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# Portraits of Science

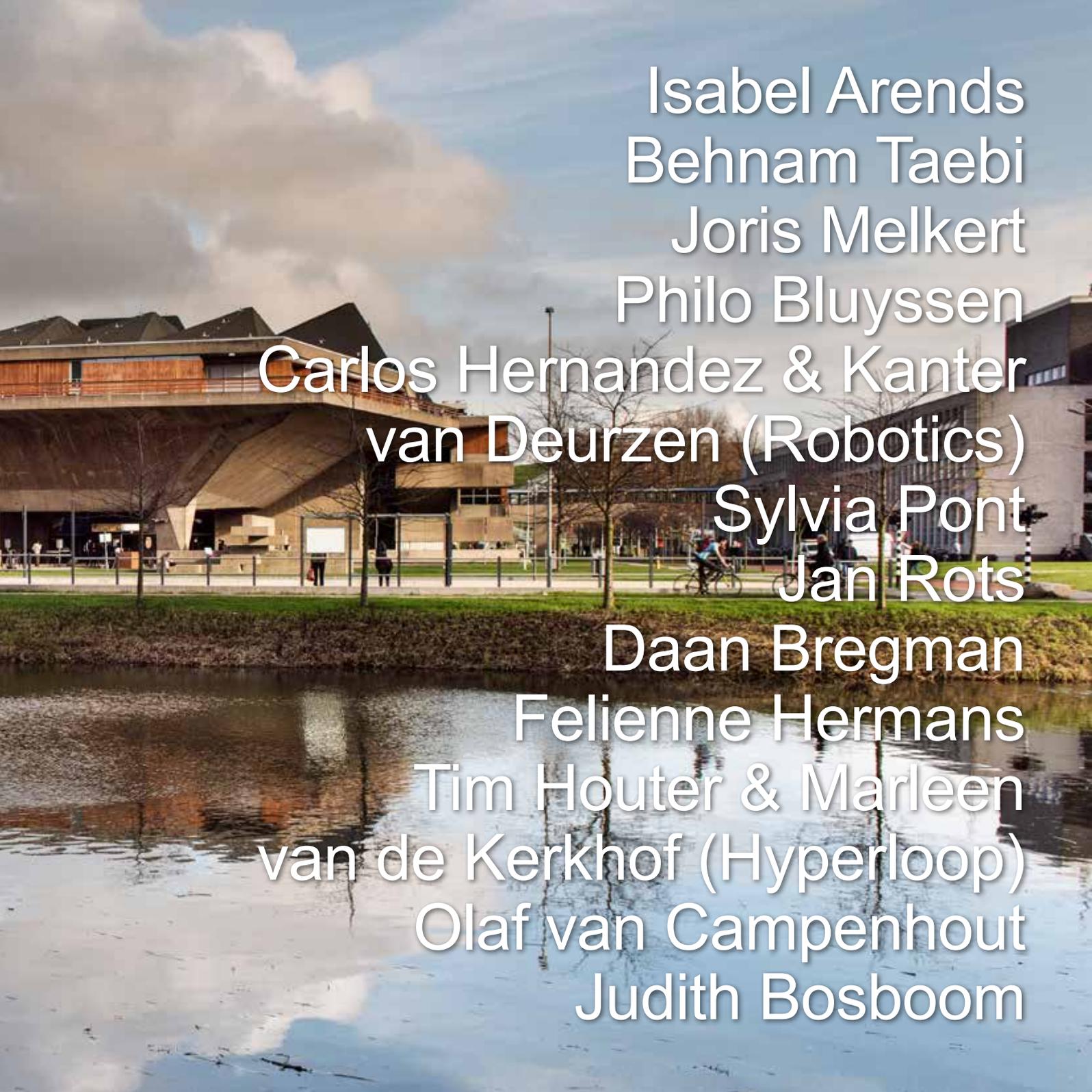
Science is as good as the people who practice it. In this 'Portraits of Science' we showcase a number of people who made the year 2016 a special one with their achievements. Together they represent our whole community of students, academics, entrepreneurs and support staff. People who know how to get the best out of themselves and who inspire others to do the same. And often the total then turns out to be more than the sum of its parts.

At Delft University of Technology (TU Delft) we want to encourage such people. We do that by stimulating innovative teaching methods, by keeping our buildings and research facilities up-to-date, but most of all by investing in human capital. Who becomes a part of our university community therefore remains a member for life. In a world of change that is a constant.

Collaboration is a theme in everything we do. Our successes are the result of alliances between science and society, university and industry, lecturer and student. The breakthroughs and accomplishments you will read about are therefore never the work of individuals. We put them in the spotlight, but we dedicate this publication to all those inside and outside of our university who contribute day in, day out.

On behalf of the Executive Board  
Professor Tim van der Hagen  
President





Isabel Arends  
Behnam Taebi  
Joris Melkert  
Philo Bluyssen  
Carlos Hernandez & Kanter  
van Deurzen (Robotics)  
Sylvia Pont  
Jan Rots  
Daan Bregman  
Feliene Hermans  
Tim Houter & Marleen  
van de Kerkhof (Hyperloop)  
Olaf van Campenhout  
Judith Bosboom

## TU DELFT'S 175TH ANNIVERSARY

In 2017, TU Delft is celebrating its 175th anniversary. The occasion will be marked by 175 days of events around the 'Technology for Life' theme, which will appeal to everyone. The celebrations will be kicked off on Foundation Day, 13 January. Professor Isabel Arends chairs the anniversary committee. "The opening of the Beijerinck Museum is set to be a particularly momentous occasion. Beijerinck's former work room was tucked away in our old building, but will now be given pride of place in the Science Centre," she explains. "It is a room full of old furniture, but of course it is really about the story behind it. Beijerinck did such great things. Everyone knows him as the discoverer of viruses. But he also discovered the cause of the sulphur smell in the canals of Delft: anaerobic bacteria converting waste substances into sulphurous chemicals." The official opening will take place on 16 March, Beijerinck's birthday. "That day will also be Bioday, an initiative of five young scientists that will bring together doctoral candidates and postdocs to share their results. 'Showcasing Delft's biodiversity' is how they themselves describe it."

# Isabel Arends

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# A passion for bringing people together

**Isabel Arends is Professor of Biocatalysis and Organic Chemistry in the Faculty of Applied Sciences (AS). In her research, she focuses on green catalysts for the chemicals industry, particularly on the use of enzymes. As the founder of the new Delft Bioengineering Institute, she brings together people from the campus and beyond.**

**I**f you were to awaken me in the middle of the night and ask me what I am, I would say: a chemist. Everything around us is made up of molecules; everything we do in biotechnology therefore starts with molecules. My specialist field is enzymes, which are also molecules: pieces of protein made by nature, which actually makes them much more cleverly and effectively than we can.

Multidisciplinarity is an important theme in our work as a technical university. Chemistry itself is a discipline that combines elements from physics, biology and engineering sciences. Biotechnology is at the interface between biology, chemistry and engineering sciences. Founding an overarching Bioengineering Institute was therefore an obvious path to take. The outside world does not necessarily

associate TU Delft with biological sciences. But it should. Our department alone has a rich history in biology, and our Applied Sciences Faculty has its Bionanoscience department. Then, when I took a tour around the campus, I also encountered biologists everywhere. All of them share my fascination for the building blocks of biology and what we can achieve with them.

## THE YOUNG ACADEMY

The Young Academy is an independent section of the Royal Netherlands Academy of Arts and Sciences (KNAW). This platform for leading young academics was established in 2005. It is made up of 50 members, each appointed for a five-year term. Behnam Taebi became a member in 2016. He was one of the two nominees on behalf of TU Delft as one of ten new members in this cohort. "The term young in this context refers to the position in your career, namely less than ten years after achieving your doctorate.

"We focus on wide-ranging issues in the academic world. There are all kinds of areas of interest, including inter-disciplinarity, academic policy, science communication and internationalisation." Members can join ongoing projects or initiate their own projects that contribute to academic welfare in the Netherlands. "I am particularly interested in interdisciplinarity. It involves much more than simply collaborating with people from different disciplines as people used to think. It actually means having to speak each other's language and know about each other's methods and tools in order to develop new academic work together."

# Issues that have moral dimensions

**T**aebi worked with colleagues from the faculty of Civil Engineering and Geosciences (CEG) on the development of the Master's course on Climate Change: Science & Ethics. "Climate change is a question of science. You need to be able to understand, measure, analyse and simulate it. Future engineers will soon also be expected to put forward solutions for mitigation and adaptation", he explains. "A faculty like CEG excels in the technological and scientific aspects, but it is important to realise that these issues also have moral dimensions. The issue of fairness, for example. Who should bear the burden of preventing climate change reaching a too dangerous level?" Education that combines science, technology and ethics appears to be a hit – the course is popular, attracting more than 100 students every year. "We plan to apply this method more often. We will establish

courses based on specific themes: energy ethics, computer ethics, robotics ethics, etc."

So what does a philosopher do, in addition to developing courses? "A philosopher's most important activity is to engage in a lot of serious thinking", jokes Taebi. "However, to be serious, a significant proportion of my research involves talking to stakeholders, analysing and writing. Of course, I also publish and encourage others to do so." For example, he has encouraged philosophers and social scientists to follow his lead in thinking about the recently-resurfaced issues relating to nuclear energy. The result of this can be read in the book entitled *The Ethics of Nuclear Energy*, which he co-edited with his colleague Professor Sabine Roeser and which features such subjects as international justice, generational conflicts of interest, sustainability and proliferation.

A portrait of Dr. Behnam Taebi, a man with dark curly hair, a beard, and glasses, wearing a dark turtleneck sweater. He is sitting in a chair, looking slightly to the right of the camera. The background is a blurred, light-colored wall.

# Behnam Taebi

Dr Behnam Taebi is associate professor in Philosophy of Technology in the faculty of Technology, Policy and Management (TPM). “I aim to demonstrate the role that ethics can play in what may at first glance appear to be purely technological choices in the development of new technology”, he explains. Since 2016, he has been a member of the Young Academy (Jonge Akademie), the platform for leading young academics of the Royal Netherlands Academy of Arts and Sciences (KNAW).

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## **BUILDING AIRCRAFT**

The 'Building Aircraft' project is one of the Aerospace Engineering faculty's 'Pioneering Innovations'. The Aeroplane Hall mezzanine is being converted to serve as a production line, where students will be supervised in making a construction kit of a VAN RV12. There will also be a reception area for interested parties.

The plan is to offer the elective three times every year, lasting around 20 weeks. "That way, you have an overlap and avoid knowledge becoming lost between groups," says initiator ir. Joris Melkert. A maximum of 15 to 20 students will be able to participate each time.

“Aviation is forecast to continue to grow by 5 to 7% every year, which means it is set to double in size in the space of 15 years. That will make it four times its current size by the middle of the century. That growth will probably not happen in Europe or North America, but in Asia and Africa. What is certain is that large numbers of new aircraft will be built. This will call for engineers specialised in aircraft construction, which is why we intend to focus on that in our teaching. To achieve this, we are setting up our own production line, to let students build an aircraft kit. For that purpose, we are setting up an infrastructure that will enable us to work under precisely-controlled conditions, just as in an aircraft factory.”

“This project is a response to the anticipated additional demand for specialist aircraft builders. But in a fast-changing world, we are usually unaware what direction the change will take. The World Economic Forum expects two-thirds of children currently

at school ultimately to have careers that do not yet exist. My father qualified as what roughly translates as a scientific calculator, a job that has no longer existed for a long time. In it, he learned to think in terms of algorithms, something we still use in programming. He was still able to adapt to the advent of computers – at a time when punch cards and programming languages like Algol, an abbreviation of Algorithmic Language, were still being used.”

“In order to educate people for careers that do not yet exist, you need to teach them skills that will be of use for their entire careers. One of the most important of these is learning to learn. So, we have students solve non-linear differential equations, although they are likely to never do them again in their careers. But the fact that they have learned something difficult like that gives them the skill and self-confidence to learn new and difficult things in the future. Learning to learn something new is the most important skill we can pass on – it lasts forever.”

# Learning to learn lasts forever

*Dr. Joris Melkert was made a TU Delft Education Fellow for his 'Building Aircraft' project. He is set to involve students in the construction of real aircraft. To achieve this, an aircraft factory is being set up in the faculty of Aerospace Engineering. "This project is a response to the anticipated increasing demand for specialist aircraft builders," says Melkert.*

**Joris Melkert**

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## SENSELAB

The Senselab is built around the four indoor environment factors (indoor air, thermal comfort, light and acoustic quality). Part of the lab is open to the public. "In four separate experience rooms, visitors can discover what effect light, sound, temperature and air have on them," explained Prof. Philo Bluysen, who founded the lab.

The research area can be configured flexibly, for example as a classroom or an office. The indoor environment can be modified with precision, using climate control and measurement equipment and the light and sound system. It is possible to use three types of ventilation: adding air from above (mixing ventilation), adding it from below (displacement ventilation) and opening windows.

"We can use the sound system to mimic traffic noise, for example," clarified Bluysen. "We also have the option of adapting materials in the room. This enables us to change the acoustics as well as the ambience by playing with structure and colours."

# Philo Bluysen

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**Integrated research into all of the factors that influence the indoor environment should bring science, education, professional practice and users closer together. The new Senselab in the TU Delft Science Centre is set to make that happen. Philo Bluysen, professor of the Indoor Environment in the faculty of Architecture and the Built Environment, has spearheaded this special research facility.**

# Buildings are for people

**W**e spend most of our time indoors, in houses, offices and classrooms. What we often do not realise is that a poor indoor environment can literally make us ill. "Everyone knows that you can get cancer from asbestos fibres, but there are all kinds of moulds that thrive in damp conditions and give off pathogens that can make us ill," clarified Bluysen. "Many building materials give off substances such as formaldehyde that can irritate the airways." Various indoor factors can also act as stressors, of which we may not

even be aware. Noise, for example: "We know that people do not always notice if they are exposed to noise at night. You live next to a motorway and think you are used to it, because you sleep through it. But your body is still reacting." Bluysen's preference for a practical approach lies at the heart of Senselab. "What exactly are air quality, light quality, sound quality and thermal comfort? And how can you influence them by means of installations, materials or behaviour? That is something that I want students to experience for themselves." The lab's

role as a research facility is equally important. In the Senselab, research can be conducted into the perception of all these different parameters together – light, sound, temperature and air – and their interactions. In the kind of holistic approach to interior environment research and design advocated by Bluysen, the room's user must also have a role to play. The lab can therefore be converted into a range of practical situations, such as a classroom, an office or a bedroom.

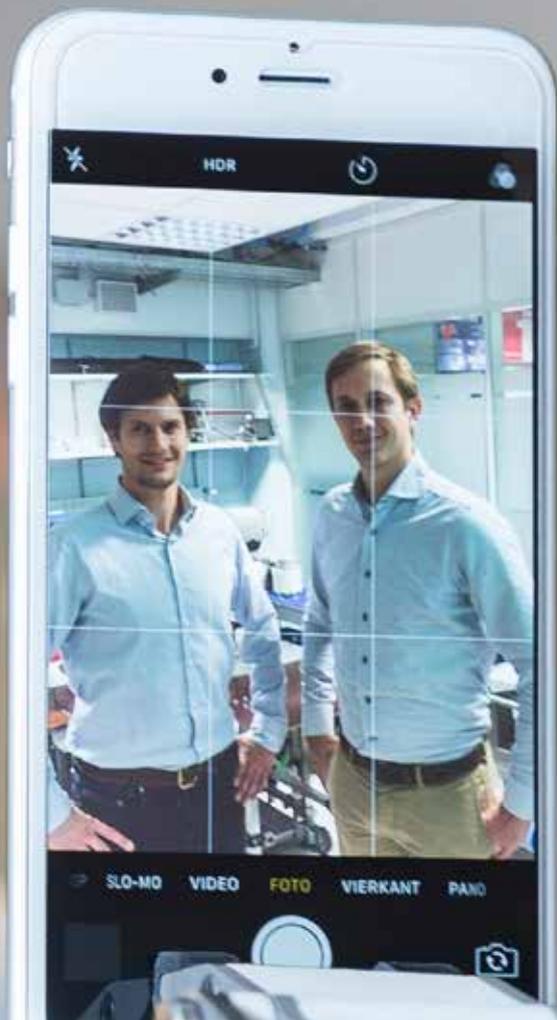
# Picking and stowing your way to victory

## **ABOUT CARLOS HERNÁNDEZ CORBATO AND KANTER VAN DEURZEN**

Kanter van Deurzen studied Industrial Design Engineering and embarked on a PhD. “Machines are more and more involved in autonomous tasks. Operators have to understand the context of what the system is doing”, he explains his research. “I was also connected to the Factory-in-a-Day project, and when there was talk of starting up a company, I moved.”

Carlos Hernández Corbato studied Industrial Engineering and did a PhD on Automation and Robotics. “I also researched autonomous systems, but I focussed on the machine side. After my PhD, I joined a start-up in knowledge-based innovation. After three great years and a great experience it was time to go back to research on robotics. I decided to look for a postdoc position, which I found at TU Delft.”

**When a team of engineers from Delft entered the Amazon Picking Challenge 2016, they won both the picking and stowing finals, making them double champions. TU Delft Robotics Institute researcher Carlos Hernández Corbato and Kanter van Deurzen from Delft Robotics led the winning team. “We handpicked the robot, the parts and the team. That is what put us in the top scoring teams”, believes Hernández.**



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Locating and manipulating objects are at the heart of the second edition of the Amazon Picking Challenge that was held in conjunction with this year's RoboCup in Leipzig. The challenge comprised two tasks: retrieving a wide range of items from the shelves and putting them in a container (the picking), as well as the reverse (the stowing). "The challenges we currently face in automation for SMEs are similar to those for warehouses: being able to find, recognize and handle objects quickly", says van Deurzen. Team Delft entered the competition with a mind-set to win it, to prove their Factory-in-a-day approach works. "One of our objects is to develop technologies that facilitate quick installation and configuration of robotic systems. So we used components that were already available, to demonstrate there already is robot technology out there that can be integrated in an industrial situation", says Hernández. Being new to the competition, they initially focussed on the picking challenge. "We prepared for the picking challenge, keeping in mind we would be using the same system for the storing challenge. Due to logistics we were in a rush. We could only use the testing days in Leipzig to integrate the stowing application. Before that, we had had to quickly install and calibrate the system after shipping. We managed to do all that in a week, so all in all, it was an excellent result."

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# Scientifically informed lighting design

**In 2016 Sylvia Pont was appointed Antoni van Leeuwenhoek Professor for her work at the Perceptual Intelligence lab (PI or  $\pi$  lab). She leads the research on perception at the Faculty of Industrial Design Engineering (IDE). She specialises in light and its interactions with material, shape and space. “That’s not about lamps or bulbs, but about the scientifically informed design of light and its visual effects”, says Pont.**

**T**o describe the light in a space you only need a few easy, and intuitively understood phrases, according to Professor Pont. She demonstrates them with the help of a golf ball, or rather a ‘beam catcher’: “See, the light in this room is coming from above, as the ball is lighter on top. We call that the ‘focus’ component of the light”, she explains. “You can also observe that the shadow is not a 100 % dark. That is caused by ‘ambient light’, the kind of scattered light you get when you go skiing in the mist. Then there is ‘brilliance’, light with an angular frequency, like under a starry sky.” Those three phrases – focus, ambient and brilliance – can be used successfully to design the lighting plan for a space, as students are

being taught in the course on Lighting Design.

Proof for this design approach can also be found in perception research. “We have tested how sensitive people are to certain components of light. You then find a similar classification as we use to describe light. So this approach we use intuitively and from practical experience, is supported by our scientific results”, explains Pont, who is not surprised by this connection between intuition and perception. “Intuition plays a large part in art and design. Painters often base their works on sharp observation. Painters don’t do things randomly. They somehow possess some practical knowledge that we are now discovering the theory of. I am fascinated by this interplay between art, design, perception and optics.”

# Sylvia Pont



## LIGHTING GUERRILLA

During a 'lighting guerrilla' students jointly create special lighting effects on buildings. In the past years this has been done among others at TU Delft's Aula and Library buildings, and in the city centre of Delft at the former St. Agatha convent, which now houses the Prinsenhof Museum. "We think up a concept beforehand, and set out with an enormous amount of torches and lamps. Students are instructed what they should be lighting, and at some point we all light our torches together. The effect is usually amazing", says Pont. "That always creates quite a few aha moments, when students suddenly realise what light can do. It is completely different from designing light on paper or on a computer screen."

# Masonry work was always a hobby for me

**Professor Jan Rots is conducting large-scale academic research into structures in the earthquake area in Groningen. The Professor of Structural Mechanics in the faculty of Civil Engineering and Geosciences (CEG) puts all kinds of masonry structures to the test in his laboratory until they give way under the pressure. “Mechanical failure is scientifically interesting,” says Rots.**

**H**e explains how he once accompanied the Groningen national coordinator Hans Alders: “We arrived at one of those lovely Groningen villages, where everyone had been invited to meet at the village community centre. You can really see people’s emotions, their feelings of insecurity and vulnerability.” Professor Jan Rots can empathise with those emotions: “It can really affect you if there is something wrong with your house.” Rots aims to take away some of that insecurity. Under his leadership, researchers at the TU Delft Stevin laboratory are attempting to find out how robust the houses in Groningen actually are. His main focus is on the masonry, a subject that struggled to attract much interest until very recently. “People used to think ‘why bother with those old houses’. But if you give a lecture on masonry mechanics now, the lecture hall is packed.” His main difficulty is in the wide variety

of homes and buildings. “There are terraced houses, detached houses, semi-detached, school buildings, hospitals, you name it. A building like that often has quite a chequered history. It may have had renovation work done, and not always by a professional contractor,” explains Rots. “You first need to do an assessment of potential issues with existing buildings. Some are sufficiently robust, others extremely fragile and most somewhere in-between. So you could start by reinforcing houses closest to the epicentre and those that are particularly weak.” An individual analysis of every house is unrealistic, which is why the building population is categorised by typology. “When you have done all the calculations for one type of building, you can apply the same solutions for buildings that are similar to it. Obviously, your initial calculations need to be right.” Teams of researchers, engineering firms, the Safe Living Centre CVW, and the NAM are now taking up that task.

# Jan Rots

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## ABOUT JAN ROTS

Professor Jan Rots studied Civil Engineering at TU Delft, completing his doctorate on concrete mechanics. He spent years at the Netherlands Organisation for Applied Scientific Research (TNO) modelling building structures, making a significant contribution to the development of 3D models that can predict how structures behave. One of these is the DIANA software programme, internationally acclaimed as the best of its kind. Professor Rots also devised a way of using the finite element method, the standard method for calculating stress and strain in structures, for glass. His method – sequential elastic analysis – makes it possible to calculate the failure of glass structures, which had been impossible until very recently. In 2014 he was made an Officer in the Order of Orange-Nassau, for his research, and also for his contributions to TU Delft as an organisation.

# Daan Bregman



The worlds of sport and science can sometimes be very useful for each other. This was proven yet again when TU Delft received extensive media coverage for a specially-designed suit for time-trial cyclist Tom Dumoulin. But according to Dr Daan Bregman, coordinator of the TU Delft Sports Engineering Institute, there is potential for a great deal more. “TU Delft is a treasure trove of science, much of which could be applied in sport.”

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# Translating fundamental science into the world of sport

“Our collaboration with the Giant-Alpecin cycling team is going so well because they have a clear long-term vision and are open to all kinds of ideas. This open-mindedness is actually quite rare in the world of sport. Many people who engage in sport have a tendency to stick with the same strategy, if they believe it works for them. But team director Iwan Spekenbrink actually thinks that you should do something different every year in order to stay ahead of the competition. That mentality also keeps things interesting for the scientists. Most are extremely enthusiastic. It raises the profile of their research. It is also usually much easier at a party to talk about something like a sensor skate or bike than about quantum technology. This collaboration also helps place us on the sports technology map, opening the door to other players.”

“I believe that the future will be about measuring in practice rather than in specially set-up labs. You need to have a strong scientific basis, which means that principles and concepts still need to be tested in the lab. However, currently the conditions are simplified and assumptions made during experiments. Our sensor bike enables us to test in practice and discover things that we are not yet aware of. The next step is to be able to measure racers on their own bikes, in the course of a descent. It only really becomes interesting if you can do it during actual races like the Tour de France. Ultimately, it is always about translating science into something that is of benefit to the practical world. In that respect, I see TU Delft as a treasure trove of fundamental science, with huge potential for application.”

## **SPORTS ENGINEERING INSTITUTE**

The TU Delft Sports Engineering Institute was founded in 2014 to bring together all the sports-related research in Delft and raise its profile within and beyond the University. The institute aims to improve the performance of leading athletes, as well as encouraging amateur sport and helping to prevent injuries.

Frans van der Helm, Professor of Biomechanics, is the director of research. Dr Daan Bregman and Anoeek van Vlaardingen are responsible for coordination. In 2016, institute brought ISEA2016 to Delft: the conference of the International Sports Engineering Association, where more than 150 papers were presented to over 300 delegates from across the world.

Sports research is popular among students, attracting many graduates every year. To add to the minor in Sports Engineering, an international Master's programme in that field is now being considered. The special Student Board involves students in sports research and organises excursions.

# Programming for everyone

Earlier this year, Dr Felienne Hermans, Assistant Professor in the Faculty of Electrical Engineering, Mathematics and Computer Science (EEMCS), launched a free online programming course for children: Scratch. Children are wildly enthusiastic about Scratch, which allows them to design games in no time. For Hermans, the most important aspect is empowerment: 'Every child should understand that you can make computers do what you want, that they could also create something like Facebook or YouTube themselves.'



**Felienne Hermans**



“It’s very simple,’ says Felienne Hermans, grabbing her laptop. ‘Scratch is a programming language that uses blocks. You drag and drop the blocks into the field and click them onto each other.’ And indeed, before you know it, a cartoon figure is somersaulting around the screen. ‘It needs a bit of livening up,’ says Hermans, adding an audio block. ‘Children love working with sound.’ And this is just a fraction of what the programme can do. You can personalise or draw your own figures, make them move and talk, and much more. It has all the elements that a child needs to create their own fun maze, fishing game, race track or shoot-‘em-up. The possibilities are endless. Hermans would like children to see a website and think that one day, they will also be able to create one. ‘But not at the

level of zeros and ones. It’s about empowerment, about realising your own qualities and potential.’ She believes that computer science is for everyone, hence also for children in disadvantaged neighbourhoods, and for girls. ‘Almost from birth, society as a whole tries to convince girls that things like programming are not for them. So, if you wait too long, it’ll be too late to put things right.’ Hermans is personally contributing by organising weekend programming lessons at a community centre in Rotterdam city centre. ‘Coming from a middle-class family with two parents, I had plenty of opportunities as a child. You’re sometimes inclined to think “Look at all that I have achieved in this world,” but I was given so much as a child. Not just material things like a computer, but also encouragement.’

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## **INNOVATIVE TEACHING TALENT**

Felienne Hermans created three Massive Open Online Courses (MOOCs) about Excel. Everyone can take the MOOCs on the edX platform, but she now also uses them in her teaching at TU Delft. ‘I used to give two hours of lectures a week. Now I first ask students to watch the videos on YouTube. We then meet every week, and students can ask specific questions,’ she explains. It is more efficient, and it also takes more account of educational needs varying between students. If they already know most of it, they will just end up checking Facebook anyway.’ That is why Hermans is a champion of this so-called flipped classroom method: ‘It gives students much more freedom to choose their own path through the subject.’ Online courses like this produce a wealth of information about learning styles. Hermans sees the same in her online programming course for children. ‘We identified 20,000 moments when children paused the video. Is it that they don’t understand it, or are they just taking a break to do something else? That is what we want to research in more detail. This modern approach to education has not gone unnoticed. In December 2016, TU Delft presented Hermans with the first Innovative Teaching Talent Award.

# The answer to the demand for fast transport

When SpaceX top man Elon Musk launched a competition to design a super-fast transport system known as the Hyperloop, a team of students from Delft was among the first in the starting blocks. It was a golden opportunity, according to team captain Tim Houter and spokeswoman Marleen van de Kerkhof. The student team's streamlined pod has made the final (postponed until 2017) as one of the favourites. "Bring it on!", says Van de Kerkhof.



# Tim Houter & Marleen van de Kerkhof

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The Delft Hyperloop works like this: to get going, the pods travel along aluminium rails on tiny wheels. At the same time, magnets under the pods create a magnetic field, enabling the vehicle to start hovering several centimetres above the rails from a speed of thirty kilometres per hour. Once they start hovering, they will be able to reach speeds of up to 1,200 kilometres per hour. At least, this is what happens in computer simulations and on the two specially developed tracks built to test the braking system and the levitation and stabilising system. The prototype will only show what it is really capable of during the final of the competition in January 2017. “A test tube has been constructed next to the head office of SpaceX. It’s 1.2 kilometres long and all the teams will take turns to test their vehicles”, explains Van de Kerkhof.

The first big step was making it to the final; the competition was fierce. “Two thousand teams originally applied to enter the competition. After selection, 360 official teams remained, 124 of which went through to the next round”, says Houter. These 124 teams presented their designs in January 2016 during the Hyperloop Design Weekend organised at Texas A&M University. The team from Delft achieved an incredible second place, just behind MIT. “The jury in Texas comprised people from SpaceX and Tesla and lecturers from Texas A&M University. It was so tense. We won the innovation prize – the Pod Innovation Award – and came second for ‘overall design & build’. So we are one of the thirty finalists who will be allowed to test their prototype next year.”

## TEAMWORK

The unique composition of the team, which included more than 30 students from across TU Delft, was one of the main reasons that they reached the Hyperloop final. “We have someone from every faculty; all our expertise is home-grown”, says Marleen Van de Kerkhof, spokeswoman for the project. In addition, they were able to select the best, most motivated students from the 200+ people who signed up for the project. “We all have very high standards of quality. Our basic mindset is: it can always be better”, says team captain Tim Houter. “Every member of the team wants to get the best out of him- or herself. Put them together and they’re unbeatable”, continues Van de Kerkhof. “That’s what makes the Delft Hyperloop such a strong contender, and that’s why we’ve come so far in the competition. We achieved a great deal in a very short space of time.” There was just one year between setting up the team in June 2015 and presenting the prototype.

# I was attracted by the counter-intuitive aspect

**Can surfaces with dents on them reduce resistance in turbulent boundary layers? This was the central question in the graduation research conducted by ir. Olaf van Campenhout. It earned this student from the faculty of Aerospace Engineering the title of Best Graduate for the 2015-2016 academic year. It is an honour he is happy to share with his graduation supervisors: "It was very much a team performance."**

**W**hen Olaf van Campenhout was looking for a graduation project, the research being carried out by a friend of his sparked his interest. He had been researching whether it is true that dented surfaces can reduce resistance in turbulent boundary layers. "Dents make a surface less smooth, and the general rule is that smoothness improves aerodynamics. That is what attracted me about the subject: it is counter-intuitive." First a bit of background. Turbulent boundary layers can be found everywhere. Over cars on the motorway, over aircraft, in pipelines and under ships' hulls. This means that there are numerous potential applications for methods for reducing resistance. "Reduced resistance results in less fuel consumption and fewer emissions," explains Van Campenhout. "It particularly applies to aircraft, where there is a snowball effect. If you can fly more efficiently, you need to take less fuel with you. This means that the wings do not need to be as strong and the engines can be smaller. For every kilo in reduced weight in an aircraft, you actually

save much more."

Van Campenhout created his own test set-up. "I designed a sheet that had around 250 dents in it, each of which could be individually switched on or off using an actuator. This enabled me to test both a dented sheet and a flat sheet and also examine the effects of different patterns of dents," he explains. "I devised and designed the sheet with movable dents myself, and the same applies for the actuators." He was also determined to validate this new method. "I worked with Bram de Smit from the faculty of Industrial Design Engineering to make a 3D scan of the definitive sheet. This enabled me to show that it also matched the design I had created." During the set of experiments, he noticed that the reduction in resistance is highly dependent on the inflow conditions, in other words the flow that you allow to pass over the surface. In the second part of his research, he therefore concentrated on the airflow, which he explored using two methods: Particle Image Velocimetry (PIV) and Particle Image Surface Flow Visualisation (PISFV).





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#### **BEST GRADUATE AWARD**

Every year, each of the eight TU Delft faculties chooses its own Best Graduate. They then compete for the title of 'TU Delft's Best Graduate'. This year saw Van Campenhout take the crown after lengthy deliberations by the judging panel led by Anka Mulder, Vice President for Education & Operations. She explained that it had been a very difficult decision and praised the eight outstanding candidates as true TU Delft ambassadors. The eight nominees received a medal from the Delft University Fund, which organises the competition, and the well-deserved praise of the judging panel. "Backed up by theory and tested in practice, relevant for the environment and business and industry, patents applied for and dents everywhere." This is how Mulder summed up Van Campenhout's work when announcing him as the winner. In addition to a medal, he received €2,000 in prize money, a Dell laptop and membership of the Royal Netherlands Society of Engineers (KIVI).

# Olaf van Campenhout

## **VISUALLY ATTRACTIVE**

"I have been involved in photography all my life", says lecturer Judith Bosboom. "I am inspired by beautiful things: art, photography, design, colours. Even when I was studying in Delft I used to take courses in photography. I have long thought it would be great to study at the Photo Academy. Then, ten years ago, I thought: if I don't do it now I will regret it later."

"I graduated from the Photo Academy in 2010. I had a fantastic time, during which I really developed as a photographer. In the past couple of years I haven't been photographing that much. I can no longer simply snap a picture. Photography for me entails setting out with my tripod for the day and losing myself in my surroundings, be they a lonely farm or a parking garage. I get a lot of energy from looking for images. That remains, if only in my presentations. I believe in the power of visually attractive materials."



**Judith Bosboom**

# Learning rather than scoring

***Ir. Judith Bosboom is senior lecturer Coastal Engineering at the Faculty of Civil Engineering and Geosciences (CEG). In December she was named Best Lecturer 2016 of the TU Delft. Her tip for lecturers: “Choose your educational methods carefully. Success often depends on the method you choose.”***

**T**he online interim tests I have introduced over the past couple of years have been an enormous success. That’s mostly due to how you set up such tests. Naturally, the content of questions has to be right, but test questions alone are not enough. Interim testing has its pitfalls. For example, without enough strings attached, often only the students who need it the least will take part. You can wield a stick by resorting to compulsory participation or you can try and dangle a carrot by awarding a bonus that counts towards the final mark. However, this just shifts the focus from learning to scoring, and that

is not a good setting for students to master a subject. You want to offer them a safe learning environment where they can learn from making mistakes.

I’ve puzzled for a long time about how to achieve both goals: getting the majority of students to participate, as well as having them actually learn something. My principle is that you should not force Master’s students to do anything. I can make it as attractive as possible for them to participate, but in the end it is their responsibility. My solution was to split the test in two parts, thus deliberately separating the two goals.

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