Most graduates these days want to be updated with current knowledge, so it is excellent that there is this wide offer of courses. TU Delft is a prestigious university, and I know the quality of its education. The level is similar to the Master's courses, and though it can be difficult to balance your working day with your studies, I never hesitated: I knew the course was going to be good."

AD

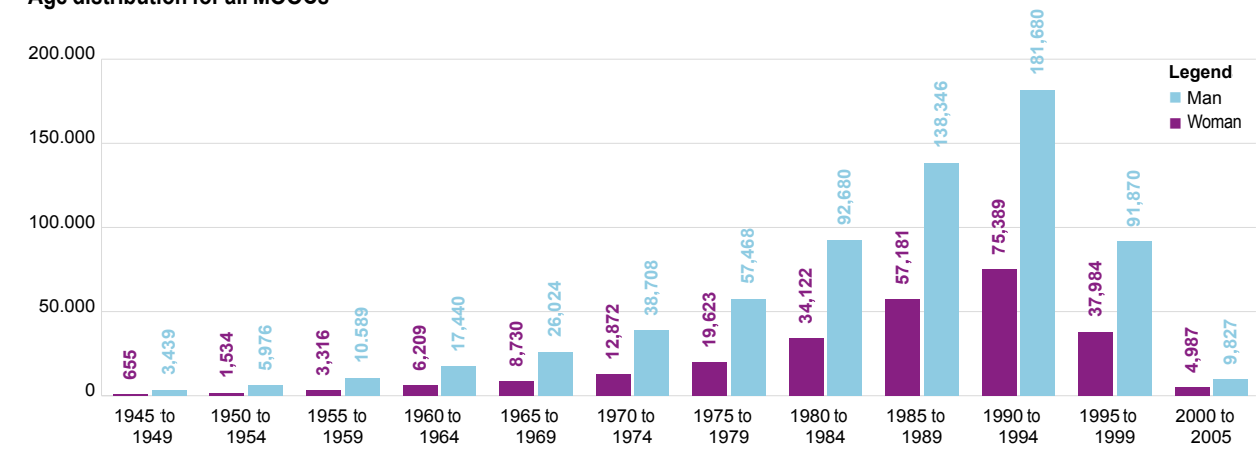
**To get the full picture please visit: [online-learning.tudelft.nl](https://online-learning.tudelft.nl)**

# More MOOCs

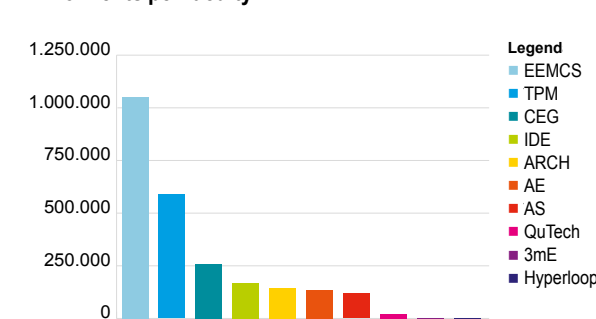
Speaking of exponential growth. Six years ago, TU Delft's first MOOC, Solar Energy, attracted 50,000 participants – 3,000 of whom made it to the finish line. Since then, over 2.5 million participants have registered for a TU Delft Massive Open Online Course, of which more than 21,000 have obtained a certificate. The faculties that have produced the most MOOCs are EEMCS (34 courses), TPM (25), Architecture and the Built Environment (14) and

CEG (12). Participants come from all over the world, with India (10%) and the United States (8%) topping the list. Only 3% of the participants come from the Netherlands. Most participants are recent graduates (27 years old), of which 30% are women and 70% men. MOOCs are offered through the Extension School, which also offers paid Professional Education Courses and Online Academic Courses as part of a Master's programme.

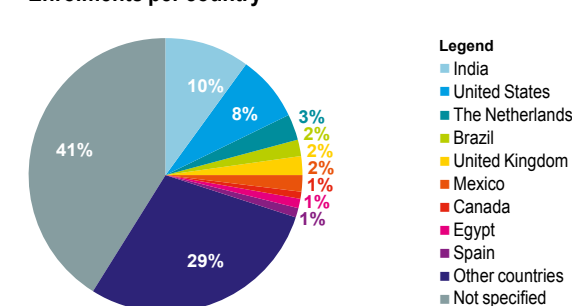
Age distribution for all MOOCs



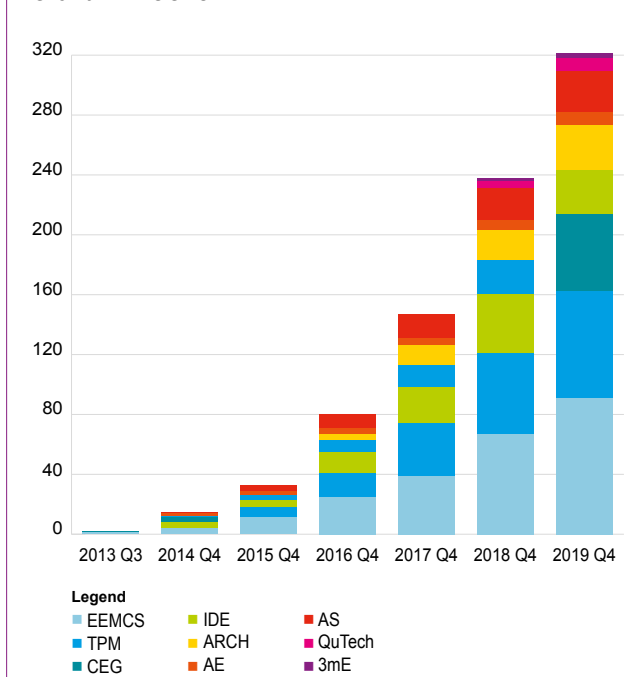
Enrolments per faculty



Enrolments per country



Growth in MOOCs



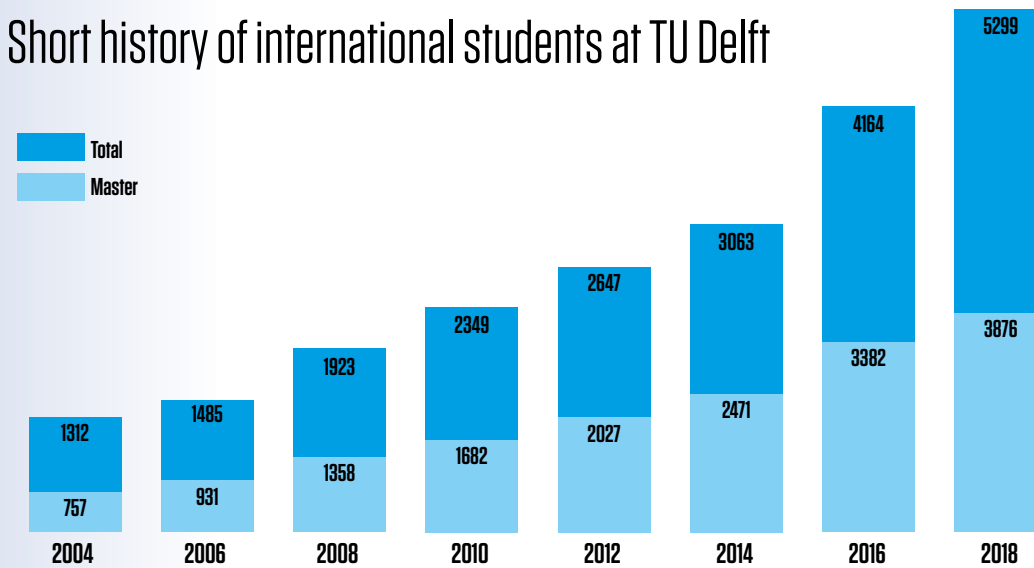
The figures were collected by ir. Willem van Valkenburg, manager of Teaching & Learning Services.



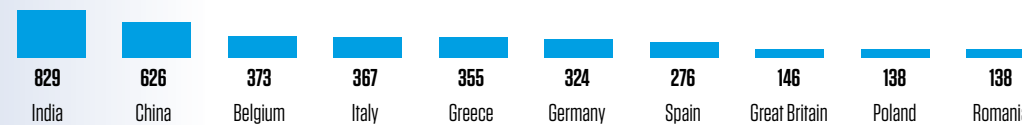
# Internationals

More and more  
international  
students  
choose  
TU Delft.

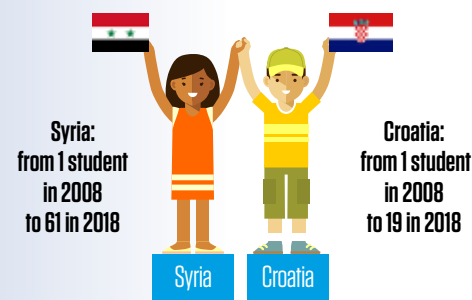
## Short history of international students at TU Delft



## Top 10 countries of origin - 2018



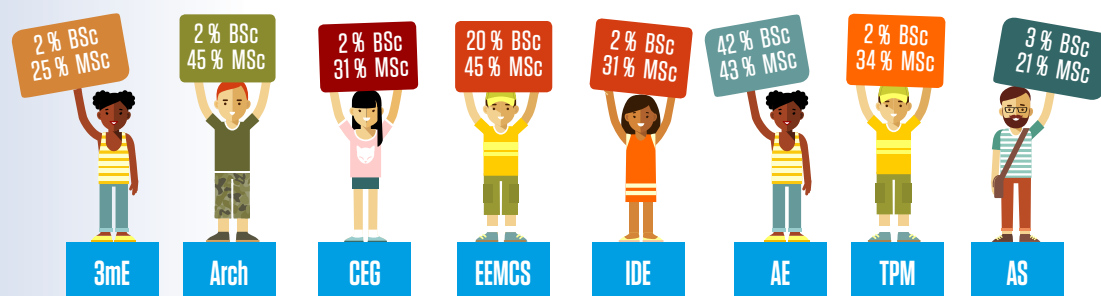
## Countries on the rise



In 2018 **5299** out of  
**24,703** are international  
**= 21%**



## International students per faculty - 2018




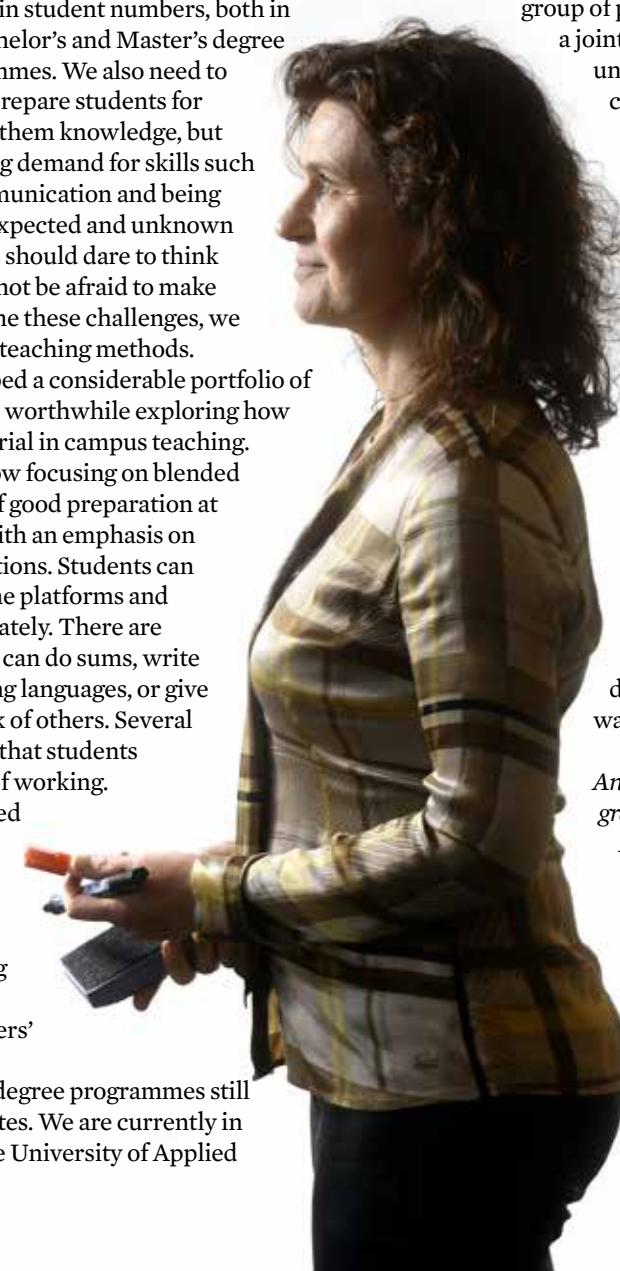
# View

Dr Annoesjka Cabo is academic director of the Teaching Academy and director of Service Teaching. She wants to make teaching more flexible and personal using new methods.


“Teaching at TU Delft is facing a number of challenges at the moment, primarily the growth in student numbers, both in the Bachelor’s and Master’s degree programmes. We also need to find the best way to prepare students for their future. We give them knowledge, but there is also a growing demand for skills such as cooperation, communication and being able to deal with unexpected and unknown situations. Engineers should dare to think outside the box, and not be afraid to make mistakes. To overcome these challenges, we need to use different teaching methods. TU Delft has developed a considerable portfolio of online education. It’s worthwhile exploring how we can use that material in campus teaching. That’s why we are now focusing on blended learning, a mixture of good preparation at home and lectures with an emphasis on interaction and questions. Students can also practice on online platforms and get feedback immediately. There are platforms where you can do sums, write code for programming languages, or give feedback on the work of others. Several projects have shown that students appreciate this way of working. Lecturers have noticed that students participate more actively now. Ideally, this will improve the student’s learning experience without increasing the lecturers’ workload. TU Delft Bachelor’s degree programmes still have high dropout rates. We are currently in talks with The Hague University of Applied

Sciences to see if we can do more by way of cooperation and exchanges. I think it would be beneficial for a particular group of pre-university students to start by doing a joint semester at both a university and a university of applied science as a transition class to see what is the best option for them. We’re also discussing Master’s degree programmes. The nominal study period is two years, but some students take much longer to finish. It’s also worth considering whether all programmes should only offer two-year Master’s programmes. Other universities offer one-year Master’s, sometimes with an internship or applied element. I would like to see more flexibility and customisation. I propagate flexibility at all levels. Students are very different and some of them want more flexibility when it comes to finding their way. Students will always come here to study engineering and then go into research. But TU Delft also has to meet the needs of people who want to develop themselves more broadly or who want to develop other skills.”

Annoesjka Cabo has a PhD in mathematics and graduated as a violinist from the conservatoire. After a career as a concert musician with the Rotterdam Philharmonic Orchestra (among others), she joined TU Delft as a lecturer in 2012. She is now an associate professor in the Statistics research group at the Department of Applied Mathematics (DIAM). She plays the violin in her spare time. She will perform with pianist Bas Verheijden in the Aula Building on 23 December. 





A black and white photograph of Joris Melkert, a man with glasses, wearing a dark jacket over a light shirt. He is shown in two ways: a profile view on the left and a frontal view on the right. The background is dark.

‘Individual  
attention is  
really a thing  
of the past’

On 7 November, Joris Melkert, lecturer and Educational Fellow at the Faculty of Aerospace Engineering, was voted TU Delft's Best Teacher of 2019. "After each section, I do a quiz where students can vote for the ugliest aircraft."

TEXT CONNIE VAN UFFELEN PHOTOS SAM RENTMEESTER



## CV

Joris Melkert refers to his year of birth, 1969, as “a fantastic year for aviation” due to the first Concorde (‘a technical wonder of the world’) and the Boeing 747. He claims that 747s will still be in the sky when he dies. “And I plan on living a long time.” Melkert graduated in 1992 with a project on a glider that can do measurements in the stratosphere. He’s been teaching ever since. After Fokker went into liquidation, he headed a faculty office for strategic development to tackle declining student numbers. In mid-2004 he joined Ockels’ chair in Aerospace for Sustainable Engineering and Technology. Now he’s a full-time lecturer at Flight Performance and Propulsion.

**Congratulations. Right before the ceremony, you didn’t think you stood a chance.**

“Statistically speaking, no. There’s only a very small chance that the winner would come from the Faculty of Aerospace Engineering two years in a row. I saw Jan Rots’ name on the list of nominees and thought he would win. He’s a great teacher and has more experience than I do.” Your colleague Calvin Rans was last year’s teacher of the year. What’s your secret at Aerospace Engineering?

“I know he’s a great teacher. Three years ago, I worked with him to revamp one of our difficult courses, Structural Analysis and Design – a nightmare for students. When one of the previous lecturers left, it turned out that both Calvin and I had said that we wanted to teach that course, to solve the problem.”

**What did you do?**

“I asked for an overview of the learning objectives, but there wasn’t one. Calvin and I were involved in the final assignment in the Bachelor’s third year, a design exercise, and we both saw that students really struggled with it. They could analyse a structure, but didn’t know how to design it. We split the course into two parts and gave more examples about designing from scratch. We then started doing six two-hour voluntary workshops, on Friday afternoons. Students who take part in those have a better chance of passing the exam.” Which lecturer inspired you?

“Professor Hans Wittenberg was very good. He really was a talented lecturer. The way he structured his lessons and wrote derivations neatly on the board in chalk – a born teacher.”

**Have you borrowed any of his methods?**

“I use some of his jokes. In those days we had two chalkboards. If the board at the front was full, you’d slide it up and use the board behind it. But the frame wasn’t that high, so you’d have to get lower and lower to write on the back board. At one point, Wittenberg was crouched on his knees writing out formulas and said: ‘This formula is so beautiful, you have to bow down to it.’ (Laughs) I use that joke every now and again. He also had a special chalk jacket, because he sometimes came out of that lecture room covered in dust.”

**How do you keep the students engaged?**

“In the first-year Dynamics course I use two tricks. Firstly, I ask mini multiple-choice questions in between, online. Actively participating will get you a quarter of a bonus point. This is mainly about feedback. Students know where they stand and I know whether they have understood the material. The second trick I use is the ugly aircraft competition, an idea that I stole from a French test pilot who had to tell a boring story. After each section, I do a quiz where students can vote for the ugliest aircraft.

*The real challenge is that aircraft are getting better and carbon emissions are decreasing, but aviation is growing by 5% a year’*

I’ve pre-selected forty. In the following quarter, I teach the aircraft design course. One of the things you have to learn is to look at aircraft. Why is the undercarriage where it is? Why is that wing so big? Telling them something about each of those forty aircraft is a good way to prepare them for that course.”

**You also help Master’s students construct a two-person aircraft. Why?**

“I do that as part of my Education Fellowship (a TU Delft grant for educational innovation, ed.). We used to see lots of new types of aircraft on the market. They then became more complex and developments slowed down. Now you see only a few new types, but there is enormous growth. Producing aircraft properly is becoming more important. That means you need engineers who can oversee that process. That’s why we’ve started an ‘aircraft factory’ with a kit for a two-person aircraft, where everything is done in the same way as in a normal aircraft factory. Everything is certified: staff, materials, design, documentation, tools and training.”

**What do the students think about it?**

“I expected it to really take off, but that wasn’t the case. The students who participate are incredibly enthusiastic, but you can see that they



have difficulty with the fact that they have to take responsibility for the first time. People will die if you make a mistake, to put it bluntly. It’s the first time they’re confronted with that.”

**You teach about six courses, supervise graduating students, coordinate the Bachelor’s graduation project and are a member of all kinds of associations and boards. And you took part in the climate accord talks, you’re often in the media giving explanations and, according to students, you ‘always have time for a chat’. Where do you find the time?**

“I very rarely leave here before 20.00. I always say that I work half-days, from 9.00 to 21.00. You get used to it. I don’t have a wife and children, so that helps.”

**What can be done to maintain the quality of teaching today?**

“The numerus fixus is set at 440 but in this box (he points to a box full of exams, ed.) there are 480 exams taken by first-year students alone.”

**Have we reached the limit?**

“At times, yes. Individual attention is really a thing of the past. My biggest fear is that we will end up reviewing our teaching every year. It’s busy and

we also have to do some research, so let’s cut a few corners. It’ll be fine.’ And then again next year, and the year after that. You run the risk of looking back in fifteen years’ time and thinking: how did we let it come to this?”

**‘Flying is the new smoking’ and we all know the phrase ‘flight shame’. How are you tackling that in your courses?**

“That’s the biggest challenge of the future. The bad news is there’s no quick-fix. You can’t just put a few batteries in planes. The good news is that there’s a lot we can do. The real challenge is that, on the one hand, aircraft are getting better and carbon emissions are decreasing by about 1% a year, but on the other, aviation is growing by 5% a year. The second problem is that turnovers are high but profits are small. Worldwide, the net profit on a ticket is less than a tenner. That leaves little room for innovation.”

**How do you balance that?**

“There is no magic solution. You need more research and development. You need to invest. The planned flight tax is supposed to go towards innovation. We will have to introduce new aircraft more quickly, because they are cleaner, quieter, more economical and therefore cheaper. We need to look at alternative fuels, stop detours and switch to a single European airspace. That on its own could achieve savings of between 5% and 10%. But there’s a lack of political willingness to get it done. It’s a disgrace. We need more legislation and regulations and more social pressure. The best thing would be if that growth would slow down in the short term, so that we can catch up with innovations. That means that you will need well-trained people who also think about sustainability.”

**Do you have any tips for other lecturers?**

“Observe your colleagues. I used to go watch Wubbo Ockels. There are a lot of good teachers here. You can learn a lot from Calvin Rans, too.” <<



# A TU Delft forest

TU Delft wants a carbon-neutral campus by 2030. In a recently published report, researchers outline how the university can achieve this ambition.



**M**aking TU Delft carbon-neutral by 2030 is certainly ambitious. Maybe impossible? But not if you plant trees. And lots of them! If TU Delft were not to take any energy-saving measures whatsoever nor generate more renewable energy than it does at present, it would have to plant around 3,500 hectares by way of compensation in order to meet the target. That's an area almost one and a half times bigger than the city of Delft. This was calculated by architects Prof. Andy van den Dobbelsteen and Tess Blom. But a smaller area may suffice since there are many measures the university could take. With this in mind, Van den Dobbelsteen and Blom continued their calculations. On behalf of Campus & Real Estate (CRE), they wrote the report 'CO<sub>2</sub> roadmap for TU Delft'.

It provides an analysis of how much energy is currently used on campus and of the energy systems. It also explores measures that could be used to achieve this ambition.

## A 48,000-tonne footprint

TU Delft currently has a carbon footprint of almost 48,000 tonnes of CO<sub>2</sub> equivalents. The researchers talk about 'equivalents' because they also take into account other greenhouse gas emissions, such as nitrous oxide and methane. These have been factored into the footprint according to their global warming potential. Apart from natural gas for heating the buildings and electricity consumption, the effects of food consumed while working or studying on campus are also included in the calculation. As is water consumption, waste management,

business flights and commuting. The researchers want to minimise all these effects. They want to compensate the remaining CO<sub>2</sub> with sustainable energy or offset it by planting trees. When you think about carbon footprint, the first thing that probably comes to mind is all the buildings that need heating and the high electricity consumption of experimental installations. Wrong. Most (estimated at nearly 14,000 tonnes of CO<sub>2</sub>) comes from the food consumed during the working day. Second highest (more than 13,000 tonnes of CO<sub>2</sub>) is natural gas for building heating, largely via TU Delft's heating network. Electricity consumption ranks third (over 8,000 tonnes), followed by business flights (6,700 tonnes) and commuting (almost 5,000 tonnes). The rest covers

covering waste processing and water consumption. The researchers propose changing food pricing in the canteens; environmentally-friendly options should be cheaper; environmentally-unfriendly food (animal products) more expensive. They also want to experiment with new forms of food production on campus, for example, greenhouses on roofs and crops on vertical walls. The Prêt-à-Logerhuis at The Green Village. Showed that glass skin on a building has many advantages: it acts as a thermal buffer and heat collector, and can be used to generate electricity, increase user space and also to cultivate food. Van den Dobbelsteen and Blom suggest that greenhouses on the side of large buildings are also a good option.

## Energy systems on campus

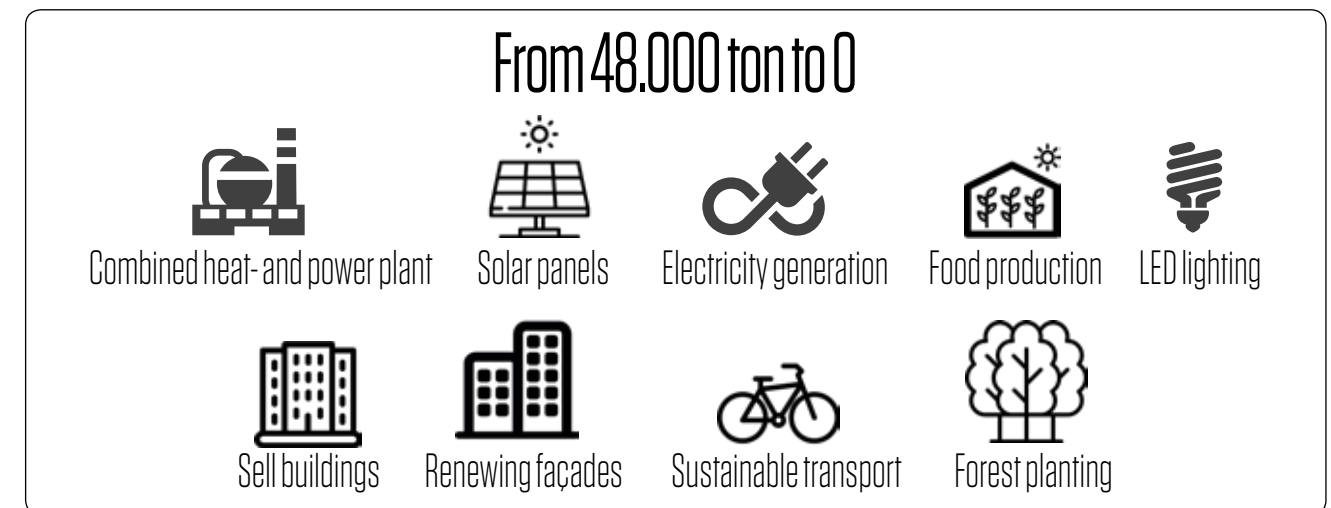
Thirty percent of current electricity demand comes from lighting. Switching to LED lighting is a simple first step. According to the authors, TU Delft will need to part with some energy-guzzling buildings. These could be demolished, but also sold. There are also four faculty buildings that score very poorly in terms of energy consumption. Of all the buildings on campus, the Applied Physics building (built in 1963) has the highest total energy consumption. This building's heat demand must be

reduced by 80%. The entire building envelope needs to be replaced. Only the load-bearing structure will be retained. Big changes will also have to be made to the façades of CEG, 3mE and EEMCS. The Combined Heat and Power Plant (Building 43) has a crucial role to play in making the campus more sustainable. It is supplied with natural gas and provides the campus with hot water for heating and some of the electricity. The plant needs to switch to geothermal and other forms of renewable energy. TU Delft has an ambitious plan to produce geothermal energy. It is expected that, by the end of 2020, two pipelines will have been bored from the campus to a hot-water reservoir, more than two kilometres below the A13 motorway. This geothermal energy source, at 75 degrees, will be used to heat buildings on campus and in the surrounding area. In addition, the campus will need infrastructure for exchanging heat and cold. 'Smart exchange, coupled with seasonal storage of heat and cold, is a must for a university that focuses on sustainable, innovative energy systems', the researchers write.

## Solar panels and wind energy

TU Delft currently has about 1.1 megawatts of solar panels spread across the campus, covering 1% of total electricity consumption. That's not enough. CRE has a commissioned a study to find out where more panels can be installed. "There are more and

more integrated PV solutions available, which means that in addition to rooftop generation, façade generation is also interesting option," says CRE's Maria Hänsch. Despite all the energy-saving measures TU Delft will actually need even more electricity, to power geothermal pumps and heat pumps and to cope with the electrification of mobility (there will be more and more electric cars). The Combined Heat and Power Plant and solar panels alone will not be enough. The remaining demand is currently covered by imported wind energy, which is virtually carbon neutral. Towards 100% sustainable transport According to the researchers, a sustainable campus should, first and foremost, move away from road traffic. There should be more and faster cycle routes to the campus and more business Public Transport cards, say the researchers. Electric and hydrogen cars should be encouraged. And it would 'be great for TU Delft if the tram that runs across campus could be powered by batteries that are themselves recharged on campus using sustainable electricity'. The researchers conclude that 1282 hectares of forest will need to be planted to make the campus carbon neutral. That's over five times the surface area of the campus. Or 2564 football fields. Will those trees actually get planted? CRE can't commit itself just yet. <<





# Force on the stick

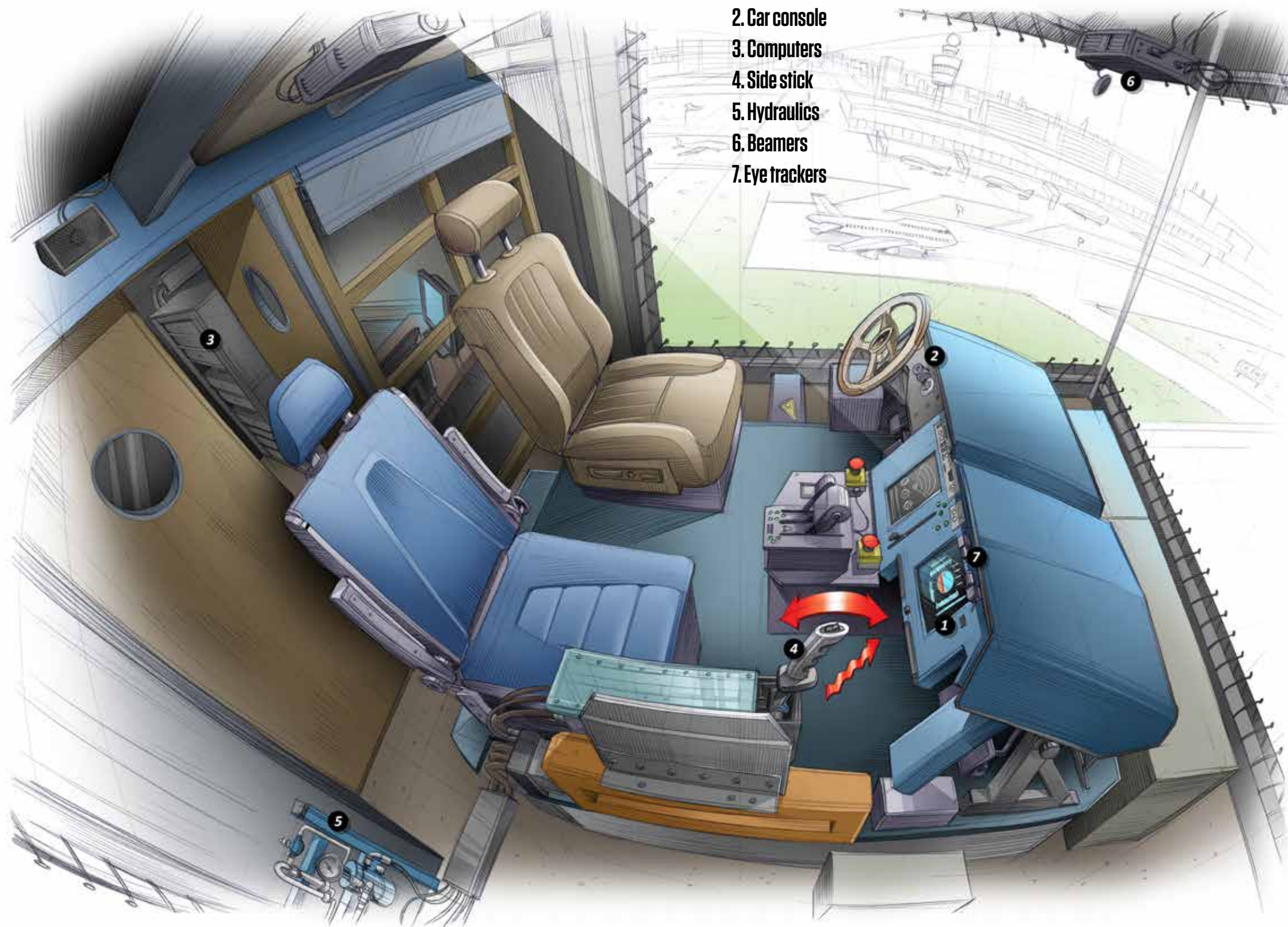
How do people steer a plane or drive a car? That's the key question for researchers at the Human Machine Interaction Laboratory (HMI Lab) at Aerospace Engineering.

**T**est subjects are asked to keep a cross on a moving dot while computers measure their reaction speed, precision and strength. The installation can also be used as a simulator in which pilots can be introduced to new supporting technologies that they could come across in cockpits of the future.

The lab was originally set up as an aircraft simulator, until research simulator Simona (Simulation, Motion, Navigation) largely took over that role. The left side of the installation is fitted with a steering wheel and pedals instead of a stick so that driving can also be simulated. All the screens and hardware are controlled by six computers. These computers perform their calculations, each with their own update speed, varying between 100 (screens) and 2000 times per second (stick). Two computers provide images of the surroundings. Others power the primary flight screen and the navigation screen, keep track of data (data logging), measure and control the stick, foot pedals and the steering wheel. The in-house developed operating program, Dueca (Delft University Environment for Communication and Activation), ensures that all the computers are in sync with each other and that simulation programs run just as easily on the six HMI Lab computers as on the Simona or a laptop.

"The research topics always come from outside TU Delft," says Dr Daan Pool, assistant professor in the Control & Simulation section. As an example, he mentions the study into haptic feedback on the stick (in this case, a side stick). Accident analyses have shown that pilots sometimes don't know when they're getting into trouble. Exerting a force on the stick, in this case with pneumatics, is a direct way to inform the pilot when the aircraft is approaching its limit. Doctoral candidate Dirk van Baelen is researching the effectiveness of this method. It's similar to Nissan's accelerator pedal that pushes back if you're approaching the vehicle in front too quickly. This technique was also tested in this installation.

"Many ideas for supporting technologies in aviation now end up in cars," says Pool. An example is lane assist, which makes sure that cars stay between the white lines. But things tend to happen a lot faster in cars than in planes, and not everyone is happy that the wheel does its own thing. That's why a lot of research still needs to be done to find the best possible balance between man and vehicle. **JW**



1. Navigation screen

2. Car console

3. Computers

4. Side stick

5. Hydraulics

6. Beamers

7. Eye trackers



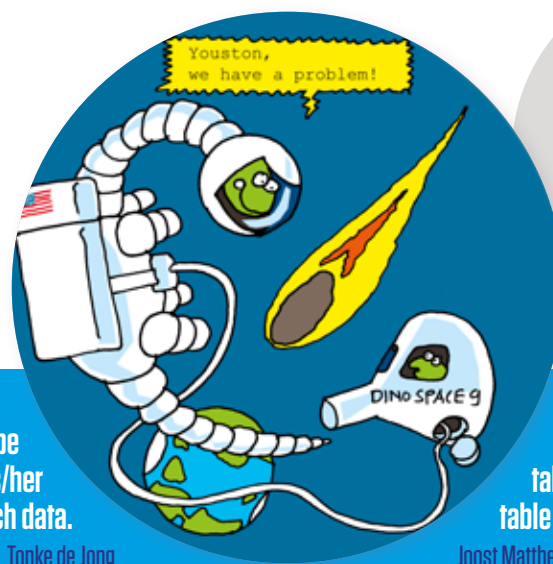
**HORA EST**

## Gender equality is as impossible as it is necessary and more achievable with generous and equally shared parental leave.

Dr. Emma Westsson, chemical engineer.

"I was concerned when I noticed that at every step going up the academic ladder, the share of women gets smaller. When our two daughters were born while I was working on my doctorate, it became clear to me how difficult it is to combine an academic career with starting a family, given the current employment conditions. Parental leave at universities is too short, and you end up taking unpaid leave to care for your children. In the Netherlands, it was ironically considered

a major improvement when parental leave for men was increased from 2 to 10 days. In contrast, Swedish couples get 18 months paid joint parental leave, and it's up to them to decide how to divide the time. It seems like the most obvious thing: A baby has two parents (typically) so the responsibility is shared – to everyone's benefit. And yet, proposing more generous and equal parental leave seems to be very controversial."



**A scientist should also be assessed on the impact of his/her research data.**

Tonke de Jong

**The dinosaurs became extinct because they did not have a space programme**

Larry Niven

**Placing a coaster under a table leg does not make the table top level.**

Joost Mattheijer

**Political correctness is counterproductive.**

Victor Chavarrias

**Technology is not neutral.**

Ernst Joachim Houtgast

**Experimental ill-defined details such as 'room temperature' or 'overnight' should be banned from scientific literature.**

Emmanuel Skupien

**European people eat to live; Dutch people eat to not-die.**

Qiang Liu

**The belief in bizarre conspiracy theories is the result of man's natural tendency to be freed from responsibilities.**

Mateo Bonci

# After Delft

When the banking crisis rocked the construction industry in 2008, the young architect Thera Huijsmans found herself without a job. She now teaches at a technasium and founded Archiklas.

"I really didn't have a clue what I wanted to study," confesses Thera Huijsmans (1979). When she heard one of her friends talking enthusiastically about his work as an architect, she decided to study architecture. She was drawn by the combination of creativity and science. She found the first year particularly difficult. "Most of the other students had made a very conscious decision to study architecture and used models in their presentations; I turned up with drawings on squared paper. I had no idea! I started my studies with a fail." After a somewhat difficult time during the Bachelor's phase, things picked up during her Master's degree in Architecture and Modernity and she graduated in 2006. Huijsmans

## 'We need to involve children in social issues'

looks back on a vibrant social life as a member of the Sint Jansbrug student association and she did an internship abroad. She then got a job at an architects' firm. But when the financial crisis rocked the construction industry in 2008, she lost her job. "A lot of architects I knew started to retrain. I decided to do the short version of the PABO because I liked interacting with kids. After that I ended up at WeekendKlas Leiden, where children from less privileged backgrounds are taught by architects,



**Name:** Thera Huijsmans  
**Place of residence:** Rotterdam  
**Civil status:** Living together, three children  
**Programme:** Architecture, Master's degree in Architecture & Modernity (2006)  
**Student Society:** Sint Jansbrug

confectioners and doctors. It's a great way for them to find out about jobs that they perhaps don't know much about." Huijsmans is now a research & design teacher at the technical department at the Christian Lyceum in Delft. Last year, Huijsmans teamed up with Karen Schuijt and Maël Vanhelsuwé to launch Archiklas, an initiative aimed at introducing primary school children to the principles of inquiry-based and design-based learning. The first pilot programmes have since come to an end. "You can apply a design cycle like this, which is used in architecture, to all kinds of subjects. I want children to use it as a tool to look at problems and solve them. Archiklas teaches them how to brainstorm, analyse, sketch variants and be critical. Children have an open

attitude and are enthusiastic about this form of learning." Archiklas is not only for schools, but also for municipalities and companies. For example, the municipality of Rotterdam asked Archiklas to develop climate talks for children. "We need to involve children in social issues. Our clients find Archiklas's open and flexible way of thinking refreshing." Through Archiklas, Huijsmans has found a bridge between the PABO and architecture. And yes, she has Delft to thank for that. "When we kept having to do analysis after analysis, I often thought to myself: 'Here we go again.' When I was studying, I didn't really know what I was learning. Now that I'm working, it all makes sense. I wouldn't have been able to do all this had I not done that degree." 





# Fat glass, the building brick of circularity

The solid glass façade of Chanel's Crystal House in Amsterdam was their breakthrough. Three years on, Faidra Oikonomopoulou's and Telesilla Bristogianni's 'fat glass' has colour, curves and circularity.

Read more on page 34



The glass brick wall of a boutique in Amsterdam's PC Hooftstraat is a spectacular sight. Its structure mirrors the masonry of the adjacent premises with its trio of high windows set in classic rigid brickwork. But the boutique's bricks at street level are made of solid glass. MRVDV architects came up with the original design of this 'Crystal House' after consulting Professor Rob Nijse (Faculties of Civil Engineering and Geosciences and Architecture and the Built Environment) and Dr Fred Veer (Faculty of Architecture and the Built Environment) because of their expertise in 'structural glass'.

#### 10 times more pressure-resistant

Glass is commonly considered as a fragile and unpredictable material. Nijse has proven in numerous architectural projects that solid glass can be used to build load-bearing structures. Lab tests have shown that the Italian-manufactured glass bricks specially created for this purpose were 10 times more pressure-resistant (200 MPa) than normal bricks. The proviso was that the bricks had to be extremely flat and glued together with a special UV activated glue. In Civil Engineering's Glass

Construction group, two Greek PhD candidates, Faidra Oikonomopoulou and Telesilla Bristogianni, performed the load tests on the glass bricks with the help of technician Kees Baardolf. They also spent seven months on the construction site in Amsterdam where they taught builders and masons how to construct the glass brick wall within a tolerance of 2 millimetres over the entire height of 10 metres. Their efforts on the 'Crystal House' were rewarded with the Innovation Award from the Society of Façade Engineering in London on 1 December 2016. Under the motto 'Fat glass is our baby', the PhD candidates declared their devotion to the transparent yet robust material.

#### Color and curves

Three years later, the Glass Lab in the Stevin II Hall of the Civil Engineering building has undergone a major extension. Their original workplace, a dark corner under the stairs, has given way to a roomy and light space. In the back, there are two large furnaces the size of walk-in cupboards. Dozens of glass cubes, forming a pallet of colours and patterns, lie on a large table. Next to them are small piles of glass bricks. Some look like Lego blocks, others are shaped like shackles from a chain. The



Re3 Glass – upcycling waste glass into a visually attractive and durable building material.

material has changed as well. There's not only colourless transparent glass but some shapes are semi-transparent with frozen whirls of colour while others are as opaque as marble.

### They also spent seven months on the construction site in Amsterdam

In the hands of Bristogianni and Oikonomopoulou, fat glass has diversified. It now has colour, patterns, shades of transparency, and curves. Despite the great variety of glass products – think of crystal, optical glass, laboratory tubes, car glass or TV tubes – glass from bottles is the only type that is recycled (73.5 % in the EU). Other types of glass are kicked out of the recycling system because of a toxic heavy metal content or because metal specs called intrusions will cause cracks in bottles or window panes. It ends up in landfills, road foundations, or as grains on abrasive

paper. Ironically, glass that is routinely trashed often reveals unexpected beauty when melted and cast as small cubes. The form of the original glass, the size of the grains, the melting temperature and the speed of cooling all influence the outcome of the cast glass. "The higher the temperature, the more homogenous the melt," says Oikonomopoulou. "This means that higher temperatures create clearer glass." Bristogianni adds that the speed of cooling influences the crystallisation process. More crystals grow in the material during slow cooling. "Melting glass is like a cook book," she says. "There are so many variables that will lead to a totally different outcome."

#### Cook book

Much of their research has been to build an inventory of the various types of glass and their ability to be reused as cast glass. In a paper\* with Prof. Nijse and Dr Fred Veer, Oikonomopoulou and Bristogianni give a glimpse of their glass cook book. They mention, for example, that TV tubes and crystal tableware with high heavy metal content are nonetheless 'excellent sources' for kiln-cast glass with a melting point of between 750-900 degrees Celsius. Window glass and mouth-blown remnants require a higher temperature and quick cooling to become fully transparent. Alternatively, lower temperatures and slower cooling results in a less homogenous and visually more appealing material. The possibilities seem endless. Looking back to the Crystal House, the researchers in the Glass Lab have developed more naturally shaped building blocks that don't require chemical glues to stick. "Cooling glass naturally takes on an egg shape," says Oikonomopoulou. "That's why we developed curved forms instead



of rectangular bricks." Another innovation is the interlocking form of building blocks. They fit onto each other like Lego – and they can be taken apart anytime to be reused.

#### Showcase for sustainability

The Glass Lab has developed a process it calls Re3 Glass – upcycling waste glass into a visually attractive and durable building material. The procedure consists of recycling discarded glass, reducing material demand and the embodied energy, and making reusable building material that doesn't require chemical glues. Reduce, reuse, recycle. That philosophy, applied to waste glass, earned them a nomination for the New Material Award 2018. The jury considered Re3 Glass to be a showcase for sustainability. Because of the inherent variety in incoming material, Re3 Glass will probably fit special architectural projects better than large scale industrial processes. Oikonomopoulou and Bristogianni envision the production of tailor-made badges of 3D glass elements for façades, floor slabs or interior design objects. "Glass

bricks are the building blocks for circularity," Oikonomopoulou says suddenly. That's nicely put.

*\* Faidra Oikonomopoulou defended/ will defend her PhD thesis Unveiling the third dimension of glass. Solid cast glass components and assemblies for structural applications on 25 November 2019. Telesilla Bristogianni expects to finish her PhD in 2020.*

*\*) Telesilla Bristogianni, Faidra Oikonomopoulou, Clarissa Justina de Lima, Fred A. Veer, Rob Nijse, Structural cast glass components manufactured from waste glass: Diverting everyday discarded glass from the landfill to the building industry, Heron, Vol. 63 (2018), No. 1/2*

**In 2017 Delta published an interview with the two PhD's about the glass façade of the Chanel shop: [www.delta.tudelft.nl/article/fat-glass-our-baby](http://www.delta.tudelft.nl/article/fat-glass-our-baby).**



## IN PERSON



**Djonno Bresser** was named Best Graduate of 2019. He graduated from the Faculty of CEG with a project on modelling cracks in concrete structures. He was presented with the award by Evelyn Esveld, director of the University Fund, on Education Day, which was held on 12 November. He received a 9.5 for his thesis, graduated cum laude, obtained 138 ECTS instead of 120 and his model was used in the software program Diana.

Alumnus **IJsbrand de Lange** received the Inspiration Award during the opening of the 2019 academic year. This award goes to a student who inspires the new cohort of students. De Lange founded Stil, a MedTech start-up that is developing a wearable for suppressing tremors in arms.

Every year, TU Delft appoints four new **Education Fellows**, who receive a grant for educational innovation. Lecturers, professors and assistant professors are eligible for the Fellowship if they make a 'visible, substantial and valuable' contribution to education at TU Delft. This year's newly appointed Education Fellows are **Reinout Kleinhans**, urban geographer and associate professor at ABE, **Rolf Hut**, physicist and MacGyver researcher, **Astrid van Laar**, who teaches Dutch to internationals at TPM and **Jeroen Pruyn**, associate professor at 3mE.

*A lamentation*

When Victor van der Chijs (University of Twente) passed on the 4TU chairperson's gavel to his successor Louise Fresco (University of Wageningen), he sounded the alarm in Het Financieel Dagblad (FD) newspaper. That was to be expected – universities of technology (TU) are good at doing that.

There are always too few students. Or too many, like two years ago.

Or rather, there was not enough money to accommodate the hordes of aspiring engineers who came knocking on their door. Numeri fixi were introduced to square that circle, which inevitably caused an uproar because there weren't enough technicians.

It's true, more young people are going down the technical route, said Van der Chijs in the FD, but even then the TUs are unable to meet market demand. And who is to blame for that? The Cabinet. Apparently, they're still not doing enough to train more scientists.

But hadn't the Cabinet promised more money for technology in the coalition agreement? Didn't the Van Rijn Committee recommend transferring money from general universities to TUs? And hadn't the Cabinet and the House of Representatives adopted that advice? Yes. But that goes nowhere near far enough.

If you look at the figures, you will see that between 2013 and 2018 the number of students at all universities increased by 17%. That's 14% if you exclude the TUs. Because the number of students at TUs increased by no less than 31%. There is more money, there are more

students, and yet there is

still cause to complain.

If only a fraction of the woes that have been predicted over the past few decades had materialised, the Netherlands would no longer exist.

Which industry is now suffering from a lack of engineers? Which companies have gone bankrupt? Or left the country? Where are engineers' salaries rocketing?

And while we're at it, can

someone explain to me why TUs need to keep running 70 Bachelor's programmes and 159 Master's programmes with 454 specialisations? Is that all for the benefit of that "market" or is it because nobody wants to shut up shop?

Putting quality above quantity can lead to growth. Fewer degree programmes means more money for those that remain. World-class programmes that also attract more international students. Because apparently they don't know we exist either.

From now on, every time someone sounds the alarm about a lack of money, students or whatever else, I want to hear a concrete example of what will happen if that money and those students never turn up. And then let's also hear what the TUs are going to do to get their own house in order.

Remco de Boer is a technology and science communications expert.



## THE FIRM

It was at TU Delft's MAVlab that two researchers hatched an exciting idea: to combat insects with a drone. Now they run Pats.

It sounds like science fiction – computer-controlled mini-drones plucking insects out of the air at lightning speed – but it's actually the product being developed by Pats. Founders Kevin van Hecke and Sjoerd Tijmons know each other from their time at TU Delft's Micro Air Vehicle Laboratory (MAVLab). Brother Bram Tijmons is the third founder.

*'We want to use our drones to pluck the moths out of the air before they reproduce'*

He studied business administration in Rotterdam and takes care of the commercial side of the business. The idea arose when, one morning in 2016, Sjoerd arrived at the MAVlab completely exhausted. He'd had a bag night's sleep courtesy of mosquitos buzzing around his room. "We thought: 'we work in a drone lab; can we come up with anything to tackle this?' After some trial and error we managed to pluck an insect out of the air with a mini-drone. A few more experiments later, we started to think it might be a marketable product." The system proved to be less suitable for the bedroom, since it requires an expensive computer and a camera. In the greenhouses in Westland, however, there are possibilities aplenty. "In glasshouse horticulture, they have a lot of problems with insect pests such

as moths," says Bram. "Those critters lay their eggs all over the place. The caterpillars that emerge cause a lot of damage. You can only control them using insecticide and even that is not always effective. We want to use our drones to pluck the moths out of the air before they reproduce."


The system is currently being tested in three greenhouses. A camera with infrared light detects the moths and a computer calculates the drone's path. The mini-drone itself is actually very simple: four plastic propellers with a rechargeable battery and a flight controller. "The drone flies towards the moth at lightning speed and sucks it up through a propeller, creating moth confetti," says Kevin.

According to Bram, the biggest challenge in business is being able to



Kevin van Hecke (left) and Sjoerd Tijmons.

Company: **Pats, Indoor Drone Solutions**  
 Founders: **Kevin van Hecke, Sjoerd and Bram Tijmons**  
 Degree programme: **Kevin: MSc in Embedded Systems, Sjoerd: MSc and PhD in Aerospace Engineering, Bram: MSc in Business Administration in Rotterdam**  
 Product: **Indoor drones for insect control**  
 Founded in: **2018**  
 Employees: **Five full-time (including the three founders) and one intern**  
 Turnover: **Negligible.**  
 In five years' time: **A regular feature in greenhouse horticulture, with the system installed in 1000 greenhouses**

develop as fast as you want to deliver. "There's a lot of interest in our system. We are keen to make deals with greenhouse horticulturists, but while the product is still under development, we can't make any promises." At the moment, the main revenues are investments and subsidies for the further development of the system, which the company uses to pay two full-time employees and an intern. The aim is to launch the product on the market as soon as possible. "If we can help reduce the use of insecticides at the same time, that would be a nice bonus," says Bram. "Idealism in business is allowed." 



# TU Delft and university rankings

TU Delft is doing well in international university rankings and we are proud of that, says President of the Executive Board Prof. Tim van der Hagen. “We want to maintain and, where possible, improve our strong position in these rankings.”

TEXT: AGAATH DIEMEL EN ALEXANDRA CZARNECKA ILLUSTRATIONS: TU DELFT

**H**ow important is a university's position in these international rankings? And what does it actually mean? “A position in the rankings is not in itself a goal. It should be a logical consequence of our educational and research efforts to meet the needs of society,” says Van der Hagen. International students use rankings to compare universities so that they can make their choices. Scientists also prefer to work at institutes that do well in leading rankings. Rankings therefore help attract top talent from

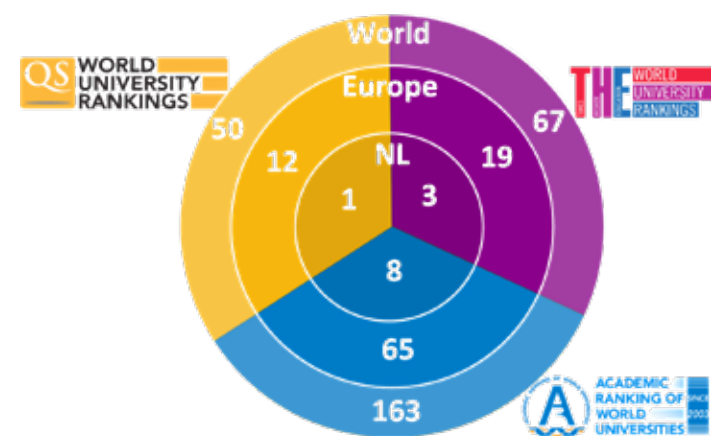
home and abroad. And employers are giving more weight to a university's ranking to see where their applicants studied.” Van der Hagen continues. “TU Delft is well placed in many rankings and our 100,000 engineers across the world and we should be very proud of this. At the same time, we should also be a little cautious.” There are many organisations that compile the rankings and new rankings are added regularly, each with a different focus. The position of a university can change dramatically between these rankings. It's

sometimes hard to see the wood for the trees and it makes you wonder how these rankings work. The organisations behind the rankings make choices and assumptions on which to base their assessments. They use subjectively chosen quantitative indicators that are supposed to give an indication of the quality.

## Set rankings and multi-year perspective

For TU Delft, three international rankings are particularly important. These are the Quacquarelli Symonds (QS), the Times Higher Education (THE) and the Shanghai Ranking

## World University Rankings



## Subject Rankings



(ARWU). Internationally, these are the best known rankings. They have track records and are fairly consistent in terms of methodology and publishing. All three differ in the way in which they compile their rankings so we can assess our position in the world from different perspectives. In addition to a World University Ranking (WUR), they also look at issues such as reputation or the employability of graduates and they produce rankings per subject. Of these three rankings, TU Delft scores particularly well in the QS and THE, featuring in the international top 50 and 70 respectively. In Europe, TU Delft is even in the top 20 and in the Netherlands in the top three. TU Delft's position in the ARWU is slightly lower. “That's mainly because the ARWU focuses on different things,” explains Van der Hagen. “Its indicators depend on a small number of individuals, such as Nobel laureates, which count for 50% of your position. We don't score very high on this, but should we produce a Nobel Prize in the near future, we will shoot up the table.” “We won't get overly excited if we move up three places in a ranking,”

he emphasises. “And we won't get worried if we drop a couple of places either. Our current position might be good, but the long-term trend is more important. All three WURs and the two Engineering & Technology rankings have shown a relatively stable upward trend in recent years, with a slight fluctuation from time to time.”

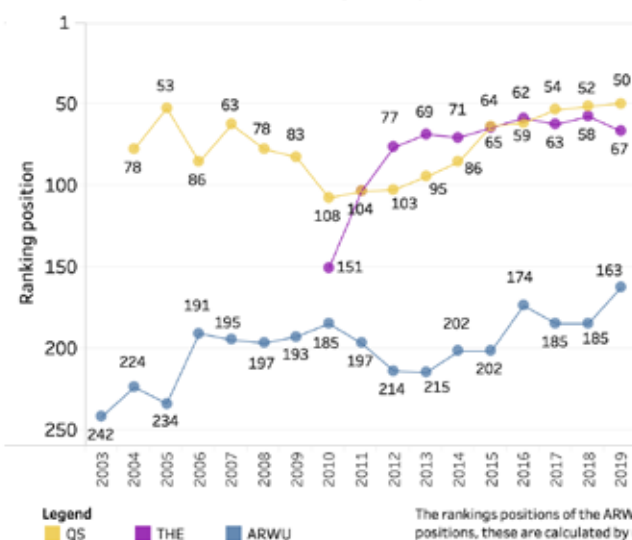
## Subjects

Given that TU Delft is a technical university, the Engineering & Technology rankings are the most relevant rankings. The subject rankings are useful for individual departments and faculties. TU Delft holds a number of international top spots: Architecture, Civil & Structural Engineering, Mechanical, Aeronautical & Manufacturing Engineering, Water Resources, Transportation Sciences, Marine/Ocean Engineering, Aerospace Engineering and Chemical Engineering.

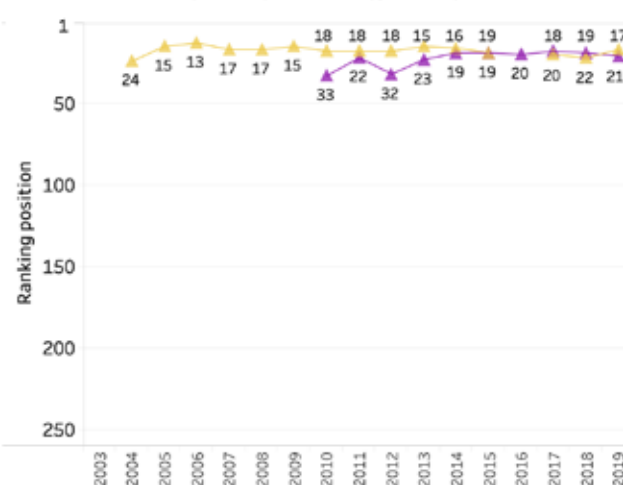
**Read all about the rankings on**  
<https://www.tudelft.nl/en/about-tu-delft/facts-and-figures/rankings>.

<<

Trends in QS, THE and ARWU Rankings  
World University Rankings



Engineering & Technology Rankings



The rankings positions of the ARWU (Shanghai) ranking are partly published in brackets. The graph shows the recalculated ranking positions, these are calculated by using the indicators scores and their weightings.

## You too can determine the rankings. Share your thoughts!

The most important indicator in the QS WUR ranking is reputation as it determines half of the score. To calculate this, QS conducts an annual survey. Are you an academic? Or do you have regular contact with graduates? Then you too can take the QS Global Academic Survey or the QS Employer Survey on [www.iu.qs.com/survey-signup](http://www.iu.qs.com/survey-signup). If you are selected by QS, you will receive an invitation between January and March 2020 to take the survey. You can then choose the universities that you think excel in the field of research and education in the Netherlands and abroad.

# 'I donate to TU Delft because I think the future is important'

Delft University Fund will celebrate its 95th anniversary in 2020. A lot has happened in those years, and alumnus Anton van den Berg would certainly agree. This year he too turned 95, and recently he started donating to science via Delft University Fund.

TEXT: ELLA DONGSTRA AND AGAATH DIEMEL  
PHOTO: ERNST DE GROOT

According to Anton van den Berg, his studies were the perfect start to his career and everything that followed. As a chemical student, he was a member of the Delftsche Studentenbond (DSB) student association. In 1952, he graduated from what was then the Delft Institute of Technology. "After my studies I went straight to Phillips in Eindhoven. There was a shortage of university graduates in those days. Chemical engineers were immediately approached by Philips as soon as they graduated. I didn't have to take any action myself. I simply got recruited; that's how things were back then," says Van den Berg.

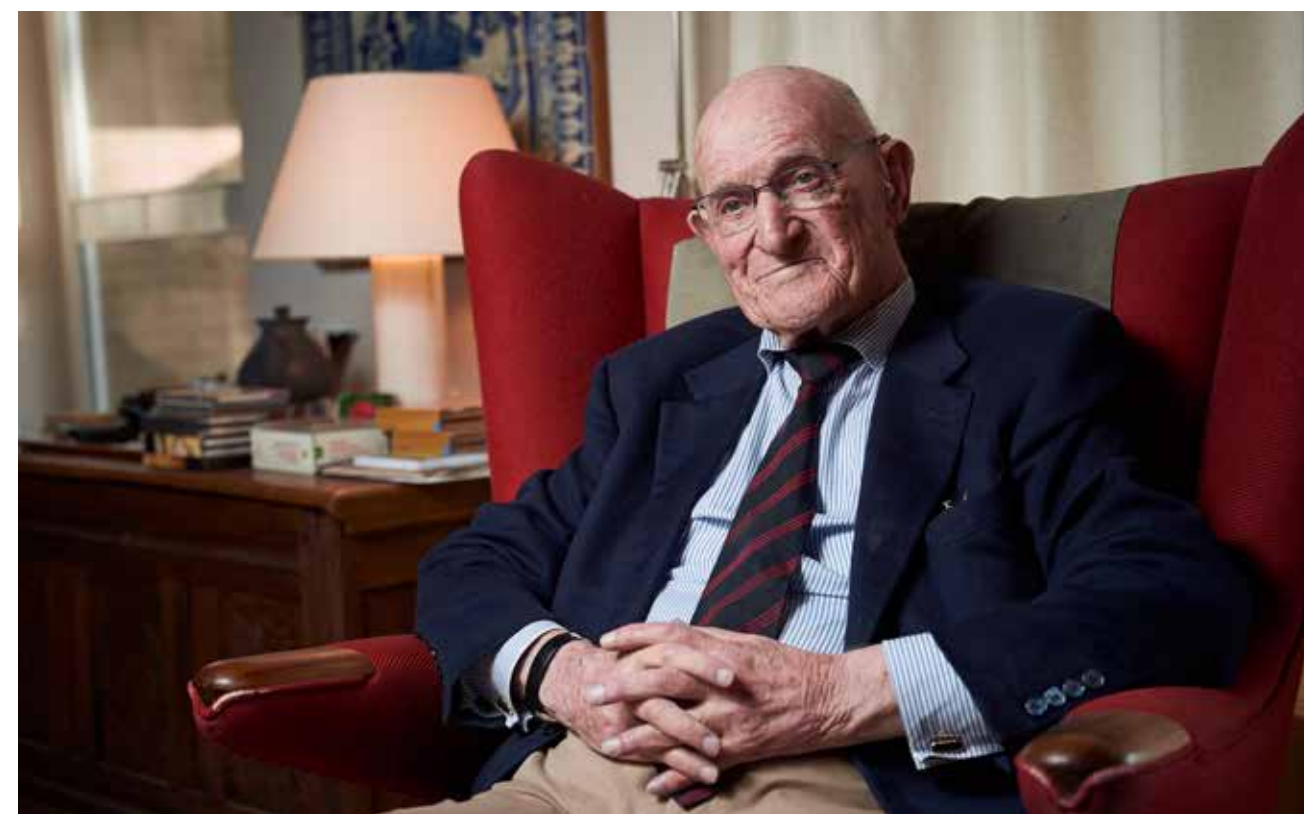
## Teething problems

In his house in Hummelo he shows prints on the wall of Pico da Neblina, the highest mountain in Brasil, where he moved for work in 1954 and of which he has fond memories. "Philips had only been operating there for a few years, so there were plenty of teething problems. For example, I remember the Bakelite paint issue," he says. This early plastic had a disadvantage: its ugly brown colour. So Philips painted a series of

its radio cabinets in a different colour. "However, those radios contained heavy transformers that became terribly hot. These transformers were all in the same place in the device. The Bakelite above it got so hot that it scorched and turned brown again. That was a huge disaster as it affected the entire series." As a chemical

## 'People who retire take a lot of knowledge with them'

engineer, Van den Berg always enjoyed solving teething problems like this. He stayed in Brasil for nine years; three of his four children were born there and they are proud of their Brazilian nationality. His fondest memories of his career are also from his time there. "I often think back to the time when I travelled from Sao Paulo to Rio de Janeiro every week to a factory where vinyl gramophone records were made. That factory was at an altitude of 700 metres, near a waterfall. This turned out to be very useful for the vinyl pressing process, because the ice-cold water from the waterfall could be



Ir. Anton van den Berg: "I'm a bit old-fashioned in that I've only had one employer."

used to cool the records. At the time, the factory was quite primitive by European standards, but we produced very good gramophone records." He returned to Eindhoven in 1962. "I'm a bit old-fashioned in that I've only had one employer, and Philips was an excellent place to work. They already had a good pension scheme in those days and it's still pretty good today." He was plant manager at the Philips factory in Doetinchem from 1966 to 1970, after which he was asked to move to Portugal. He had already mastered the Portuguese language during his time in Brasil. "I had a Brazilian accent of course, which my colleagues in Portugal found very amusing."

## David Rockefeller

He was technical director for Philips in Portugal until 1982. He then retired, but continued to live in Portugal for another twelve years. During those

twelve years, he worked as country director for the American organisation IESC, the International Executive Service Corps, founded by banker and philanthropist David Rockefeller. "People who retire take a lot of knowledge with them," says Van den Berg. "Rockefeller didn't want that knowledge to go to waste – he wanted to use it to set up relief agencies in other countries that could help local businesses." The IESC operates in 137 countries and aims to reduce world poverty by supporting the private sector.

Van den Berg doesn't really have any advice for the newest generation of engineers: "Life just happens. Before you know it, you'll be 95," he says, laughing. His age played a role in his decision to donate to medical themes, such as Stan Brouns' bacteriophage research, Marcel Reinders' Alzheimer's research and Mark Bisschops' dementia research.

Van den Berg had to say goodbye to a lot of people, including his wife with whom he was together for 70 years. "I've also lost almost all of my friends, many of whom suffered from a form of dementia. It would have been great if there had already been a cure for." <<

**Are you inspired by this story? And do you also want to explore the possibilities for permanent involvement at TU Delft? Then we would like to get in touch with you. Send an email to [alumnirelations@tudelft.nl](mailto:alumnirelations@tudelft.nl).**

**Would you also like to contribute financially to research with impact? For more information please contact Jacqueline Kalkman, via [ufonds@tudelft.nl](mailto:ufonds@tudelft.nl), +31(0)15 278 6409 or have a look at [www.tudelft.nl/en/delft-university-fund/research](http://www.tudelft.nl/en/delft-university-fund/research).**



# ALUMNI NEWS

## Alumni Activities

**9 January 2020**

Alumni Event - Orlando

**10 January 2020**

Celebration 178<sup>th</sup> Dies Natalis - Delft

**11 June 2020**

TU Delft for Life | Xperience Day - Delft

**4 July 2020**

Karel Luyben Lunch Lecture - Bandung

**5 July 2020**

Karel Luyben Lecture - Jakarta

Sign up on the alumni community platform  
tudelftforlife.nl or on the alumni.tudelft.nl  
website.

### Get in touch

Questions, comments or ideas?

Email: [alumnirelations@tudelft.nl](mailto:alumnirelations@tudelft.nl)

Website: [alumni.tudelft.nl](http://alumni.tudelft.nl)

Community: [tudelftforlife.nl](http://tudelftforlife.nl)



'TU Delft for Life' is the online community for all TU Delft alumni. Expand your network, meet your old university peers and stay up to date on the latest news and events. Sign up on [tudelftforlife.nl](http://tudelftforlife.nl). You can also change your contact details and communication preferences there.

## A big thank you to over 5,000 alumni

This year, we invited you to share your opinions on alumni activities, give us feedback on your studies, and share with us your wishes with regards to professional development.



We were overwhelmed that more than 5,000 of you participated in this survey, and we are grateful that so many of you gave us valuable insights into the needs and wants of our alumni. Although we are still working to analyse all of the data, we have already identified some general outcomes.

### Access to TU Delft Library

One of the outcomes was that many of you would like to keep access to scientific articles after graduation.

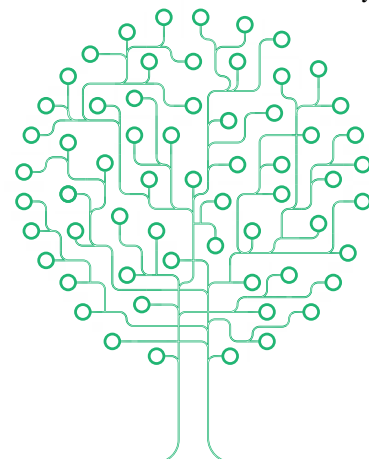
We have therefore arranged a free Lifelong Library card for alumni. For more information, please visit [alumni.tudelft.nl/benefits](http://alumni.tudelft.nl/benefits).

### Giving back

Also, many of you indicated your willingness to give something back to the university. There are many ways to do so. Please visit [alumni.tudelft.nl/givingback](http://alumni.tudelft.nl/givingback).

## Alumni welcome to Dies 2020

On Friday, January 10, 2020, TU Delft will celebrate its 178th anniversary as



a university. That means 178 years of impact on and by students, employees, alumni and partners of TU Delft. This anniversary is the perfect time to get together with all the people who form our university today: to celebrate what we have achieved so far, and also to look ahead. Because everything we do now influences our future. Keynote is the Dies Natalis lecture "Design for Values" by professor Paul Hekkert. Traditionally, it is also the time for granting honorary doctorates. For more information, visit [www.tudelft.nl/dies](http://www.tudelft.nl/dies).



## INHABITING a LIVING HOUSE

**TU Delft is teeming with talent. With the help of generous donors, Delft University Fund supports talented students in developing their ambitious ideas. In 2019, almost 7000 students received a grant from Delft University Fund.**

One of these talented students is Bob Hendriks. During his master's thesis at the Faculty of Architecture and the Built Environment, he researched living architecture. In his research, he explored mycelium, an underground network of fungi and threats, with which he developed living building materials. According to Bob, we should look out for new ways of building, by which raw materials are kept alive instead of killed. With the help of Delft University Fund, a full-scale model of his living house "Mollie" was shown at the 2019 Dutch Design Week.



Hendriks: "I am very grateful for having the opportunity to share my project with a large audience and for being able to make people enthusiastic about building with living materials."

{ 'IF WE CONTINUE BUILDING LIKE WE ARE DOING NOW, ALL RAW MATERIALS WILL SOON BE GONE AND LIFE ON EARTH WILL NO LONGER BE POSSIBLE'  
Ir. Bob Hendriks

### WILL YOU HELP?

Do you want to make impactful ambitions of talented students like Bob Hendriks possible? You can give TU Delft students the opportunity to excel with an extra gift on account number NL48 ABNA 0441 4822 95. Thank you for your support!



# The lab of...

## Architecture and the Built Environment

Architecture Master's students Bart Schipper and Dobrochna Lata are building a full-scale replica of the Holocaust Memorial in Berlin. They covered the box with concrete wallpaper to make it look exactly like the blocks used in the monument. They want to simulate how the disabled, the blind and children experience the monument. During their presentation, they give their fellow students headphones playing sounds of the city and blindfolds, or have them sit in a wheelchair. The aim is to investigate how different groups act at a memorial.

