



DELFT | NO.1 | MAR 2019 | YEAR 36
OUTLOOK |  **TU Delft**

**Andy van den
Dobbelsteen**
**'Energy-neutral Amsterdam
by 2040 is achievable'**

50 YEARS OF IDE
History of IDE in eight designs

Machine of millions
A peak in the new quantum lab

THEME
The city

Cover:

'I found a night shot of the city more exciting than a photo during the day. It is pretty when the buildings in the foreground are low and in the background high. Water brings extra atmosphere, and you get the best colours when you look in the direction where the sun has just set. The Coolhaven in Rotterdam seems to have everything'.
(Photographer Sam Rentmeester)

EDITORIAL
Saskia Bongers

The city

More and more people are living in the city; a global trend that also applies to the Netherlands. Last year the Netherlands Interdisciplinary Demographic Institute calculated that in 2015, 53% of Dutch people already lived in an urban municipality. According to the latest forecasts from the Netherlands Environmental Assessment Agency, this trend will continue, presenting the government with many challenges. It is of course an interesting question: how to keep areas with falling populations liveable for people who are not attracted by magnets like The Hague and Utrecht. This issue of Delft Outlook focuses on the other side of the coin: how can cities cope with growth in times of climate change and energy transition, and how can TU Delft help? Take Amsterdam, for example, where Prof. Andy van den Dobbelsteen's Climate design & sustainability

department (A+BE) is co-authoring the roadmap for the development of an energy-neutral capital by 2040. The struggles with the City, energy companies, residents and Historic Building Preservation, make Van den Dobbelsteen the personification of this year's Dies Natalis theme: Climate Action. Closer to home, in Overschie, researchers are investigating the metropolitan climate, here by measuring and preventing air pollution from the adjacent A13 motorway. TU Delft alumnus Wouter Plaetinck is now working with a German start-up to prevent particulate pollution by developing alternative transport. If after reading about these and other metropolitan issues you still haven't had your fill of 'the city', the free online courses shown on page 18 are a must!

Saskia Bongers,
editor-in-chief



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The city

Photo: Sam Rentmeester



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Andy van den Dobbelsteen

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problem of the future'



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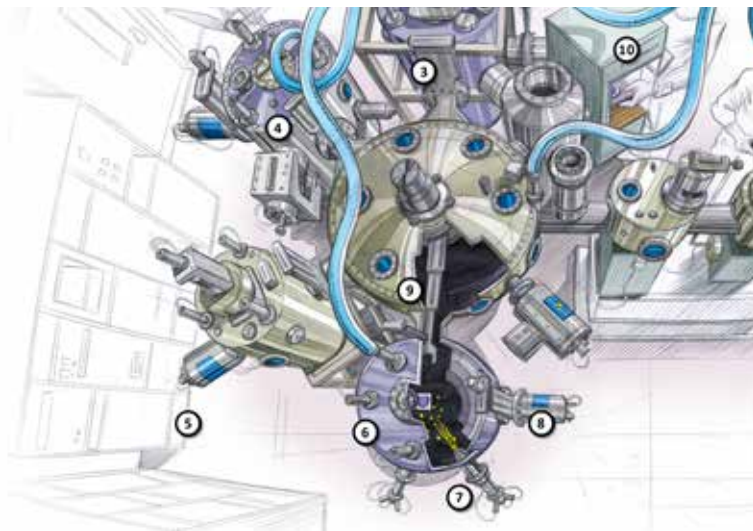
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Huge machine fabricates nanowires

Seducing stubborn atoms to crystallise



DELFT IN BRIEF

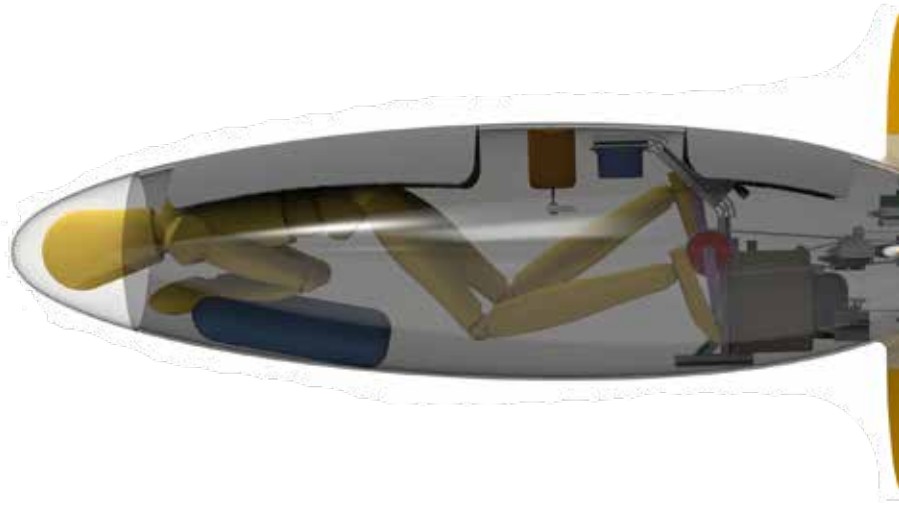


Photo: Nina van Wijk

Dies Natalis

The 177th anniversary of TU Delft took place on Friday 11 January. This year's theme was Climate Action, with a corresponding symposium. Speaker Pier Siebesma (CEG) spoke on predicting climate change in the future and the need for supercomputers for collecting the right information. Søren Hermansen and Prof. Mercedes Maroto-Valer

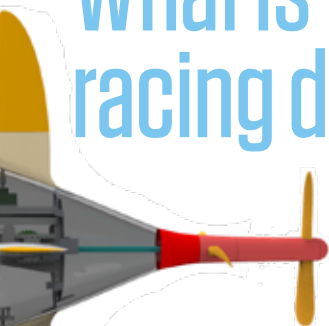
received honorary doctorates. Meteorologist and NOS weatherman Gerrit Hiemstra called the TU Delft community to action, giving practical solutions, such as using electric cars, not eating meat, not flying and buying less, especially from China.



Photo: Sam Rantmeester



What is the ultimate racing design?



Every spring, the Delft dream teams present their latest vehicles. Nuna, Wasub, Hyperloop: each year the streamlining is different. And that's quite surprising. You would think that after all these years of experimenting, the students would have found the ultimate design. "In theory, the computer could calculate the optimal shape," says Elja Ebbens, member of the Hyperloop (high-speed transport system) team. But it's not that simple. You also have to take into account practical matters such as high speeds and production costs. For the human-powered submarine Wasub, frontal resistance is the most important factor: 'The best shape would be completely flat' says team member Willis Houtman, "but then the pilot wouldn't fit in it."



Photo: Wasub

Stained glass

Five historical stained glass windows have returned to their original location on Kanaalweg. For years they were displayed in the glass facade of the entrance to EEMCS. Jan de Quack designed the windows in 1904 for the physics and electrical engineering lab. They show the five major pillars of technology: power, movement, heat, light and sound. When Electrical Engineering moved to the high-rise building on Mekelweg in the 1960s, the windows went with it. Last year they were returned to their original home, as the finishing touch to the



refurbishment of the Duwo student accommodation on Kanaalweg.



The King and the quantum



Photo: Marco de Swart

On 21 February Professor Leo Kouwenhoven and King Willem-Alexander jointly opened the Microsoft Quantum Lab. "I promise that we will make amazing discoveries here," said Kouwenhoven. After the opening ceremony, the King, who sadly didn't make a speech, left the hall for a tour of the laboratories. Rector Tim van der Hagen introduced the Microsoft Quantum Lab as an example of how the dissemination of knowledge has changed. In the past, promising innovations were often left stranded in the 'valley of death', between the university and industry. Van der Hagen argued that TU Delft can have an even greater impact on society by bringing industry and the University together in an innovative ecosystem, such as the Q campus.



Heart-powered pacemaker

We're not quite there yet, but Dr. Nima Toulou (3mE) can already see it. Last March, he was named Engineer of the Year after developing a priceless watch in which thirty mechanical parts were replaced by a silicon oscillator. Now he and his team are working on a mechanism that converts heart beats into electrical energy to charge pacemaker batteries. A rechargeable pacemaker would reduce the need for heart surgery (on average every seven years).



Sebastiaansbrug closed

Photo: Sam Rentmeester



The Sint Sebastiaansbrug is being replaced. Anyone using the bridge to get to the TU Delft campus will have to use a different temporary route. The City expects the new bridge - with sound-absorbing tarmac - to be finished in the first half of 2020 and that tram 19 will be using the new bridge to the campus by the end of the year. The clearance height of the new bridge is 4.5 metres.



24.703

That's how many students were enrolled at TU Delft on the reference date (1 December 2018). Almost 25,000 students; the upper limit of the University's preferred total. However, there is not a lot the University can do to influence this number. And that makes the current situation extra critical. 21% of all TU Delft students come from abroad, the majority from India, China, Belgium, Germany, Italy and Greece. AE has the highest proportion of international students, with 42%. More figures? Scan the QR code and read the following article.



Learning from games

Thanks to the master course 'building serious games', all prejudices about nerds gaming all day can be overturned. During ten weeks, students worked in project groups to develop a computer game that is not only fun but also serves educational purposes. The interdisciplinary course, which teacher Rafael Bidarra calls 'a bit weird', welcomed students from both TU Delft and Leiden University. The games themselves varied from blindfolded solving an escape room to the virtual cleaning of canals.



New medical projects for the elderly

Medical Delta, the collaboration between TU Delft, Leiden University, the LUMC and Erasmus MC in Rotterdam, is launching 12 new projects for sustainable healthcare. These include programmes in the field of dementia, helping the elderly to stay mobile for as long as possible and regenerating tissues using stem cells. Almost every project will receive €400,000. The journalistic platform Delta spoke to six of the Delft researchers involved.



The Steerable Punch, one of the projects.

Photo: Sam Rentmeester

THEME

The City

Cities are growing. But what does this mean for housing construction, transport and liveability? Researchers at Delft are investigating all kinds of subjects relating to urban problems, from modular houses, better sewer inspections, flying taxis, and how to reduce heat consumption.

Air quality between Delft and Overschie

Fluid experts from TU Delft have created a model to determine how air pollution spreads from the A13 through the adjacent Overschie area. The DisTurbE (dispersion in the turbulent urban environment) project tests the effectiveness of measures designed to combat air pollution.

TEXT: JOS WASSINK PHOTO: SAM RENTMEESTER

'Satellite images show that the Ruhr area, the mouth of the river Rhine and IJmuiden have the highest levels of NO_x in Europe', says Professor Jerry Westerweel, Head of the Environmental Fluid Mechanics (EFM) section in the Faculty of 3mE. 'I live at the heart of one of these polluted areas. Models for the spread of pollution are available at a scale of 1,000 metres and upwards. We wan-

ted to zoom in on the source, but the models between 10 and 1,000 metres are substandard. We have now simplified things'. The team examined the section of the A13 between Delft and Rotterdam that is separated from the adjacent residential area by a perspex screen. Would such a screen help?

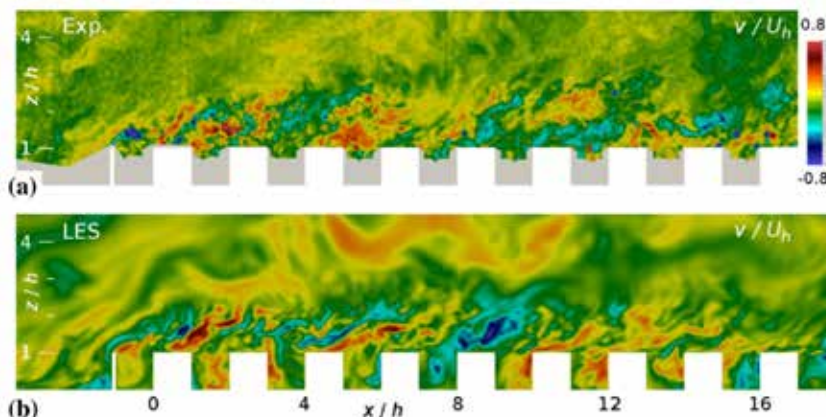
People living in Overschie know that they often have to clean the window frames to keep them from turning grey. And that it is better to take it

easy during the evening rush hour to avoid coughing fits. They also think that they are less affected by the motorway behind their house than in front.

The EFM section took an experimental and theoretical approach to the spreading issue. Doctoral candidate Jerke Eisma conducted measure-

They know that it's better to take it easy during the evening rush hour to avoid coughing fits

ments in the lab's water tunnel. A scale model of part of the neighbourhood was mounted on a disc the size of an LP. A 30-centimetre-deep layer of water flowed over the model, representing the atmosphere. Eisma rotated the disc to simulate different wind directions. A flow of water offers benefits in terms of being calmer (it has a lower Reynolds number),



Experiment (above) and simulation of the spreading of pollution match. The wind comes from the left, the white boxes are the blocks of houses behind the screen.



The A13 highway between Delft and Rotterdam runs close to the residential area. There is a lot of air pollution here.

which makes it easier to control conditions. Jasper Tomas, another doctoral candidate, used the DALES model (Dutch Atmospheric Large Eddy Simulation) to calculate the spread of exhaust fumes over the neighbourhood. DALES calculates the air flow in a 'box' of air several kilometres across the ground and at an altitude of two kilometres. A third doctoral candidate, Manu Goudar Vishwanathappa, provided the theoretical basis for the applied numerical simplifications.

A cursory glance shows that the results of the water tunnel experiment (Exp.) correspond with the simulation (LES). The colours indicate vertical air movement. Noteworthy is the fact that the air mixes a lot more readily after passing the di-

viding screen than the air flowing from the left. The air rises shortly before the screen (light blue), while polluted air flows downwards on the far side of the houses (the white blocks). The intuitive notion that the effects of particulates would be less at the far side is therefore incorrect.

The project will now continue along two paths. Researchers want to use a simplified flow model that requires fewer calculations to demonstrate the most relevant aspects of the spread of particulates. They also want to use a combined approach of simulations and experiments to test and improve various measures to combat particulates. Vegetation, for example, or deflecting particulates using electrically charged


grids. But what is the ideal size? And why would a particular tree or grid be better at removing particulates than another? For those living in Overschie and comparable neighbourhoods, this will undoubtedly be a relief. <<

H.E. Eisma, J.M. Tomas, M.J.B.M. Pourquie, G.E. Elsinga, H.J.J. Jonker, J. Westerweel, Effects of a Fence on Pollutant Dispersion in a Boundary Layer Exposed to a Rural-to-Urban Transition, Boundary-Layer Meteorology, 3 July 2018

An end to tailbacks on the A4

A taxi service, only airborne. A private jet, but cheaper and fully electric. Meet Lilium, a German aviation start-up dedicated to developing and building the world's first fully-electric vertical take-off and landing (VTOL) jet.

Flight test engineer and TU alumnus Wouter Plaetinck (Aerospace Engineering) sees the VTOL jet as an addition to current transport resources both within and outside cities. Forget about the daily tailbacks on the A4 between Amsterdam and Delft, as the journey will only take 15 minutes with the Lilium jet. 'And VTOLs only need a small landing platform, facilitating a point-to-point network, which means you do not waste time travelling from intermediary transport hubs to your final destination'.

Travelling with this 'flying Uber' is not only exciting, but also sustainable. The jet is fully electric and does not produce any operational emissions. And its silent engines and the limited amount of infrastructure required makes it 'the way of travelling in the future', as Plaetinck calls it. 

Specs

- Range: 300 kilometres
- Speed: 300 km/h Fully electric
- On-demand (use an app to order your taxi)
 - Low noise
- Space for 5 passengers
- Vertical take-off and landing



How can Amsterdam ditch the gas?

Together with his team from the Climate Design & Sustainability Department (ABE), Prof. Andy van den Dobbelaars is working towards making the capital energy-neutral by 2040.

For many of us, energy means electricity, but in fact we use nearly twice as much energy for heating. There are 430,000 houses in Amsterdam, alongside 645,000 'units' using a similar amount of heat. The two largest producers of heat are still the gas-fired power plant in Diemen and the waste incineration plant in Amsterdam-West. If the researchers have their way, this is going to change. So where should the heat come from instead? Extending and modernising the Amsterdam heating grids, for example. Each grid currently has a single source delivering heat at high temperatures. In the future, heat will

come from different sources, e.g. from geothermal heat and solar collectors, at a lower temperature. A lower temperature in the heating grid impacts how houses are insulated. The better the insulation, the lower the temperature of the incoming water can be. Lower temperature systems operate between 25 and 40 degrees Celsius; today it is still 70 to 90 degrees. Van den Dobbelaars estimates that 18,500 houses a year could be renovated and made suitable for lower temperatures. Even if heating usage is reduced, production of sustainable heating remains a huge challenge. The plan outlines how energy can be saved by using sur-

face water, groundwater, thermal storage in boreholes and geothermal heat from aquifers deep underground. The researchers note that the latter requires additional research. Van den Dobbelaars would like to see Amsterdam record annual CO₂ emissions, energy and gas usage, and publish this information in public annual reports. The plan does not consider the required investments, but the municipality is working on a plan addressing economic, social and legal aspects. **JW**

Page 20: Interview Andy van den Dobbelaars

Using DNA to scan ground water flows

Medicinal waste, E. coli bacteria from a leaking sewer, oil and all sorts of chemicals pollute ground water in urban areas. Increasing global urbanisation is only exacerbating the problem. In order to chart pollution, we need to understand how water flows underground. After all, pollution spreads through these ground water flows. Dr Thom Bogaard from the Water Management Department (CEG) was recently awarded €250,000 to develop technology to make this possible. He fills microscopic grains of silicon oxide, artificial grains of sand, with synthetic DNA. 'Imagine this DNA as a barcode. You can allow it to drain into the ground at various locations. If you encounter it in water samples taken from elsewhere in the city, this will give you information about the origin and speed of water flows'.

The potential of the technology has already been proved in controlled lab tests. Bogaard is now conducting experiments on the so-called Waterstraat, a plot of land next to the Green Village that is used as an open-air laboratory. The research is part of a larger research project called Urbanwat, in collaboration with the University of Barcelona and the University of Montpellier. **WV**



Dr Thom Bogaard is experimenting in the Waterstreet on campus.

Photo: Sam Rintmeester

Choosing a new kitchen in virtual reality

In Arno Freeke's VR Lab, you can try out endless colours and cabinets in a virtual version of your house.

Virtual reality (VR) is certainly no longer the exclusive domain of the gaming world. There are endless other applications for VR, the technology in which a computer simulates an environment with 3D objects and 360-degree images. Psychologists use VR to treat patients suffering from PTSD, for example, and surgeons use it to visualise operations.

The Faculty of A+BE is home to one of the country's leading academic labs for visual representation, offering everything from urban design and visualisation tools to design methods. However, coordinator Arno Freeke sees VR primarily as an important communication tool.

For example, a housing corporation commissioned the lab to simulate the consequences of a major renovation project. 'We collaborated with researcher Clarine van Oel to 'build' houses. In a virtual world, residents experienced how the planned work would affect them'. Residents entered their future environment virtually, complete with scaffolding and a trench in front of their door. 'Including the noise from drilling, digging and piling. This helped manage their expectations and address concerns'.

Freeke and his colleagues also developed a module for the housing corporation allowing residents to choose a new kitchen in their virtual home. 'What's great about VR is that it makes things intelligible and tangible, so that people can make choices without taking risks.



Photo: Sam Remmeester

What's great about VR is that it makes things intelligible and tangible, so that people can make choices without taking risks.

In VR, replacing a kitchen is easy of course'.

Next to offering interior design support, the lab advises on property matters within TU Delft as well as on course programme development. The team is keen to develop a setting for the Faculty of Aerospace Engineering that will challenge students to locate the black box from a crashed plane in a field. 'VR offers us a range of possibilities at various scales', explains Freeke. 'You can replicate everything in actual size, or make things as small as Madurodam, which makes it ideal for area development'.

In late December, the lab collaborated with researcher Stefan van der Poel to replicate Paddepoel – a neighbourhood in Groningen – to analyse traffic flows.

Speaking of Groningen: 'You could also use VR to investigate the damage caused by the earthquakes', says Freeke, thinking aloud. 

Until recently, virtual reality activities at TU Delft were fragmented. This is why on 26 February the VR Lab was opened in the Library. The VR Lab assists students in graduation projects, invites researchers to conduct experiments and teachers to develop course material or have it developed locally.

New life in the 'cauliflower neighbourhood'

Connecting the city to the university was a primary aim of an urban design student project in Tanthof, a neighbourhood in Delft.

Tanthof is a so-called 'cauliflower neighbourhood': a maze of winding streets and lots of low-rise buildings, explains Frank van der Hoeven, Associate Professor of Urban Design. In the 1970s, 'cauliflower neighbourhoods' were a response to neighbourhoods with impersonal blocks of flats arranged in a grid-like fashion, such as Voorhof and Buitenhof. Neighbourhoods needed to become more small-scale, dominated by green, low-traffic areas full of children playing.

Van der Hoeven says that Tanthof always scored high on resident satisfaction, but no longer. That is why the municipality believes it is time to think about improvements. Some of the challenges that lie ahead include:

🏠 Tanthof is separated from the rest of Delft by the Kruithuisweg and is split into a western and eastern part.

🏠 In both parts, a school is being closed down due to falling student numbers.

🏠 The flow of residents has stalled: children have flown the coop, parents have paid off their mortgages and find new homes elsewhere too expensive.

🏠 Today, the low-traffic areas are dominated by car parks.

🏠 Delft needs to build 15,000 new houses across the city.

There is no shortage of work for urban designers, who once characterised 'cauliflower neighbourhoods' as 'modern-day drab'. Wrongly so, believes Van der Hoeven. A view shared by Anna Myllymäki, one of


the 75 students who visited Tanthof last autumn to develop ideas.

Myllymäki focused on security.

'There was a lot of burglary and vandalism. Perhaps people no longer feel at home there'.

She combined this with climate adaptation: creating a larger water surface to catch heavy rainfall. She transformed existing ditches and the numerous grass lawns into areas of water, creating little islands. 'This clearly defines your area, your territory'.

For the old school in the east of Tanthof, student Rebecca Smink developed a plan for small houses with green roofs, which collect water and provide cooling. This creates a broader range of houses, for example to cater to parents with paid-off mortgages living in large family homes. Jian Yuan developed an algorithm that optimises walking routes and designed miniparks with long sitting benches as a new approach to low-traffic areas.

The municipality presented dozens of plans. 'Lecturers selected the plans based on ideas, not on grades', says Van der Hoeven. The city therefore helps lecturers to take a different perspective and the university helps the city by introducing good ideas. 



A fresh look on the sewer system

Flooded, stinking streets and no toilet facilities anywhere. That is what a world without sewers would look like. Inspection and maintenance are vital, but how do you organise this as efficiently as possible?

With some 150,000 kilometres of sewer pipes running beneath Dutch soil, the sewer system is one of the country's most important infrastructures. Researchers from Delft and Leiden are working together in the 'SewerSense' project to develop a new inspection method. 'Sewer management starts with good inspection', explains Lisa Scholten, Assistant Professor of Urban Water Infrastructure (CEG). 'You'll need the right information about the condition of the sewer, and you need to be able to analyse those data correctly. The aim is to create long-term maintenance policy that pre-empts potential problems. This is not possible with the current inspection methods and decision-making processes'.

Why not? A camera takes pictures inside the sewer, after which someone assesses these images and determines the current condition of the pipes. Is something acutely wrong, or can repairs be put off for a few




more years? It is sometimes difficult to tell from the images. More – and more reliable – information will make it possible to plan targeted sewer maintenance.

The required information is collected by an inspection vehicle that was developed in collaboration with Leiden University. The vehicle is fitted with various sensors and cameras, allowing it to actually 'see' in the sewer,

as it can perceive depth and collect data both above and below water. 'By using a self-learning algorithm, we can automatically identify potential problems'.

But how do you make decisions regarding sewer maintenance based on this information? Scholten and her colleagues organised workshops with representatives from the field to find out. Scholten: 'We expected

to quickly discover how this process works, but that was not the case. People agreed on the strategic maintenance objectives, but not on how you translate these into practice and on which maintenance activities are required to achieve these goals'.

Feeding the existing data, the data from the inspection vehicle and those from the Leiden algorithms into a model that enables researchers to recreate the situation digitally. It is then possible to compare various inspection and maintenance strategies and make assumptions about how long a sewer pipe will remain safe. Scholten: 'It would be great if this new technology could help us to develop a fresh perspective on sewer policy and management'. But first, laboratory experiments will have to be performed. 'It is a four-year project. That is a negligible period of time compared to the lifespan of a sewer system; some pipes last for a century! The new method will offer us even greater insight in this respect'. 

Solar-powered modular houses

By 2023, more than 34 million m² of office space will have to be more energy-efficient. Moreover, the Netherlands requires one million additional houses. TU Delft students hope to kill two birds with one stone.

“Let’s make our built environment great again”, quipped Siem van Sluijs in his presentation. This July, he and his fellow students from the Modular Office Renovation (MOR) dream team will travel to Szentendre (Hungary) to participate in the 2019 Solar Decathlon Europe (SDE). The event challenges student teams from 16 international universities to build a fully-functional solar-powered house in just 10 days. This year’s theme is renovation. The MOR team designed four modules to

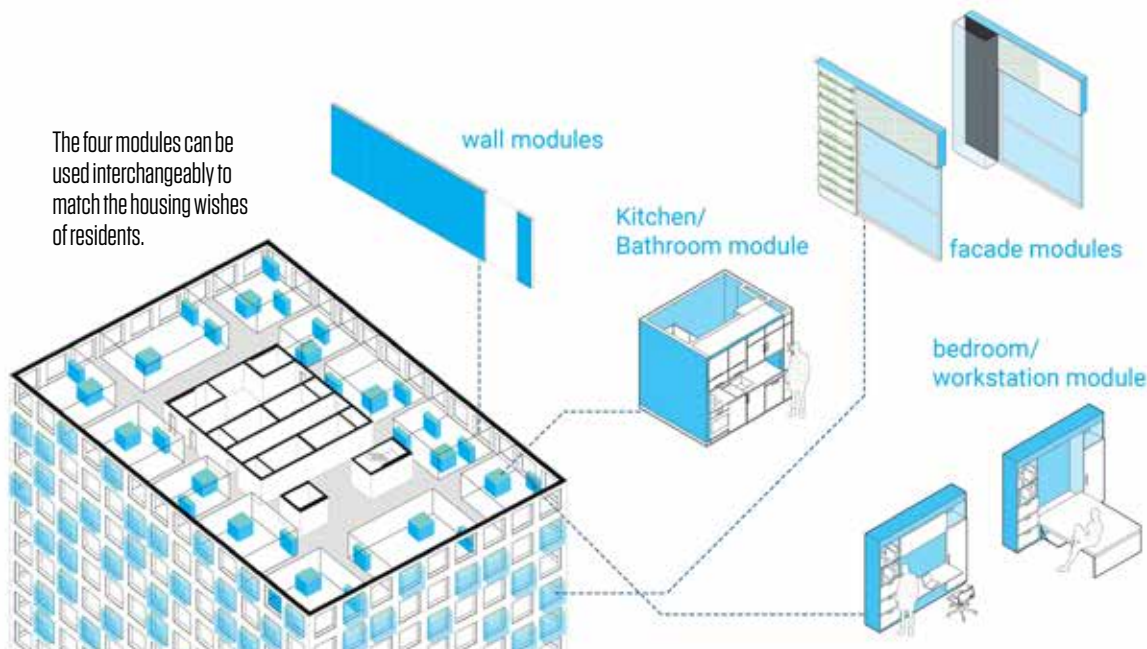


An impression of what the transformation of the Marconi towers would look like.

Illustrations: MOR team TU Delft

transform empty offices into houses: a wall module, facade module, kitchen/bathroom module and a sleeping/workstation module. The modules are interchangeable, to satisfy the housing needs of residents wherever possible.

They can be linked to create small or large homes, and it is easy to move them to another building. The design aims to be net positive, which means that the building produces more than it uses. This can



be achieved with solar panels, for example, using vegetation to filter outside air, collecting rainwater for aquatic plants and growing food on site. This intention is in line with the Dutch government's aim to become a circular economy by 2050.

In order to test the feasibility of the concept, the team is using the Marconi Towers in Rotterdam as a case study. Like other office buildings, these towers have a fixed concrete structure with open planning, suitable for modules.

The team will spend the months ahead working on their prototype in The Green Village on campus. The students are still looking for sponsors willing to provide funding in kind.

Building a house in 10 days sounds ambitious, even more so because the students have no construction experience. 'We are confident that we will finish on time', says student team leader Francesco Longo. 'In July, we will see whether that is enough to make our offices great again'.



The prototype at the SDE will be a medium-sized home. Concrete beams stick out at the top and on the sides to show it is a part of a larger building.


How driverless cars can change our lives

Working while speeding down the motorway, no more car write-offs; driverless cars promise great things. However, the social implications of the autonomous car reach far beyond user convenience.

We do not know how the introduction of these cars will affect society', says Bart van Arem, Professor of Transport Modelling at the TU Delft Transport Institute. 'Will people still take the train or bicycle if driverless cars perfectly fulfil their transport requirements? And if cars can drive much closer to each other on motorways heading into cities, how will this impact traffic in the cities? Perhaps congestion will increase dramatically'.

Van Arem is behind the STAD (Spatial and Transport Impacts of Automated Driving) project. Alongside TU Delft, this broad collaboration includes partners such as TU Eindhoven, numerous municipalities (including Delft), Rijkswaterstaat, TNO and the Institute for Road Safety Research (SWOV). The aim of the project is to develop future scenarios.

'We conduct surveys and run economic models taking the so-called 'value of travel time' into account', explains Van Arem. 'People will essentially experience distance and travel times differently. Perhaps they will start living further away from work. A two-hour commute is less of an issue if you can spend that time working. It then counts towards your work hours'.

The STAD project researchers also explore the infrastructural adjustments required to clear a path for driverless cars. 'We explore whether it is sensible to already start building separate lanes for driverless cars, and which obstacles need to be removed. Roadside advertisement boards, for example. These may confuse the car sensors'. Anyone thinking that fully autonomous transport is simply a pipe dream is in for a surprise. Within a few years, expect to see a sign on the TU Delft campus warning of autonomous traffic. As an experiment, Van Arem wants to launch a shuttle service with self-driving minibuses on Technopolis. 'Such vehicles are already on the market. They are quite basic, but you can add all sorts of artificial intelligence to them. Software to allow the minibus to anticipate pedestrians, for example'. 

Online Learning on the city

Since 2014, TU Delft has produced over 150 online courses on subjects that matter and built on the strengths of our faculties. Delft's Massive Open Online Courses (MOOCs) have already attracted almost 2,5 million learners world-wide. Sustainability is one of the leading themes in the online portfolio. The three courses are related to this Delft Integraal's theme: the City.



Zero Energy Buildings

This course introduces you to zero energy design. It will teach you a step-by-step approach to design a zero energy climate concept for existing buildings: homes, schools, offices, shops etc. It will demonstrate how an integrated approach, which takes into account both passive measures (such as thermal insulation and sun shading) and active measures (such as heat pumps and photovoltaic panels), can deliver the best results.

Instructors: Professor Andy van den Dobbelsteen (Faculty of Architecture & the Built Environment), Siebe Broersma (Researcher and Lecturer at the Chair of Climate Design & Sustainability), Eric van den Ham (Lecturer of Climate Design and Building Physics, Faculty of A&BE)

Start date: 3 April 2019

Sustainable Urban Development

The course is set up in a unique matrix format that lets you pursue your line of interest along a specific metropolitan challenge or a specific theme. You will have the opportunity to explore the living conditions in your own city and compare your living environment with that of the global community. You will discover possible solutions for your city's challenges and what it takes to implement these solutions. Your participation will also contribute to wider research into metropolitan regions as complex systems.

Instructors: Arjan van Timmeren (Professor of Environmental Technology & Design and Lead Principle Investigator of the Institute for Advanced Metropolitan Solutions (AMS), Mariette Overschie (Researcher and Lecturer Engineering for Sustainable Development and Technology Assessment, Faculty of TPM)

Starts anytime (Self-Paced)

Managing Building Adaptation

The biggest sustainability challenge for cities worldwide is adapting existing obsolescent buildings and making them future-proof. In this course, you will learn about adapting buildings for sustainability. This course first introduces you to the challenging management task of redeveloping buildings for future use. Then you will learn how different management tools can be used to convert old buildings for sustainable reuse.

Instructors: Erwin Heurkens (Assistant professor Urban Development Management), Hilde Remøy (Associate professor of Real Estate Management, Faculty of A&BE), Gerard van Bortel (Assistant professor of Housing Management), Jelle Koolwijk (Research associate of Design & Construction Management)

Starts anytime

To get the full picture please visit: online-learning.tudelft.nl.

View

‘There will be a battle for public space in the decades ahead’, predicts Arjan van Timmeren, Professor of Environmental Technology & Design and Scientific Director of the AMS Institute.

‘Cities mostly sprung up where rivers flow out into the sea or where roads intersected, for example. Cities developed in a gradual, natural way and were optimised at a later stage, but they have hardly ever been properly redesigned.

In that regard, the Netherlands are slightly ahead of the game; here, every bit of land has been re-purposed multiple times. So I expect that to continue in the future.

There will be a battle for public space in the decades ahead, for every parking space that becomes available and every public park. Energy generation and climate adaptation will also claim more and more space. Privatisation, increased population density and leisure time result in public space being used more intensively. How this public space is ultimately divided up impacts urban liveability. What’s certain is that Europe, and the Netherlands in particular, will have to proceed with care.


Today’s major transitions all want to claim the same space. ICT and various technical innovations make it possible to use this space more efficiently or use it for multiple purposes. At the AMS Institute (Amsterdam Institute for Advanced Metropolitan Solutions), we currently have 101 projects concerning traffic, water and energy, adding a layer of information to conventional engineering. This allows us to optimise usage. But ultimately, we will need fundamentally different solutions. For example, we should take a close look at the orga-

nisation of the ‘city as a system’. The city will become less centralised, and we will need to develop decentralised, clustered and connected solutions as part of centralised networks.

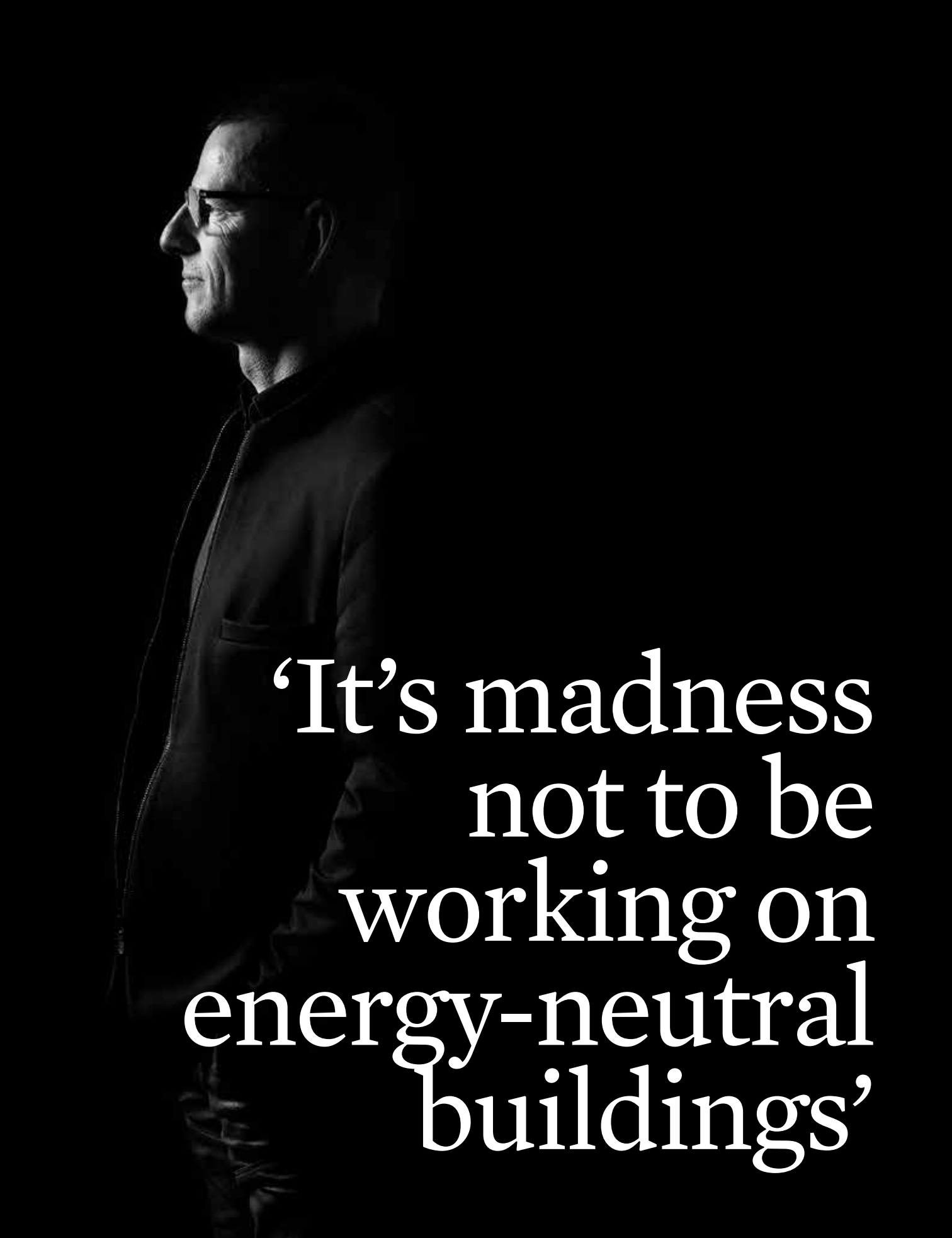
In other words, we will have to work towards integrating the existing individual systems for energy, transport and

climate adaptation into a single system. That’s because on the one hand we have to address the battle for space, while on the other the transitions are simply not feasible: there is just not enough construction capacity. This means that you will have to redesign the ‘city as a system’ with cohesive solutions for energy generation, food production, transport and waste water purification.

Integrally developed cities have already arrived. Google is building Quayside in Toronto, while completely new urban constructs are under development or have been completed in various Asian countries, such as Masdar City in the United Arab Emirates.

By 2030, I expect to see similar transitions in the Netherlands. We will redesign the urban infrastructures for energy, transport and water into integrated, ‘distributed’ systems. Most of these efforts will be circular: new construction using existing materials and components, potentially using new building methods such as 3D printing. Incidentally, I think that a time will certainly come when we see a trend of people leaving cities. Apart from the fact that this is always a cyclic process, it is also a logical consequence of the transitions currently underway, with computerisation leading the way’. 





‘It’s madness
not to be
working on
energy-neutral
buildings’



In the Netherlands, Amsterdam is taking the lead when it comes to improving urban sustainability. The city aims to be CO₂-neutral by 2040. Andy van den Dobbels heads up the research group that is charting the course for this mammoth task.

TEXT TOMAS VAN DIJK PHOTOS SAM RENTMEESTER

It's a city packed full of draughty 1950s housing and lopsided 17th-century canal-side mansions with old-fashioned glazing. Has the capital city actually lost its marbles? If you take a walk around Amsterdam it's difficult to imagine that the city is nurturing the ambition of becoming CO₂-neutral. But that really is a target for 2040. Other cities are set to follow suit ten years later. Amsterdam is setting the bar high. But it is achievable, according to Andy van den Dobbelsteen, Professor of Climate Design and Sustainability (Architecture and the Built Environment). He heads up the research group that is charting out the course for the city to take. The research is part of the European project City-zen.

There are bound to be some battles ahead. Not on the barricades, but on the drawing boards. Where will the heating networks be and what type will be installed? Heated discussions about these issues are already raging between the city, energy companies and residents. 'Here in this neighbourhood, Zeeburgereiland, energy company Nuon wants to install a high-temperature heating system', says Van der Dobbelsteen, who pulls up a map of Amsterdam on his laptop. 'But the residents are fiercely opposed. They want to be connected to a system for lower temperatures. This can ultimately be supplied by a range of different sustainable sources.'

Heating networks

Heating networks will be crucial for the plan's success. Hot water flows through these pipes, which will ultimately heat most of the houses and replace the gas currently used by the majority of households. The water flowing through the current heating networks is between 70 and 90 degrees and originates from the Nuon gas plants or from waste incineration. In the future, the heat will need to come from various different sources, such as geothermal heat and solar collectors. The temperature will also be lower in most cases, at around 40 to 60 degrees Celsius. (See page 12 'How can Amsterdam ditch the gas?') This means replacing the heating systems and expanding the system of networks.

Highlighted parts of the map show which areas can easily be connected to low-temperature heating networks. Large parts of the city are already highlighted; the Zuidas, Amsterdam-Zuidoost, the neighbourhoods alongside the IJ, including the islands Java Eiland, Borneo Eiland and IJburg. Noticeably, the city centre has been left untouched.

So is the city centre not participating in efforts to improve sustainability?

'The heating networks will gradually be brought inwards from the outer neighbourhoods. Whether they will completely cover the old city centre remains unclear. It's only possible to heat houses with low-temperature water if they're properly insulated. Houses that are centuries old are difficult to insulate. Monumentenzorg (the Department for the Preservation and Restoration of Monuments and Sites) insists on window frames with bubbled glass that looks like it dates from the 17th century. There is a version of double glazing that looks like it, but Monumentenzorg says it's not good enough. This is pure obstruction.'

Monumentenzorg simply wants it to continue to have a 17th-century appearance. Don't they have a point?

'We have a street scene filled with cars, rubbish bins, bicycles and houseboats that have nothing to do with the 17th century. But you're not allowed to replace a window. That's just nuts in my view. We're also not permitted to install roof tiles fitted with solar cells on visible roofs. They gladden slightly more than the old-fashioned tiles. Together with solar cell expert Prof. Miro Zeman (EEMCS) and his research group in the SolarUrban programme, we are now attempting to make products that meet the requirements, such as roof tiles that are slightly less shiny.'

You're not giving up on the city centre.

'No, my suggestion would be to install heating networks for high temperature there.'

That would mean that the centre will never give up gas because the hot water will still need to be heated by a gas plant?

'No, most of the high-temperature heat should come from geothermal energy, possibly supplemented in the winter by means of co-firing. In the future, there will always be some gas still. But it will be green gas, such as biogas or synthetic methane, produced by incinerating biomass or using surplus power in the summer.

Another alternative is simply to leave the gas pipes in place and gradually fill them with synthetic methane, biogas or hydrogen. It's important that we set our priorities properly, because the little bit of gas that we still have in the future will be sorely needed for metal processing, the plastics industry and freight transport. It's a waste to consume gas for houses. It's a very high-quality fuel. Gas combustion takes place at a temperature

CV

Prof. Andy van den Dobbelsteen is Professor of Climate Design and Sustainability at Architecture and the Built Environment and head of the department of Architectural Engineering and Technology. His chair plays an important role in the European City-zen research project that aims to create energy-neutral cities. On King's Day 2018, he was made a Knight of the Order of the Netherlands Lion in recognition of his work. In March this year he received the Academic Society Award of KIVI, the Royal Institute of Engineers. Van den Dobbelsteen also has literary ambitions. Last year, he published a thriller, *Campingsmoking* about Dutch people at a French campsite.

of 1,200 to 1,500 degrees. Using that to heat water to 60 degrees is a waste.'

You are not ruling out the mass demolition of buildings. That's strange. I thought you were against it?

'In our study, we started by looking at where we can save energy. We estimate that Amsterdam can reduce its heating demand by a third by means of insulation and the demolition of the very worst buildings. In principle, I'm against demolition. Sixty percent of all the environmental and carbon burden of an office building is in the load-bearing structure. If you don't demolish the building, but empty and strip it, you're conserving that sixty percent. But some buildings are simply no longer fit for purpose. For example, the ceiling height may be too low by modern

'We have a street scene filled with cars, rubbish bins, bicycles and houseboats that have nothing to do with the 17th century. But you're not allowed to replace a window'

standards. Some housing dating from the rapid post-war reconstruction period is also in a poor condition. There are also buildings in awkward positions, such as next motorways or in locations where urban revival is envisaged and where they are preventing it. Sometimes you have to bite the bullet and not be afraid of demolishing.'

Do you also oppose the demolition of robust office buildings with a good load-bearing structure and good ceiling height?

'No. I simply consider it to be the destruction of capital. The problem is that we don't have to pay for any residual value that remains in the materials. Currently, it makes no difference if you demolish a building after ten years or 200. In my thesis (2004), I put forward the idea of linking every building to a type of environmental mortgage that can only be written off after 75 or 100 years. Seventy-five years roughly amounts to a human lifetime. All of us can imagine a building lasting for a human lifetime. It's also realistic as there are very few structures that need to be demolished before that time for technical reasons.'

Your plan also envisages the construction of solar parks, wind turbines and the planting of woodland outside the city to compensate for residual CO₂. And forty percent renewable energy will need to be bought in the region.



You also assume that all new construction will be self-sustaining, i.e. CO₂-neutral, from now on. Is that not rather too optimistic?

'Why? It's perfectly possible. Many builders are already making energy-neutral or even energy-supplying homes as standard.'

So where are these homes? Not in Amsterdam.

'A lot are being built, mainly in the north and east of the country. In the Randstad things are more difficult, it's true. Project developers have adopted a wait-and-see approach. If it's not a statutory obligation, they don't do it. It does make houses slightly more expensive. But the plus side is that you have no energy bills. It's madness not to be working on energy-neutral buildings. If we're not careful, today's new buildings could be the problem of the future.'

Can the lessons learned from your study also be used for other cities?

'Partially. The situation is different everywhere. Amsterdam has everything: industry, post-war neighbourhoods, a historic centre and redevelopment projects. Utrecht has no industry. Rotterdam is even stranger. That city has hardly any historic city centre. It also has a port that consumes huge amounts of energy. Making that energy-neutral will be quite a challenge. The Hague has hardly any surface water, but is located on the coast, which opens up all kinds of opportunities. Every city will need to make its own analyses and plans.'

Which city is most like Amsterdam?

'... Well, it's slightly smaller, but in essence, Delft is probably the closest.'

Fifty years of Industrial Design Engineering



In 1999 first year students painted their bicycles so they could find it back easily during the Introduction Week OWee.

Two students and a few lecturers The Industrial Design research group started life in an attic room at the Faculty of Architecture back in 1962, thanks to engineer Joost van der Grinten.

When he was appointed endowed professor, Van der Grinten vowed to set up an Industrial Design degree programme; Initially a specialisation within the Architecture department, on 7 February 1969 it was officially recognised by the minister. From that moment on, the degree programme was able to continue independently from the Architecture programme and the number of students increased rapidly. The degree programme relocated to Ezelsveldlaan and not long after that it celebrated its first graduate engineer, Norbert Roozenburg. Over the last 50

years, IDE has developed into a broadly oriented programme enjoying international prestige with 1,964 students (2018). According to Dean Ena Voûte, the days of simply making beautiful chairs at the Faculty are long gone. 'All productions are featuring more and more electronics and robotics.' The following eight designs walk us through the history of the IDE degree programme. From the first graduation project, the Buxi, to the ANWB call box and one of the most recent designs, the Nudging toolkit.

Carrosserie Buxi - the first graduation project

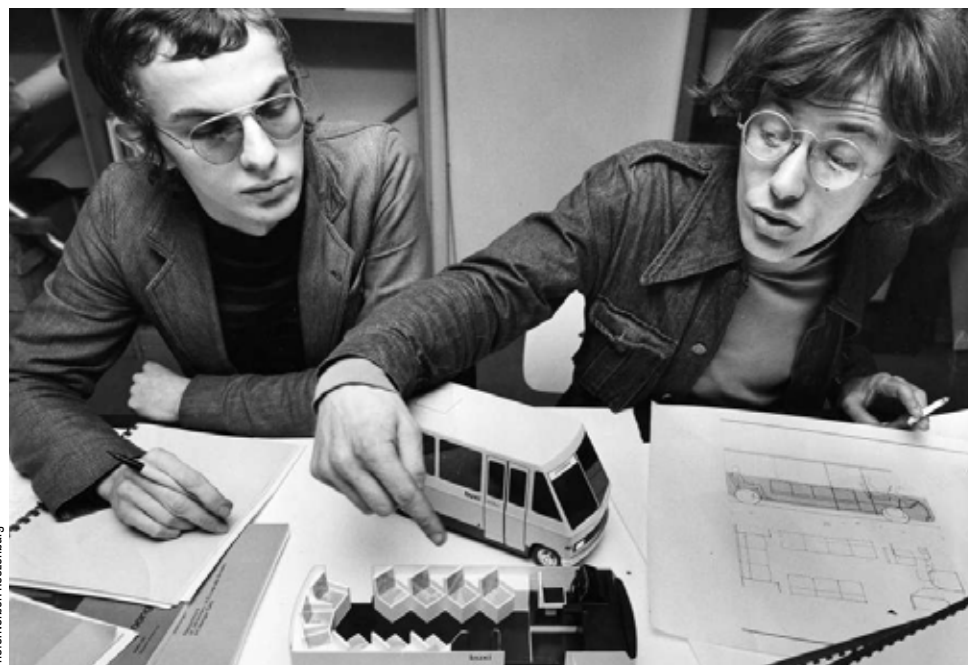


Photo: Norbert Roozenburg

buxi system, they went on to develop the layout for the vehicle, paying particular attention to the behaviour, comfort and safety of both the passengers and the driver. At the same time, they examined the technical possibilities and requirements of the vehicle. Out of their five alternative layouts, they selected one to take to the next stage. Among the innovations was the diagonal arrangement of the seats. Even that first graduation project had almost all the hallmarks of a typical IDE graduation project, says Roozenburg. 'A realistic design problem, a phased systematic design process and plenty of focus on the user, conditions of use, technical possibilities and economic feasibility'.

The first person to graduate from the programme was **Norbert Roozenburg** (on the right side in photo) in 1971. His graduation project was the buxi system: an on-

demand minibus that would pick you up and take you to the central stop. Roozenburg was asked to come up with a rough design for the minibus and to

develop specified parts. He worked on this project with student Jacob Maartense, for whom this was his fourth-year design project. Once they had analysed the

ANWB call box - an elegant guardian angel



PHOTO: ANWB

Until last year, you could spot them every 2 kilometres along the side of the road: the ANWB call box. A dream to design as a graduate, says **Chrétien Gerrits** almost thirty years later. Gerrits' task was to make the call box cheaper to produce and maintain. His research showed that the previous call box was too high for children and people in wheelchairs, yet they also had to be able to report breakdowns, accidents or emergencies. They couldn't reach the button, nor could they hear the ANWB employee above the noise of passing traffic. 'The problem was that you could not turn up the volume,' says Gerrits. Thanks to its simplified design with 'long ears', everyone - the tall and the small - could hear the emergency

services without the volume having to be increased. 'It resulted in significant cost savings: 60% on production, 70% on maintenance,' says Gerrits. The designer is still passionate about his 1994 call box, which he affectionately calls 'Brother Rabbit'. 'The impact of the design was important to me: it was an elegant guardian angel on the border between tarmac and cows, between the hustle and bustle of progress and the silence and vulnerability of nature. It was always there for many unlucky travellers, in rain or shine, day or night, along a busy road or in the middle of nowhere'.

Read more on page 26 >>

Delft Design Guide – a reference guide for students

The Delft Design Guide is the culmination of years of experience of design students, professionals, researchers and lecturers of the faculty. Since it was introduced in 2013, 'the blue book' has been a staple of the Faculty's identity, known and used on design programmes in the Netherlands as well as abroad - and it has even been translated into Chinese and Japanese. The book gives an

overview of perspectives on design, such as Design for Emotion and Brand Driven Design, models, such as the Basic Cycle of Design and Innovation models, and about 60 design methods, such as Contextmapping and the Ecodesign strategy wheel. Some methods are unique to Delft, while others are more widely known. Design students use the book as a reference guide for their

design projects, design supervisors to support students in their learning process, and professional designers to support their design processes. A revised version featuring new methods will be launched this autumn. (Photo: Delft Design Guide)



Clap skate – more power over longer distances

In collaboration with the Dutch skating brand Raps, **Maurits Homan** came up with a modification for the clap skate (2001). 'That was big news at the time', remembers Homan. 'Skaters could go even faster on these skates and set new records. In addition, the design was also conceptually interesting because it looked as though all the parts had just been patched together haphazardly.' The idea behind the design was to make the skating stroke longer, so that skaters could generate more power over longer distances. 'By tilting the

axis of the clap skate over two surfaces, the iron, together with an angular rotation of the heel, tilted inwards. This movement matched the alignment of the upper tarsal joint more closely.'

After a lot of research and a number of prototypes, a final design was developed - and has since helped skaters like Jan-Maarten Heideman and Peter de Boer win many races. (Photo: Maurits Homan)



Senz – an umbrella for gale-force winds

Gerwin Hoogendoorn's graduation project (2005) arose from his own frustration with traditional umbrellas (he once threw away three in one week) and formed the basis for the development of Senz.

The project was by no means a smooth ride and Hoogendoorn found himself well outside his comfort zone. To understand the problem with traditional umbrellas, he investigated broken

umbrellas, 'but I had to dig them out of rubbish bins first. I got quite a few funny looks doing that,' he recalls. Under the supervision of Bruno Ninaber van Eyben, he pushed himself to the limit to create a product that solved all the problems of a traditional umbrella in one fell swoop. Hoogendoorn, now only involved with Senz as a shareholder, can still see that his design is in a different league when it comes to

quality. 'You can even rely on this umbrella in gale-force winds'. The entrepreneur makes the case for 'the industrial designer'. 'As an industrial designer you learn very quickly; you can work basically anywhere in the world of business.' Something that he himself, as an entrepreneur, saw as a huge advantage; 'If I didn't know something, I would look it up.' (Photo: Senz)



50
years
of

NightBalance – therapy for sleep apnoea

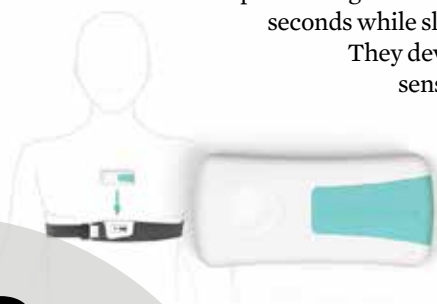
In 2008, **Eline Vrijland-van Beest** and **Thijs van Oorschot** launched a new therapy for people with sleep apnoea: they stop breathing for at least ten seconds while sleeping.

They developed a sensor that vibrates gently when people

roll over and sleep on their backs, thereby helping them avoid unhealthy sleeping positions.

It was originally Eline's father who came up with the idea for a device for this position therapy. She turned it into her graduation project and then founded the tech start-up NightBalance, where she did further research with Thijs van Oorschot. The development of the sensor was a complex process. 'You want to test with real patients and you can only do that

with strictly regulated clinical research', says Vrijland-van Beest. It took him a whole decade to test and determine that the sensor really worked. NightBalance now has fifteen patents and the device is covered by the basic health insurance package. 'Position therapy can help more than 25 million people worldwide with their sleep apnoea,' says Vrijland-van Beest. 'That's quite an impact.' (Photo: Nightbalance)



Ambulance drone – delivering a defibrillator fast

In 2014, **Alec Momont's** graduation project was an initial prototype of the ambulance drone, an unmanned and autonomously navigating mini aircraft that can deliver a defibrillator at lightning speed.

When the emergency services receive a cardiac arrest call, this drone flies to the patient's location. The drone homes in on their position using the caller's mobile phone signal and finds its way there using GPS. It can fly at around 100 km/h, weighs 4 kg and can carry another 4 kg. Using

a livestream, the drone provides direct feedback and gives instructions to the people on site. According to Momont, it is essential that the right medical care is provided within the first few minutes of a cardiac arrest. If we can get to an emergency scene faster we can save many lives and facilitate the recovery of many patients. A network of such drones could significantly increase the chance of survival following a cardiac arrest: from 8% to 80%! (Photo: Alec Momont)



Nudging Toolkit – influencing unconscious behaviour

It is becoming increasingly difficult for organisations to understand and change customer behaviour. For example, how can banks encourage people to save up money for their pension and how can care organisations motivate people to adopt a healthier lifestyle? It was while studying strategic product design that **Anne van Lieren** became interested in human

behaviour. For her graduation project (2018), Van Lieren studied more than one hundred nudging techniques (consciously influencing unconscious behaviour) and developed a new approach and accompanying toolkit for designers who are interested in behavioural change. 'It is becoming increasingly difficult for people to make conscious decisions - we simply don't have en-

ough brain capacity and energy to think about everything consciously. Designers can use this toolkit to snap people out of this autopilot at the right moment and encourage them to think about an important issue,' she says. (Photo: Anne van Lieren) <<

All fundamental research should be followed by more applied studies to ensure a benefit for society.

Damla Inan, chemical engineer

Machine learning is not a kind of artificial intelligence, it is a result of human intelligence.

Astrid Elzas, materials engineer

Mankind has evolved to the point where we can transform a tree into a rock.

Natalie Carr, civil engineer

Sometimes two different research communities study the exact same thing, but they often cannot understand each other's work.

Iuri Rocha, civil engineer

In the future, the term 'sustainable engineering' will be tautological – all engineering will need to be more sustainable.

Udai Shipurkar, electrical engineer

Experts see the world differently, and they can notice things that non-experts do not see.

Wenqin Shi, physics engineer

If principles can become dated, they are no principles.

Fan Feng, naval engineer

Foul beasts

There are some policy measures that you just know are going to be introduced, but the question is how long interest groups can delay the inevitable.

CO₂ tax for businesses, toll charges on motorways and a ban on using wood-burning stoves. It was only recently that I became really aware of the necessity of this latter measure after reading about a study by the British Air Quality Group. The study made a comparison between a 40-ton lorry and a wood-burning stove, both of which complied with the latest environmental standards. The figures showed that the wood-burning stove actually produces six times as many particulates in one hour as a diesel lorry.

But let me be quite open: I actually own a wood-burning stove myself and it always gave me a warm feeling. Put a log in and simply stare at the flickering flames. There was something wonderfully nostalgic about it all: our ancestors would have done exactly the same when life was relatively simple.

So what am I thinking about when I look at that fireplace now? Six stinking diesel lorries churning out their smoke fumes into the neighbourhood through my chimney.

I recently interviewed an asthma patient for *de Volkskrant* newspaper whose symptoms were so severe that she actually left her husband and child to go and live alone in a Spanish mountain village.

Mountain air is particularly beneficial for asthma patients because house mites cannot survive at higher altitudes, resulting in fewer allergic reactions.

But less air pollution also helps these sufferers. The Dutch Longfonds has been campaigning against wood-burning stoves for some time now. The organisation points out that these stoves cause problems for lung patients, who are unable to protect themselves against other people's smoke entering their homes. Perhaps there are owners of such stoves who think: 'Well, that is their problem. I want to enjoy my fire.' And perhaps there are others who convince themselves: 'I always make sure I use dry wood and my hypermodern stove produces less pollution.' What I actually ask myself now is whether my small amount of pleasure is really worth causing so much suffering to someone else down the road?

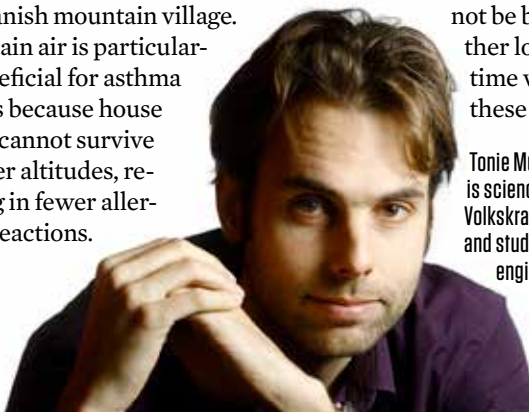
Moreover, it is also quite unnecessary, because I also have central heating.

The theme of this issue of *Delft Outlook* is 'the city': about urban problems and their solutions. The planet is currently home to more than 7.5 billion people and by 2050 this is expected to rise to 10 billion. More than half the planet's inhabitants currently live in cities and the UN expects this number will rise to two-thirds by 2050.

In short, cities will become ever more crowded. And this means that all those chimneys churning out smoke like diesel lorries are simply untenable. So my stove will

not be burning another log and it is high time we banned these foul beasts.

Tonie Mudde (born 1978) is science editor at *de Volkskrant* newspaper and studied aerospace engineering at TU Delft.



THE FIRM

Tomas te Velde never imagined that a year on the board of competition sailing association DSWZ Broach would lead to running his own business. Yet that is exactly what he is now doing with strategic consultancy firm Suit-case, together with fellow board members Daan de Wit, Marc Bolier and Bern Laninga.

‘We enjoyed working together on the board so much that we felt it would be a crying shame to leave it at that,’ Te Velde explains. In 2016, the four of them decided to set up Suit-case, an organisation that helps government bodies and major companies with concept development and project management.

Initially, there was a lot of testing the waters. ‘In the beginning, we did not have set rates, for example. The client determined how much our advice was worth, but that turned out to be difficult and particularly awkward,’ Te Velde recalls. Shifting course, they opened a small office in Delft, which earned them more commissions and brought them into contact met Blue Turtles Associates, an organisation focusing on issues relating to circular chain innovation. ‘And all that while we were still studying.’

Thanks to the Turtles, things went quickly. The organisation involved Suit-case in the development of manufacturing facility The Tec Factory. ‘Think of it as a kind of dream hall 2.0,’ te Velde comments. ‘A space where dream teams, businesses and government bodies work together on technological innovations.’ The Blue Turtles provide the expertise and Suit-case the young innovative force and methodology.

The first major commission was


Trekschuit 2.0. The group was asked to develop a concept for quiet waterway logistics in the city. ‘Many logistic flows, such as waste collection, could be made quieter and cleaner. Did you know, for example, that segregated waste is collected everywhere in Delft, except in the city centre?’ he asks. ‘Everyone wants to make Delft cleaner, but that is difficult. For example, it is virtually impossible to build underground containers in the historical centre. So why not make use of the Delft canals?’

Te Velde feels they have a simple solution. ‘An electric flat-bottomed

Company: Suit-case
 Founded in: 2016
 Degree
 programmes: Architecture and the Built Environment, Civil Engineering, Industrial Design and Engineering and Mechanical Engineering (Management of Technology).
 Number of employees: 4 full-time and 4 part-time.
 Mission: To develop interesting concepts that contribute to a better world.
 Turnover: ‘Last year we came close to 100,000 euros.’
 Target group: Government bodies and major companies.
 In five years’ time: ‘To have grown quickly so we can tackle larger projects. We want to inspire as many people as possible to think outside the box.’



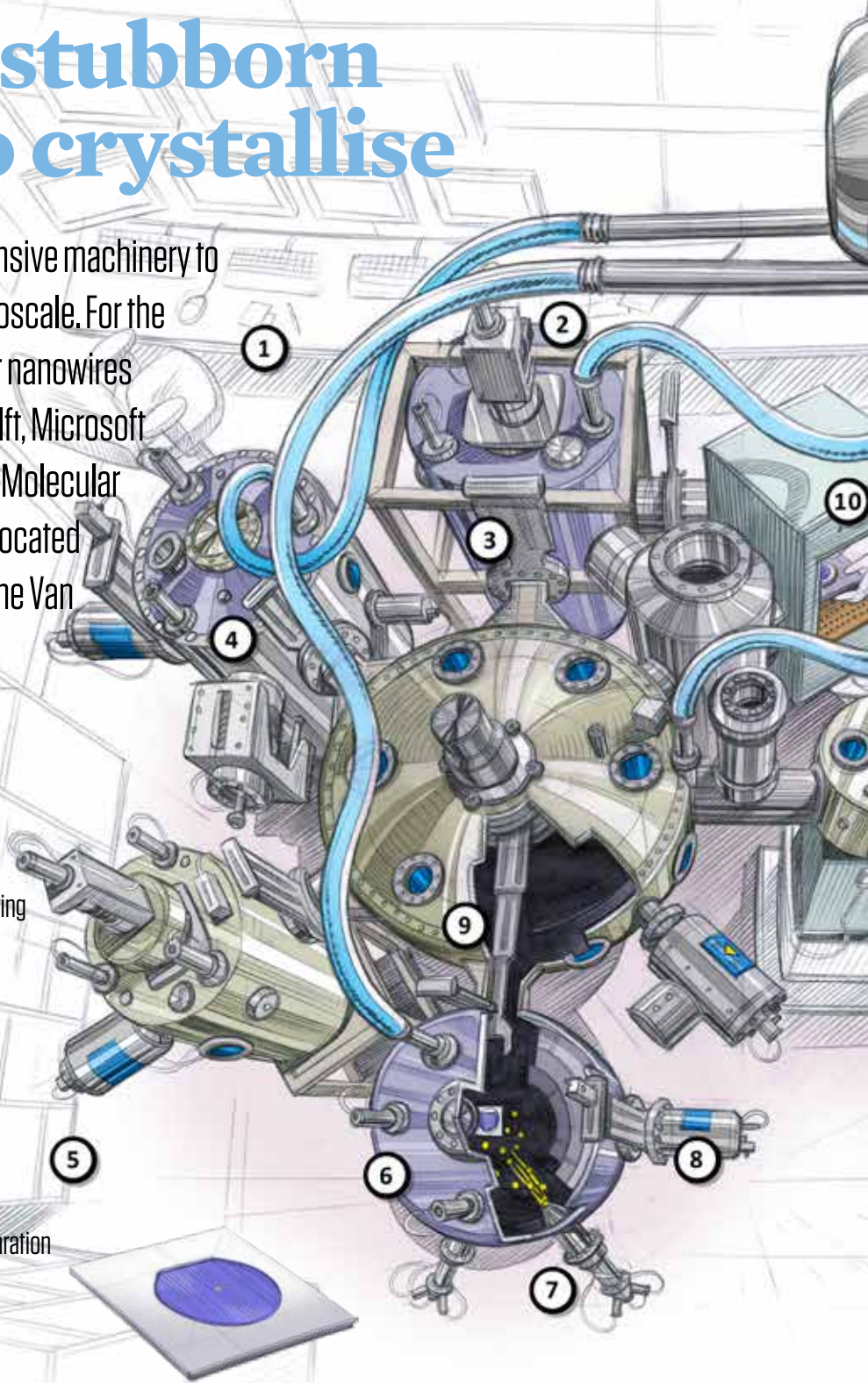
Standing: Tomas te Velde, Kito Samson. Sitting: Pieter Lenselink, Marc Bolier.

barge in the canal can collect segregated waste for a single street. It is an energy-neutral way to solve the problem of waste. If it works, we would like to develop it further. You have to start small to fulfil your ambitions.’ And ambitions are something Suit-case is not short of. The group is already looking beyond Delft. ‘We are hoping to get a similar concept off the ground in Utrecht, but then for delivering packages. And we are working on this with DHL. It is really exciting, because this means we are developing a solution from idea to concept. So now it is up to us to show what we are capable of.’ 

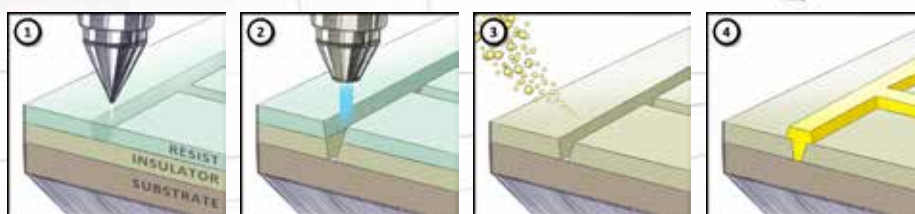
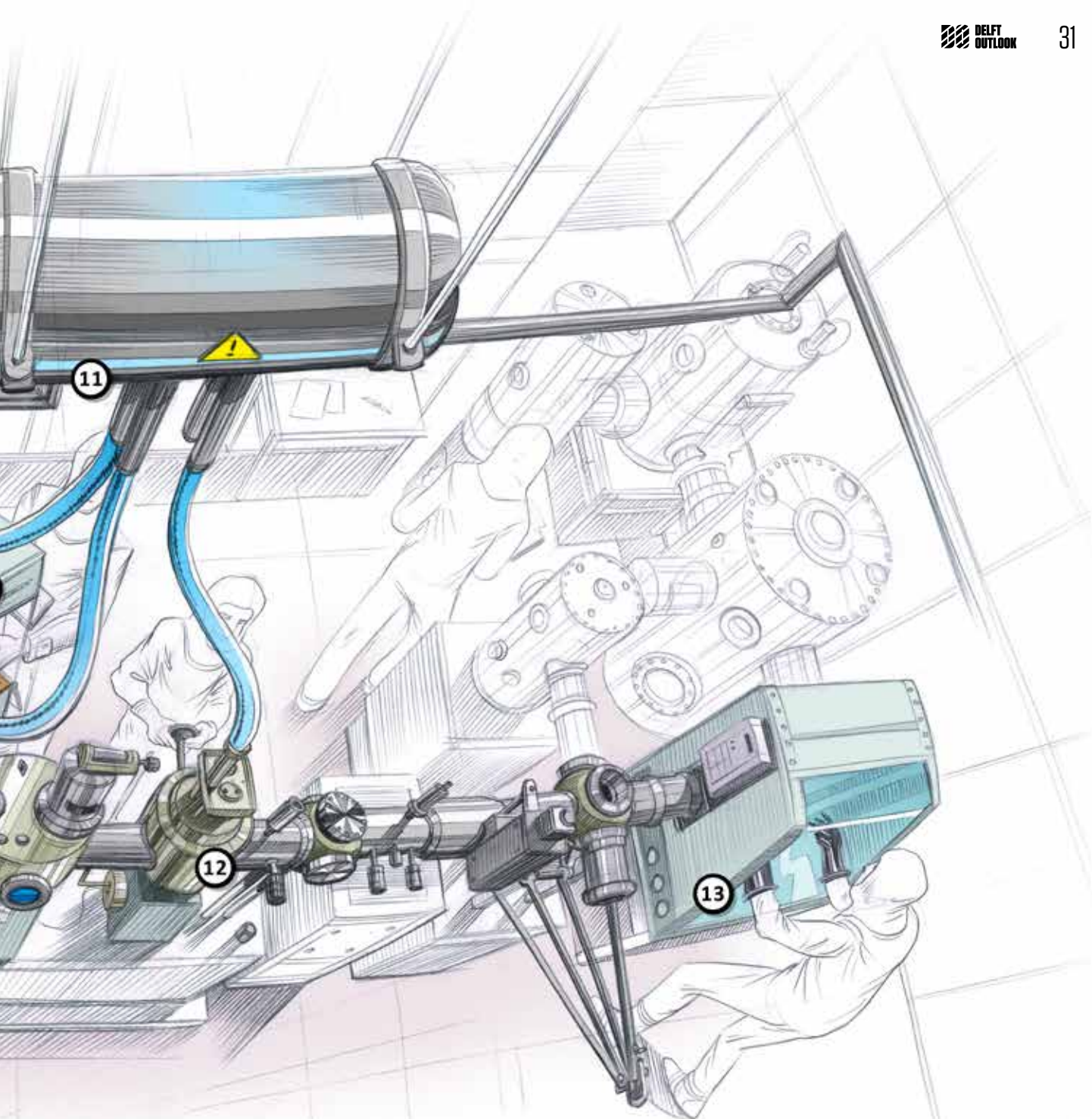
Huge machine seduces stubborn atoms to crystallise

It takes impressive and expensive machinery to control processes at the nanoscale. For the fabrication of semiconductor nanowires at Microsoft Quantum Lab Delft, Microsoft invested millions in the MBE (Molecular Beam Epitaxy) machine. It is located in one of the clean rooms of the Van Leeuwenhoek Laboratory.

1. Control and monitoring area
2. Deposition chamber 3
3. Lock door
4. Deposition chamber 2 (superconducting metal chamber)
5. Control unit
6. Deposition chamber 1
7. Electron gun
8. Vacuum pumps in cascade
9. Robot arm
10. Loading dock
11. Nitrogen tank for liquid/gas phase separation
12. Sample flipping unit
13. Glove box: manipulation in water & oxygen-free environment



Nano thread detail.



1. Writing with e-gun
2. Etching[/Opening] with plasma
3. Atomic beam to the sample
4. Grown nano-crystal

Continuation of page 31

Senior researcher Dr Philippe Caroff takes the science editor and the illustrator for a first tour to see the MBE machine. No paper is allowed inside and visitors need to put on dust-free overcoats, boots and gloves. The multimillion euro MBE machine, located in a separate room in the lab, is being used to manufacture nanowires of about 300 atoms wide (100 nanometres) and a few micrometres long. Nanowires made from semiconductor materials such as indium-arsenide or indium-antimonide, in contact with a superconductor, have been shown to be suitable host materials for Majorana particles. Majorana quasiparticles, discovered by Professor Leo Kouwenhoven in 2012, are regarded as promising candidates for quantum bits or qubits – the elementary units for the future quantum computer.

When the first Majoranas were demonstrated (Science, 12 April 2012), it was in a semiconducting nanowire made of indium-antimonide between a gold contact and a stretch of superconducting material. At the time, nanowires were grown by controlled crystallisation underneath a submicron-sized gold droplet. Caroff, senior scientist at Microsoft, calls this ‘the classic method’.

The MBE machine aims to standardise the manufacture of nanowires and to enable the production of grid-like structures instead of simple wires. The required patterns are transferred onto a piece of silicon substrate by means of electron beam lithography, a technology from the micro-electronics industry. The electron beam creates a path in the chemical resist, which is then removed to expose an insulator masking layer. Further etching removes insulator layers opening a window to the

‘We are discovering the psychology of atoms and start to understand their stubbornness’

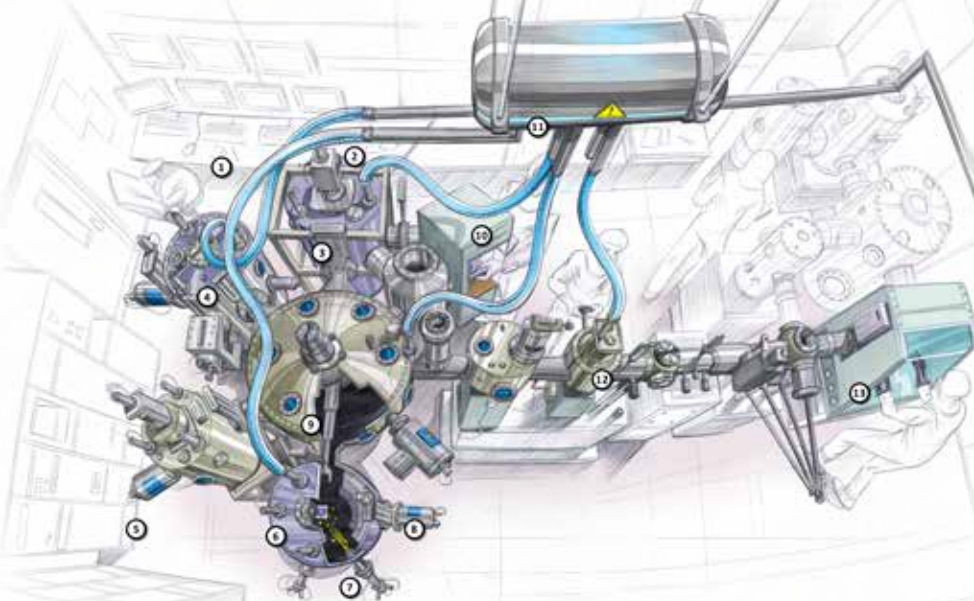
crystal below. Below lies monocrystalline semiconductor of the target, as a virgin soil for the semiconductor crystals that will guide growth in the etched submicron grooves.

But for that growth to happen, extreme requirements need to be fulfilled. The vacuum within the entire machine for instance is attainable to the highest degree. In the machine, it is just as empty as it is in space between the planets, illustrates Caroff. Grease

or rubber are absolute no-gos in this installation. Inside, the mean free path before a free flying atom hits one of its neighbours is 50 kilometres.

Another challenge is maintaining the heat imbalance between the high temperatures required to produce atomic vapours, and the cryogenic environment of the target for the atomic beams. Masses of liquid nitrogen, about 1,000 litres per day, circulate in double-wall cryo-panel inside the MBE to keep the MBE at the right temperatures and contribute to the ultra-high vacuum. Also, there is the atomic incompatibility. ‘We’re putting materials together that don’t like each other in nature,’ says Caroff. Therefore semiconductors and superconductors are applied in different deposition chambers, and a robot system transports the target in between the various production stages.

Researchers are now trying to get atoms to crystallise in the shape and composition they require. But getting an atom to crystallise is like getting a dog to lie down. You cannot force the process, you can only try to tempt it to settle. ‘We are discovering the psychology of atoms,’ says Caroff. ‘We are starting to understand their stubbornness.’ <<



After Delft

Goedhart's affinity with construction showed itself from an early age: as a child he loved to play in houses that were being built. Although he considered studying aerospace engineering, he eventually chose architecture because he loves to create things. 'Like nearly everyone who studies architecture, I thought I'd become an architect', he says. 'As it turned out, I had more affinity with the organisational aspect of building projects.'

He graduated as part of the project management research group. His thesis Knowledge Sharing in Free Form Building Design is about organising the design process in such a way that the traditional building sector steps out of its comfort zone and dares to work differently. Other than in straightforward lines without curves.

One of his case studies was the architect Frank Gehry, renowned for his free-form buildings such as the Guggenheim Museum in Bilbao. 'What Gehry does is take a lump of clay and model it in a shape that is pleasing to him', explains Goedhart. 'Then he scans it, processes the digital model and turns it into a building.'

For an original way of making this process tangible, Goedhart secretly approached the then rector Jacob Fokkema to ask if he could make a scan of his head for a 3D print. This was a first in 2004. Fokkema agreed. Goedhart's graduation mentors

Building management advisor Gideon Goedhart wants the traditional building sector to step out of its comfort zone. He calls his role as project manager for Museum Voorlinden in Wassenaar his great breakthrough.




Name: Gideon Goedhart
Home town: Leiden
Civil status: Married, one son, one daughter
Programme: Architecture & Built Environment
Student association: Delftsche Studenten Bond (DSB)

Photo: Sam Hennekes

were suitably surprised during his graduation presentation. He really learnt his trade after his graduation, working as a project manager from 2005 to 2012 at the DHV engineering consultancy. One of his projects was the Koningin Máximakazerne at Schiphol. 'We did the operational management and saw to it that the contractor did good work. I think it's a must that students see how design processes work out for contractors.'

He views his role as project and operations manager in the construction of Museum Voorlinden in Wassenaar as his personal breakthrough. This ambitious project taught him to step off the beaten track. 'At Voorlinden I was given the opportunity for personal development by taking courses at the

Rotterdam School of Management and Nyenrode.' Because despite the broad base he acquired at TU Delft, which prepared him well for his daily practice, he missed focus on skills such as leadership. This was largely compensated for by his administrative year in the Delftsche Studenten Bond.

In 2016, he moved to the ABT engineering consultancy where his work involves managing large-scale, challenging projects. These include an underground bicycle park with a high-rise building at The Hague Central Station, and redeveloping the head office of an oil and gas giant. He takes inspiration from a quote by Virginia Rometty (CEO of IBM): 'You have to feel comfortable with being uncomfortable; if you're not uncomfortable you don't learn.' 

Can algae save airplanes from rusting apart?

TU Delft researchers are developing new coatings with unicellular algae, that may prevent corrosion in aluminium airplane structures.

TEXT: TOMAS VAN DIJK PHOTO: SAM RENTMEESTER



Santiago Garcia (left) and Paul Denissen develop an environmentally friendly alternative to chromium-6 coating with the external skeletons of diatoms.

“**A**nd here are our pets. Thousands of them.’ PhD researcher Paul Denissen is giving a tour through the Novel Aerospace Materials group’s lab, a group that lives up to its name. The ‘pets’ Denissen is referring to are diatoms, a group of unicellular algae. The PhD researcher picks up a little glass container with murky sea water from the windowsill. He and his supervisor, Associate Professor Santiago Garcia, are using the algae to create a revolutionary new

kind of corrosion protective coatings. Diatoms have the unique feature of forming highly ordered hollow porous silica exoskeletons, called frustules. Typically these consist of two symmetrical sides held together. Because of their characteristics, the diatom exoskeletons are described as forming ‘pill-box’ structures. The availability, morphological characteristics and potential application of the bio-based diatom exoskeletons as carriers has recently attracted significant attention in the biomedical field where their use as drug delivery systems has been

studied. But they have not only attracted attention in the medical field. At the Novel Aerospace Materials group, the two researchers are using these microalgae as carriers for corrosion inhibitors. These inhibitors are chemical compounds that, when added to a liquid or gas, reduce the corrosion rate of metals.

CARCINOGENIC SALT

An infamous example of a corrosion inhibitor is chromium-6. This salt is extremely effective, but is also carcinogenic. Because of its toxicity, chro-

mium-6 is banned in the EU. There is one exception, however. Chromium-6 is permitted in situations where there are no good alternatives, such as in aircraft corrosion prevention. The TU Delft research focuses on using the external skeletons of diatoms to develop an environmentally friendly alternative.

Chromium-6 is a so-called active corrosion-inhibitor. When a surface treated with chromium-6 is damaged, through scratches for example, chromium-6 ions are released. These then create a thin layer of chromium oxide on the exposed metal surface, preventing further corrosion.

There are a number of alternative more environmentally friendly corrosion-inhibitors that are also very good at creating protective barriers. Take

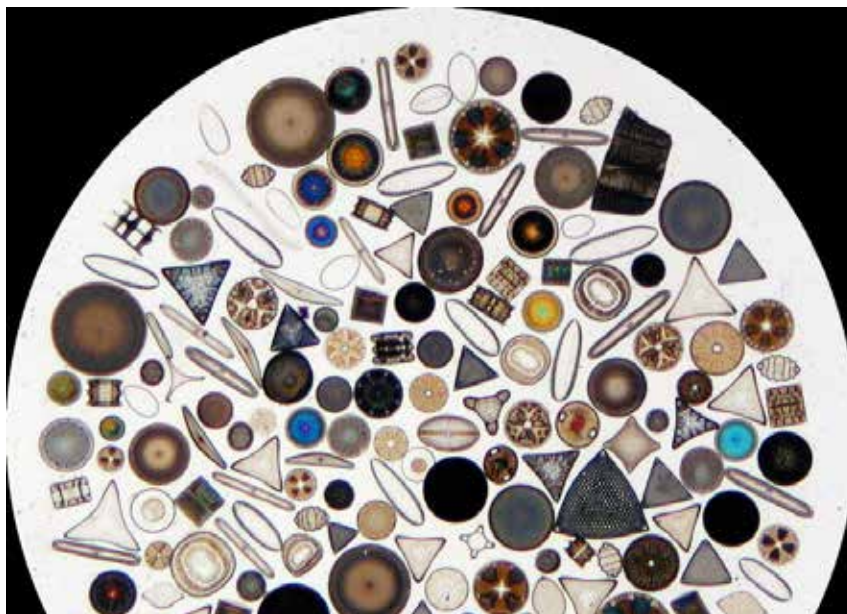
‘We saw full protection from corrosion, even after 30 days of immersion’

Cerium salts, with which the TU Delft researchers have been experimenting for years. Unlike chromium-6, however, these alternative inhibitors oxidise only once and the protective layer they create is not permanent. Long-term protection therefore requires the continuous release of these inhibitors.

And that is where the diatoms come into play.

Fill the exoskeletons with the alternative corrosion-inhibitors, add the loaded shells to the primer coating and the pill-box structure will prevent the unwanted chemical reaction between inhibitors and coating, the Delft researchers reasoned. Moreover the pores would allow the immediate and sustained release of these inhibitors when the protective layers are damaged and the metal surface is exposed.

The algae shells are easily available at low cost. Diatoms can be cultivated in bioreactors. Or one can use diato-



Different kinds of diatoms. (Photo: Wikipedia)

maceous earth, which consists of the fossilised remains of diatoms. Diatomaceous earth can be mined. Diatoms from diatomaceous earth are often used as a filtration aid and as a mild abrasive in products such as metal polish and toothpaste. Initially, the two TU Delft researchers are experimenting with diatomaceous earth. But one disadvantage of this material is that most diatoms are broken and that intact skeletons in the earth are from different species and thus differ in shape and size.

PROMISING

Still, preliminary results with diatomaceous earth seem promising. The researchers performed test where they made one millimetre wide scratches on samples of airplane aluminium which were treated with a variety of their test ‘algae-coatings’. The samples were subsequently immersed in a highly corrosive environment. ‘We saw full protection from corrosion, even after 30 days of immersion. Only a couple of alternative solutions come this close to the results obtained with chromium-6’, Denissen says.

The next step in the process is to pick one specific diatom species with the

optimal shape, size and nano pores, and cultivate it instead of using the diatomaceous earth grit with its myriad of shapes and sizes. ‘To do that, we will have to install a bioreactor here in the lab,’ says Garcia. ‘And we will look for marine biology interns to work with us.’

There are still many hurdles to cross before diatoms find their way into coatings though. ‘The Dutch Ministry of Defence wants proof that alternatives will protect their military equipment for 20 years,’ Denissen says. ‘But there are no good methods to accelerate the process and to evaluate and validate it in a short time-span.’ And many of the tests used to validate the efficacy of new coating materials are designed specifically for chromium-6. ‘It is not a level playing field. It means that you have to prove that your alternative coating behaves in a similar way to chromium-6, rather than prove that it provides adequate protection.’

But rather than waiting for coating manufacturers to replace chromium-6, airplane manufacturers are now actively developing their own solutions as well and the TU Delft researchers are at the heart of these developments.

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‘Doing something for someone else is actually dead cool’

Following a long career, much of which was spent at McKinsey, Mickey Huibregtsen is now concentrating on social issues and transferring his knowledge and experience to future generations.

TEXT: AGAATH DIEMEL PH.OTO: GUUS SCHOONEWILLE

After graduating from Delft and his national service with the Royal Netherlands Navy, Mickey Huibregtsen joined heavy engineering firm VMF Stork-Werkspoor. One of his first assignments there was supervising 70 technicians during the construction of a naval frigate. With his knowledge of partial differential equations, for example, at first he found little respect on the work floor. ‘But that all changed when we went out on a test voyage in a force 11 gale,’ he recalls. ‘Everyone was really ill, except me. I didn’t get seasick and I could hold my drink, so within a day I had become a natural leader.’ Although he made a flying start at Werkspoor – by the age of 27 he was general manager of the Gas Turbine Division – he didn’t want to follow in the footsteps of his own supervisor. Instead, Huibregtsen decided to change tack and apply for a job with management consultancy McKinsey & Company. ‘They were asking for people who could walk on water. That appealed to me.’ He would stay there for almost 30 years. ‘I worked with interesting people on interesting problems,’ is how sums up that time. ‘I advised 45 of the 50 largest companies in the Netherlands, half of the ministries in The Hague and half of the country’s teaching hospitals. That was still possible in those days, but all the consultants are really specialised

now.’ From the age of 55, however, he slowly began to retire from McKinsey. ‘Over the years, I came to realise that it was in the company’s best interest for people not to stay too long.’

SPORT

Not that Huibregtsen was now planning to sit back and relax; instead, he shifted his focus to civil society. During his time with McKinsey, he had spent eight years as a director of the Dutch Olympic committee, NOC*NSF. He had also been a fanatical sportsman – he was once national squash champion in the veterans division and he played with the Delft Student Hockey Club for six years – and so appreciates sport’s social importance. ‘Sport is an ideal platform to bolster social values,’ he declares. Values such as health, social cohesion and quality of life. Besides sport, throughout his life Huibregtsen has also followed science, education, healthcare and politics. ‘I have universal interests,’ he says, ‘so I’ve involved myself in everything.’

PUBLIC INTEREST

For many years, Huibregtsen has particularly dedicated himself to increased civic engagement. Together with former government minister Pieter Winsemius, he set up *De Publieke Zaak* (The Public Interest), an association for ‘social innovation’. ‘People have been told for decades that they have rights,’ he explains, ‘but never that they

also have duties. We want to create a mindset that taking the initiative and doing something for someone else is actually ‘dead cool.’ To this end, De Publieke Zaak is backing initiatives like MaatschapWij.nu, the ‘inspiration platform for a more social, more sustainable Netherlands’.

REBUILDING SOCIETY

It is not just people who have to change, though. So does society. ‘Most of our institutions, not least our politics, have lost their lustre,’ says Huibregtsen. ‘We have to hold them up to the light and see if we can reinvent them. Big companies are also social institutions. It is absurd to take shareholder value as the only valid measure of their performance.’ And, in his view, the political establishment lacks courage. ‘The selection process on the way up is so negative. The motto is always ‘Don’t rock the boat.’

MORE US

A new publication is now in the pipeline. Meer Wij (More Us) will be about collaboration in the twenty-first century. As Huibregtsen explains, ‘Research shows that three-quarters of respondents believe they would be at least 35 per cent more productive if they were to co-operate more with those around them. If you were also able to increase co-operation between companies and between sectors, the effects could be enormous.’



Mickey Huibregtsen: 'Attending lectures is a waste of time for students. Only one tutor in ten is entertaining enough to make it worthwhile.'

EDUCATION

Huibregtsen also foresees major changes in education in the next few years. 'Traditional teaching is too fast for half of pupils,' he says, 'but too slow for the other half. Make your children responsible for their own development, however, and 99 out of 100 will work hard.' The same applies to university education. 'Attending lectures is a waste of time for students. Only one tutor in ten is entertaining enough to make it worthwhile. The 'flipped classroom' model is already a big improvement, but I think that in the future people will follow their own self-assembled curricula, far more individually and at their own pace.'

FINAL EXAMINATION

Coincidentally, Huibregtsen's own studies at Delft were quite individual. 'I read Technical Mechanics, a course which only existed for a short time. We had more professors than students.' He can still vividly remember his final examination. 'I was interrogated for three hours by those four professors, about all the courses I'd taken since the first

year. I'd been revising for that exam for years, day and night.' And it did not stop there. 'I designed a tanker lorry, which was actually built at the time and used at Schiphol airport. I also designed a low-wing aircraft for Fokker, but that was never built.' Following his graduation, Huibregtsen was conscripted into the Royal Netherlands Navy. 'After seven weeks of training, I was sent back to Delft as a prospective reserve officer. I worked at TNO on the hull strength calculations for a submarine, which was also built.'

INSPIRING DIALOGUES

Huibregtsen has maintained a warm relationship with the university ever since he left. As a 'Good Friend' of the Delft University Fund, he still contributes financially to our development of young talent. He also likes to share his experiences directly with students. This February he is the first guest of Inspiring Dialogues, a series of interactive interviews with alumni being organised specially for students. 'I think it's a waste if, once you've reached my age and gained so much experience, you

don't share it constantly with young people. They can then do what they like with it: it's about sharing ideas and encouraging personal development.' <<

Are you inspired by this story?
Would you like to explore your options for lasting involvement with TU Delft? If so, please e-mail us at alumnirelations@tudelft.nl.

Do you, like Mickey Huibregtsen, want to financially support the talent development of our students? Then please contact Machteld von Oven, Relation Manager 'Good Friends', Delft University Fund, at m.w.vonoven@tudelft.nl or phone number +31 6 8106 0919.

ALUMNI NEWS

Activity Calendar

4 April

TU Delft Health College: *een blik op kanker*
(Cancer, visualised)

Alumni Backstage Tour Satellites

11 April

TPM / Arachnion alumni event

Alumni Event Brussels

9 May

Alumni Backstage Tour Green Village

Alumni Event Surveying in Mesdag Time,
The Hague

4 June

TU Delft for Life | Xperience Day

27 June

Alumni Backstage Tour Robotics

Register on the alumni community TUDelft-
forLife.nl or the website alumni.tudelft.nl.

Contact:

Questions, comments or ideas?

Email: alumnirelations@tudelft.nl

Website: alumni.tudelft.nl

Community: TUDelftforLife.nl



'TU Delft for Life' is the online community for all Delft alumni. Expand your network, rediscover old friends from uni and keep abreast of all the latest news and events. You can register at tudelftforlife.nl, where you can also change your address or contact details.

Save the date | 4 June 2019

Curious to find out what's going on at the university? Then come to the TU Delft for Life | Xperience Day on Tuesday 4 June 2019. This event is exclusive for TU Delft alumni and relations of the Delft University Fund.

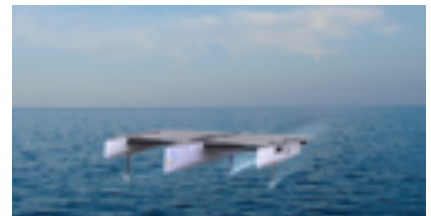
It will give you a unique insight into the most recent innovative student and research projects. The programme includes several in-depth tours in the afternoon, followed by a plenary session in which the Alumnus of the Year 2019 will be announced. Themed master classes, under the motto 'lifelong

learning', will be held in the evening. Be inspired by the 2018 aftermovie on alumni.tudelft.nl/xperienceday. Check our website alumni.tudelft.nl/experienceday for more information. We look forward to welcoming you on this inspiring day!

Solar Boat dream team going for gold in the south of France; give a helping hand and make a donation for the new trailer

From 2 to 6 July, the Delft Solar Boat Team will be taking part in the largest international competition and world championship for solar boats: the Solar & Energy Boat Challenge in Monaco. This year will be the first time that races are held on the open sea. As such, the team designed a bigger boat, taking into account new conditions such as high waves and wind.

The team has raised funds to cover most of the costs and the boat is currently being built. However, there is a slight hitch - which is why we are appealing to you as an alumnus. The boat



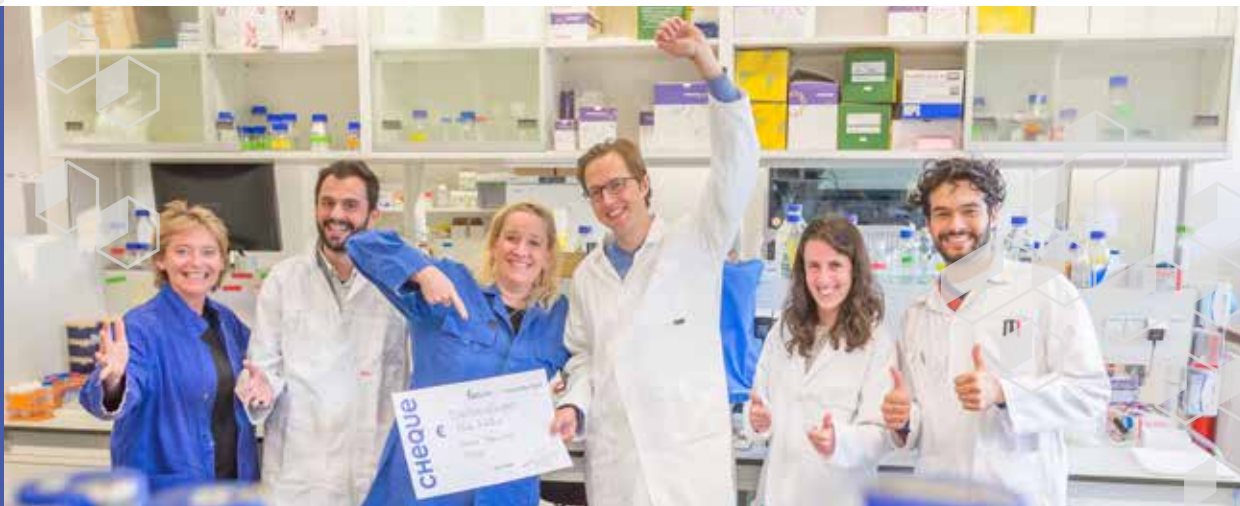
still has to be taken to the south of France! To do this the team needs a second trailer, which costs a total of € 5,250. Donations can be made via the Delft University Fund's crowdfunding platform. Help the team and go to supporttudelft.nl/solarboat

Alumni Backstage Tours 2019

Once again, TU Delft will be organising campus tours especially for its alumni. This year you can take a peak behind the scenes at Satellites, Robotics or The Green Village. The tours

start at 4 p.m. and close with a drinks reception at Café X (previously Sport and Culture). Register via the alumni community TUDelftforLife.nl or the website: alumni.tudelft.nl.

Tour	Satellites	The Green Village	Robotics
Date	04/04 and 26/09	09/05 and 24/10	27/06 and 18/11
Duration	1,5 hours	1 hour	1,5 - 2 hours
What will you get to see?	Visit the aircraft hall, cleanroom, groundstation and dream team Dare.	The latest developments in the 'living laboratory' in the field of sustainability, the car as a power station, smart lampposts, etc.	From self-driving cars to drones and from 3D printers to care robots in nursing homes



THE FIRST PHAGE BANK OF THE NETHERLANDS

Thanks to alumni of the faculty of Applied Sciences and donors of Delft University Fund, Dr Stan Brouns and his team received €144.248 for the benefit of the bacteriophage research. During the next six months

Stan and his team will work hard to expand the phage bank with phages against the most common bacterial infections.

www.universiteitsfondsdelft.nl/bacteriophages

‘We can get started! We are at the beginning of a phage bank in the Netherlands and we are already receiving requests’

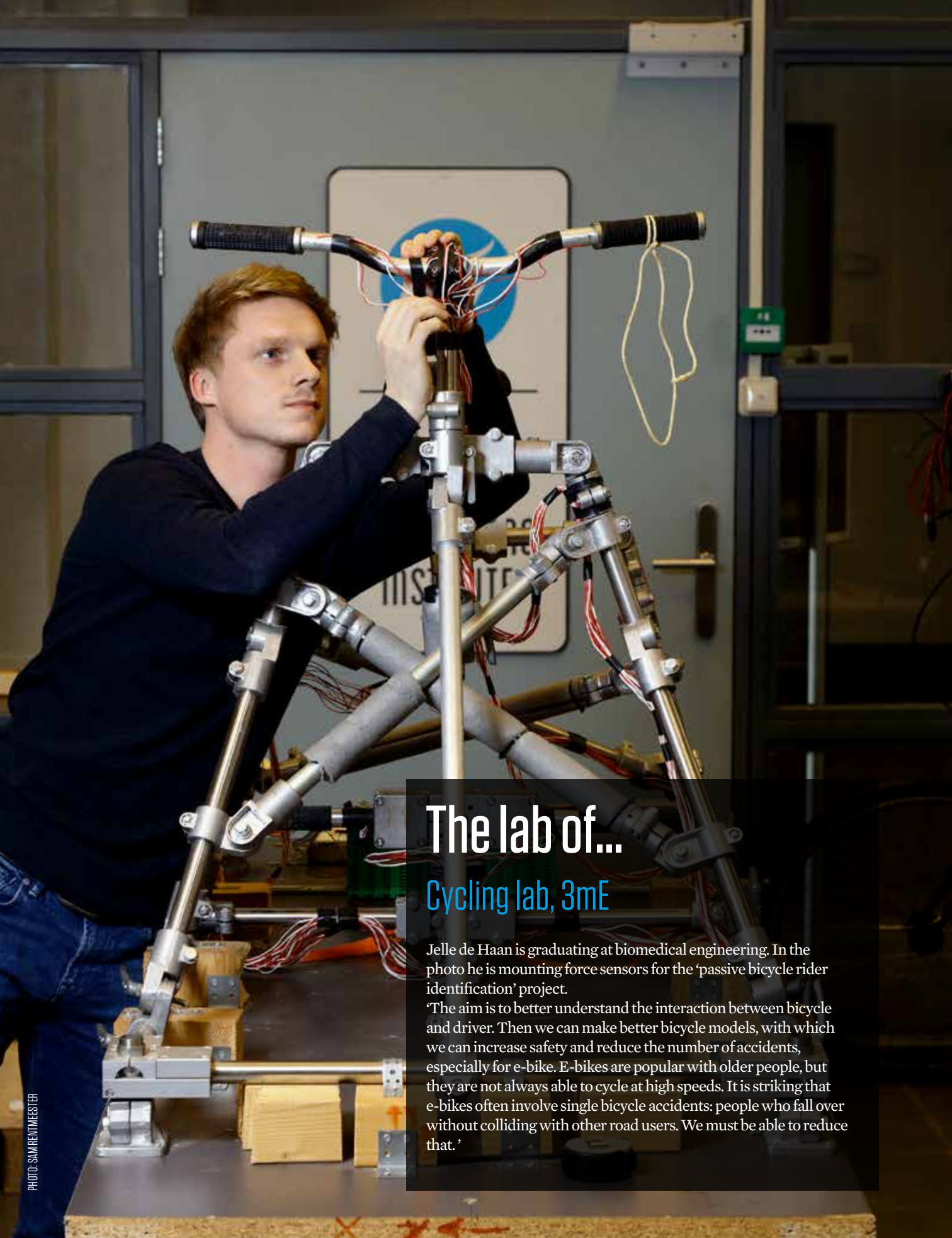
Stan Brouns

ALGORITMES AGAINST ALZHEIMER



The research group of Marcel Reinders is working on something special at the EEMCS faculty. The group works in close collaboration with Alzheimercentrum Amsterdam, Amsterdam UMC on a unique approach against Alzheimer's disease. Together they compare the DNA and protein data of Alzheimer's patients to healthy elderly people who do not have the disease. The emphasis in Amsterdam is on the biology, patient-related issues and data collection. At TU Delft the data is analysed. Delft University Fund supports ground breaking research with great societal impact such as Reinder's research.

Will you help? Your support will help accelerate research into Alzheimer's and enable our researchers to work using the latest data analysis techniques. www.universiteitsfondsdelft.nl/alzheimers



The lab of...

Cycling lab, 3mE

Jelle de Haan is graduating at biomedical engineering. In the photo he is mounting force sensors for the 'passive bicycle rider identification' project.

'The aim is to better understand the interaction between bicycle and driver. Then we can make better bicycle models, with which we can increase safety and reduce the number of accidents, especially for e-bike. E-bikes are popular with older people, but they are not always able to cycle at high speeds. It is striking that e-bikes often involve single bicycle accidents: people who fall over without colliding with other road users. We must be able to reduce that.'