

# Delft Outlook

MAGAZINE OF DELFT UNIVERSITY OF TECHNOLOGY 2012 • 3

A photograph of two female athletes, likely rowers, standing against a dark background. They are wearing white short-sleeved shirts with red and blue accents. The athlete on the left has her arms crossed and is looking directly at the camera. The athlete on the right is also looking at the camera, with her arms crossed. Both shirts feature the Dutch national flag colors and a lion logo. The word 'EGON' is visible on the front of the shirt worn by the athlete on the left.

## Sports innovation

Science meets top-level sport

## Repairing DNA

Bionanoscience ties up loose ends

## Double microscope

Optical and electron technologies in one

# London calling





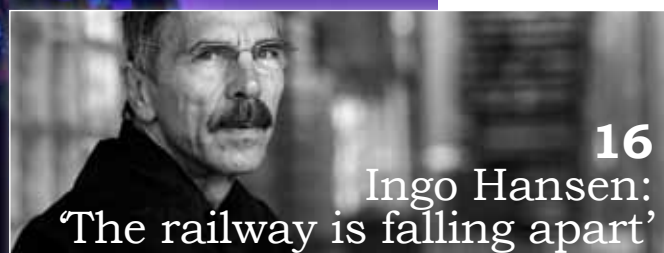
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## Braindrops

Innovating, experimenting, treading unknown paths. It is not only the researchers at TU Delft who do this, but also Delft Outlook. This year we will therefore be making three editions of the online TV programme, Braindrops, focusing on water, the theme of the university's anniversary celebrations. The programme can be seen on [www.lustrum.tudelft.nl](http://www.lustrum.tudelft.nl). Science journalist Desiree Hoving, herself a former PhD student at the Faculty of Technology, Policy and Management (TPM), will interview Professor Mark van Loosdrecht about his life's work, the Nereda water-purification installation, and about what makes a good scientist. The Hedwige polder is an issue that is exercising many minds. Should it be flooded or not? This question appeared to take on almost Shakespearian proportions during the previous government's term in office. But according to policy analyst, Dr Jill Slinger, of the TPM faculty, the answer is simple: a new cabinet must make a decision as soon as possible. It doesn't matter which way the decision goes, they should just do something, she states. And that can be done, says Deltares project leader, Arno Nolte, because all the information required for taking a decision is now available. We hope that this online video supplement to our printed magazine will stimulate your imagination. We would like to hear what you think of Braindrops. Please let us know via the *Comments* below the video or via our email address [delftintegraal@tudelft.nl](mailto:delftintegraal@tudelft.nl).

Frank Nuijens  
Editor-in-Chief Delft Outlook

## Colophon

## Delft in Brief

### Mineral resources and cyber warfare



It makes for great small talk. What do you do? 'I'm working on cyber warfare.' Or: 'I mine gold from the sea floor.' From next autumn, students will be able to say such things. That's because the Faculty of Technology, Policy and Management (TPM) will provide a compulsory module on cyber security and cyber warfare for all of the faculty's ICT Master's students. What's more, the 3mE faculty is introducing a minor in deep-sea mining. Both faculties are responding to important developments. "Wars are increasingly being fought in cyberspace," explains the initiator of the TPM module, Dr Jan van den Berg. In addition to technical matters, the module will also cover ethical and legal issues. According to Van den Berg, there is a shortage of people with such expertise. There will also be an urgent need for engineers who know how to mine at great depths on the ocean floor. According to Dr. Sape Miedema (3mE), increasing numbers of dredging and engineering companies, most of them Dutch, are focusing on the ocean floor. He anticipates being able to work extensively with these companies in the minor.

### The tram's just coming



There's been talk and bickering about it for more than ten years, but now tram 19 is really on its way. At least, the rails will soon be in place. At present, workmen are out and about laying the sleepers and rails on campus. In 2015, the section of line 19 that connects TU Delft with the station will come into use. At least, that's the plan.

### Smul design wins prize

Tessa Souhoka (23), a fifth-year student of Industrial Design Engineering, has won the annual Hema design competition 2012 for students with her 'Smul' design. When it's folded up, the Smul is a flat disc, and when it's unfolded, it's a dish. "I was looking to save space in kitchen cupboards," Souhoka said, explaining her idea. "You can put a separate bag in there, which turns it into a bread basket. If you turn over the dish, you have a cake stand. The way in which you fold it up is unique. If you fold out the flat disc, then it can be stood on its legs." Souhoka is also hoping to win Hema's public prize. People can cast their votes until 18 July at [www.hemaontwerpwedstrijd.nl](http://www.hemaontwerpwedstrijd.nl).

[www.delta.tudelft.nl/25288](http://www.delta.tudelft.nl/25288)



### Ecorunner

Driving the whole way from Delft to Andalusia on just 1 litre of fuel: theoretically, it's possible. This was demonstrated by Delft students during the Shell Ecomarathon, held last May in Rotterdam. The team from Delft achieved a score of 1698 kilometres to one litre (converted to the energy equivalent of a litre of petrol). Some 200 vehicles belonging to schoolchildren and students from across Europe ran on a track at Ahoy Rotterdam, as efficiently as possible, on hydrogen (the fuel used by the Delft team's Ecorunner), diesel, solar energy, or electricity (with a battery). Impressive though the Delft students' score of 1698 km to the litre was, they were not among the prize-winners. The winner of the hydrogen category (Polytech Nantes) ran at around 4800 km to the litre; and the best diesel vehicle did 2833 km to the litre.





## Arab energy spring

The director of Desertec, Ir. Paul van Son, was recently back in Delft. The TU Delft alumnus currently lives in Munich, where he leads the German solar and wind energy initiative, Desertec. Desertec wants to bring sustainable energy from the Sahara to Europe on a large scale. Van Son is trying to bring academia, governments, industry players and investors on board in this plan. According to Van Son, who gave a lecture for the IEEE students' association, a remarkable change is taking place in the Arab energy world. "At first they only thought about oil. But in the last one or two years, an awareness has grown that oil is finite, while the sun is not. You might call it the 'Arab energy spring'."

[www.delta.tudelft.nl/25012](http://www.delta.tudelft.nl/25012)

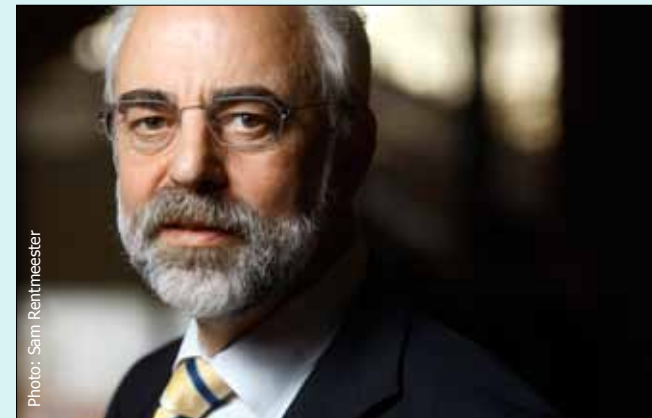


Photo: Sam Rentmeester



Photo: Roy Meijer

## Science with rubber ducks

They made for an unusual sight in the early morning of 21 May: pupils from group 8 of the Openbare Montessorischool Jan Vermeer coming to the aid of scientists, armed with rubber ducks and floats. The pupils were assisting with the project on 'Smart measuring and monitoring'. They put floats equipped with RFID tags in the water and monitored their progress. This was done in order to work out what happens to the flow through the canals if the floodgates, which protect the city against high water levels, are raised. The measuring was organised in the framework of TU Delft's 170th anniversary, with 'water' as its theme.

## Registration number for Superbus



Photo: Tomas van Dijk

Prof. Wubbo Ockels' Superbus is finally being allowed on the road. It looks streamlined and fast, it holds the road well, the seats are comfortable and it can accelerate nicely. But don't expect to see the Batmobus, as Powned called the vehicle on TV, zooming past. The bus is still very slow, as was shown at Valkenburg air base. A registration number provided by the Minister of Infrastructure and the Environment, Schultz van Haegen, is needed for further development and tests on public highways.

[www.delta.tudelft.nl/25168](http://www.delta.tudelft.nl/25168)

## Futures research handbook

In his book, 'Futures research for organisations', Dr Patrick van der Duin, assistant professor in futures research and innovation management at TU Delft, helps organisations to conduct research into the future and to apply it in decision-making processes. In 2006, Van der Duin obtained his doctorate from the Faculty of Technology, Policy and Management with research into how companies use futures research in innovation processes.

Van Gorcum publishers,  
ISBN 9789023248378,  
44,50 euro.



## Astro-Nout

He will become one of the youngest astronauts ever. Last May, eighteen-year old Aerospace Engineering student, Nout van Zon, won a ticket to space with his essay on hydrogen as the jet fuel of the future. In 2014, he will travel on the rocket belonging to Space Expedition Curaçao, a company that will offer commercial trips into space from Curaçao for around 70,000 euros per person. "It's too incredible for words," said the student after the announcement was made. "The Earth is the place where you live and then suddenly, off you go." Van Zon will not be away for very long: he will only drift above an altitude of 100 kilometres for a few minutes. The prize-giving ceremony was organised by the Leonardo da Vinci study association and KLM.

[www.noutvanzon.nl/aerospace](http://www.noutvanzon.nl/aerospace)



Photo: Tomas van Dijk

## Braindrops



Would you like to know more about technological developments at TU Delft? Then watch Braindrops, the web TV programme from Delft Outlook. In this new programme, a scientist talks about his discipline and engineers share their views on social problems.

In the first episode, Prof. Mark van Loosdrecht talks about water treatment technology, and Dr Jill Slinger and Arno Nolte debate the Hedwigepolder. Braindrops is made in collaboration with TU Delft Library and the TU Delft 170th anniversary committee. In the autumn, there will be two further episodes on water, the theme of TU Delft's 170th anniversary.

Watch the programme at  
[www.lustrum.tudelft.nl](http://www.lustrum.tudelft.nl)

## Spy plane

Illegal dumping by ships near ports is a constant problem for the coastguard. But fraudulent captains should watch out: soon they will be spied on by small, unmanned, autonomous planes. The planes are being developed by a large research consortium led by researchers from the Faculty of Aerospace Engineering, Ir. Bart Remes and Dr Erik-Jan van Kampen. The team just received 1.85 million euros from the EU (the European '2 Seas Programme'). Aside from TU Delft, collaborators on the project include the Flemish, English and Dutch port authorities and Southampton and Brest universities.

## Virtual master's

Virtual education is on its way: next year, the faculties of Aerospace Engineering (AE) and Technology, Policy and Management (TPM) will each offer five online Master's modules. With this experiment, TU Delft wants to extend its global reach not only to students, but also primarily to professionals who are keen to boost their knowledge. The programme will allow them to study independently of time and place, with supervision, examinations and possible certification. AE will offer core modules from a Master's profile on the design and optimisation of lightweight constructions. TPM will develop online variants of five modules from the Master's in Engineering and Policy Analysis. The Faculty of Civil Engineering and Geosciences is drawing up a plan to offer a virtual Master's degree programme in water management.

[www.delta.tudelft.nl/25005](http://www.delta.tudelft.nl/25005)

## Pilot Facility

It's a long way from a lab bench to an industrial reactor. Since the end of May, an intermediary step has been available: the Bioprocess Pilot Facility, or BPF. The pilot facility for this joint project between DSM, CSM/Purac and TU Delft is located at the DSM site in the north of Delft. The facility has a flexible set-up and can be adapted for various processes. The first experiments relate to the manufacture of second-generation biofuels from agricultural waste. DSM has announced further investments in biotechnology, amounting to 100 million euros over the coming two years. Delft will be the site of a biotechnology centre that will provide space for 285 researchers.

[www.delta.tudelft.nl/25204](http://www.delta.tudelft.nl/25204)



Photo: Sam Rentmeester



# All set for *London*

Five rowers from Delft student club Proteus-Eretes and one from rival Laga are heading to London with the Dutch Olympic team at the end of July. And they could well be joined by a beach volleyballer with TU blood in his veins. To prepare for the Games, all seven have taken a year out from their studies.

**Jimmy Tigges**

When your sights are set on an Olympic (gold) medal everything else – work or study – has to take a back seat. For months or even years, life is one endless round of training and competitions, strictly controlled diets and managed rest. Not to mention lots of travel. Beach volleyballer Daan Spijkers shelved his Architecture studies back in the summer of 2011 to concentrate on earning his ticket for

*‘Nerve-racking:  
everyone around me talks  
about nothing but rankings,  
points and  
tournaments’*

London alongside teammate Emiel Boersma. With the Games fast approaching, he is still battling to qualify. So what is it like devoting

a whole year to one, still uncertain, goal? “Nerve-racking,” says Spijkers. “Everyone around me talks about nothing but rankings, points and tournaments. I try to stay away from all that. I look for distractions. When I’m abroad I visit interesting buildings, and I try to keep up with the latest developments in architecture on the internet. And I read a lot. Last year I was away from home for 250 days. If I’d spent the rest studying, I wouldn’t have had any life left over. Ultimately, I think you have to make a choice.”

#### Aces

Rowers Sytske de Groot, a Marine Technology student, and Chantal Achterberg, a TU Delft graduate, are also working full-time on their Olympic mission. Both have been members of the Dutch women’s eight since 2008, rowing in the middle of the boat where they provide the power and – because they

are in adjacent seats – can encourage one another. Their qualification worries are already behind them, and they may even be in the running for a medal. Although both the US and Canada were a good four seconds faster in the World Cup race at Lucerne – a lead that looks difficult to surmount in less than two months – Achterberg draws confidence from the fact that the Dutch boat beat strong competitors like Great Britain, Australia and Romania. “Make up four seconds? Of course we can! Anything is possible. It wouldn’t be the first time.” The Dutch women, she says, have not played all their cards yet. “We still have some aces up our sleeve.” And she knows her teammates will put in the necessary drive and effort. “In Lucerne we felt we were in with a chance all the way. Only in the last 200 metres did it become clear that we were going to be third. When that happens, you subconsciously ease up a bit. We have to be able to keep it up

on that final stretch.” For Achterberg, going to the Olympics is a “really exciting and fantastic project”. But she is a little scared of what she calls ‘the moment’. “You’ve been living for this for so long, wondering so much what it will be like. But I do know that I enjoy what I’m doing.”

#### Stronger in a new boat

The Dutch men’s eight qualified early for the Olympics and finished fourth at Lucerne, four seconds adrift of favourites Germany. Seconds his crew can make up, believes Olivier Siegelaa, the 197cm powerhouse who is Laga’s sole representative at the Games. Of the eight boats due to start in London, none is really weak. “But we have a whole lot of potential and we’re so incredibly up for it”. Cox Peter Wiersum shares Siegelaa’s optimism. Things were very different four years ago, in the run-up to Beijing. The Dutch crew was rowing poorly and at the very last

### *A little scared of ‘the moment’*

minute decided to call in outside help – from none other than Siegelaa and Wiersum. With them on board, the eight qualified at the final opportunity and achieved fourth place in China. “Last time we were all young,” says Siegelaa. “Now we have seven experienced Olympians in the boat, with an average age of 30 instead of 24. Everyone is stronger now. We really have something to go for.” At the end of May the crew tried out the new orange boat, made of a special synthetic resin combined with strong carbon fibres, a

material developed by DSM and previously used in a Dutch sailing boat and in a bobsleigh described as “revolutionary”. Because it makes the shell 25 per cent more rigid, less energy is lost in the water. “The new boat is perfect,” says Siegelaa. “It responds much faster. If you row well technically, you can transfer more power lengthways rather than crosswise. Perhaps there’s a mental advantage, too.”

Roeland Lievens is back in the boat, having lost his place in the Dutch lightweight coxless four for the 2008 Olympics at the last minute: just as it was poised to qualify for London at the 2011 World Championships in Bled, Lievens was struck down with food poisoning and the chance was missed. In the end he had to wait for the final chance, at Lucerne this May. So securing an Olympic place was a relief more than anything. “We were favourites,” he says, “but you still have to perform on the day.” He does not consider his boat a serious medal contender. Although, he says, “on the other hand, there’s no clear hierarchy in this event. Form on the day is everything. It’s a question of peaking at the right moment. You have to train very hard, but not go over the top. That’s a very delicate balancing act, but fortunately we now have an excellent physio.”

#### Aiming for Rio

The most surprising Delft qualifier is 23-year-old Mechanical Engineering student Ellen Hogerwerf. In January, she and Inge Janssen, from Utrecht, failed to be selected for the Dutch women’s eight, so they switched to the double sculls. And unexpectedly found quick success. How? “We drew up a clear plan at a pretty early stage,” Hogerwerf explains. “There were three hurdles to overcome: beating a rival Dutch pair, finishing in the top eight at the

World Cup event in Belgrade, and coming at least second in the last qualifying tournament. And we managed it all. We’ve become much better in a very short time.” Is that because Hogerwerf is a ‘training machine’, as some press reports claim? “Do they really say that? Could be. We can train very hard together – we enjoy it. In rowing, plenty of training really does help build your strength. We always go for it 100 per cent.” Hogerwerf will be happy if she makes the final in London. She claims that there are too many stronger pairs for her and Janssen to be in the running for a medal. But whatever happens, she says the effort will not have been wasted: “When we started, our real goal was Rio in 2016. If we continue to develop as we are now, we stand an excellent chance there. Come what may, London will be valuable experience.” Siegelaa agrees wholeheartedly with that: “People who claim that it’s all been for nothing if they don’t win gold are wrong.” And as Spijkers says, “even if I don’t qualify, I’ll have had an amazing experience. One day I’ll be able to tell my grandchildren that I did all I could to reach the Olympic Games.” And their studies? Most will be returning to the classroom in September. Or so they say.



F.l.t.r.:  
Sytske de Groot,  
Peter Wiersum,  
Olivier Siegelaa,  
Daan Spijkers,  
Ellen Hogerwerf,  
Roeland Lievens and  
Chantal Achterberg

# From go-faster stripes to sliding tracksuits

Today sports and science go increasingly hand in hand. Together with private companies, sporting bodies and other research centres, TU Delft is involved in many innovative sports-related projects, particularly in water sports, where materials can be crucial.

Jimmy Tigges

Swimming with slightly cupped hands, rowing in a faster boat, sailing in comfortable clothes.... Delft researchers are pooling their expertise in materials and product design with aerodynamics, hydrodynamics and biomechanics. The aim: to develop sports products that improve performance, make training more effective and reduce injury risk. "We aim to lead the field in the Netherlands," says Dr Daan Bregman, Sports Innovation Co-ordinator at the TU Delft Valorisation Centre. "That's why we've joined forces with InnoSportNL, co-founded by TNO and NOC\*NSF. InnoSportNL facilitates the whole process, uniting the parties." Opened in October 2010, the InnoSportLab in The Hague is one of six Dutch laboratories where researchers are working "to improve the chance of winning Olympic medals". TU Delft

is leading three projects there; for example, one of the projects TU Delft researchers are working on is a light and efficient high-tech sailing boat where the coach can monitor crew performance in real-time via a data link. "The idea," says Bregman, "is for athletes to train in their own environment during testing, to bring the lab to the sportsman."

## 'Bring the lab to the sportsman'

Colleague, Anoek van Vlaardingen, feels that innovation in sport is attracting increasing interest within the university. "Sport is a springboard for research applications. It's great for that." As Bregman says, "it's not about the medal, but it's the spin-off that counts. Just like

space travel wasn't about men on the moon, but about the Tefal pan and the microwave. That's the real goal. The best result is when an invention filters down into everyday life, where amateurs use clapskates too, making them an interesting commercial prospect."

### Rowing research star

Athletes and trainers are often far more open than industry is to innovation, says fervent swimmer Jerry Westerweel. "That's what makes this kind of research appealing. Sport as a testing ground for out-of-the-box thinking, where new ideas for industry are born." As a professor of Fluid Dynamics in the Faculty of 3mE, Westerweel is supervising Arnoud Greidanus' PhD research on drag reduction. A keen competition rower and passionate researcher, Greidanus epitomises the meeting of sport and science at TU Delft. As reserve crewman at the 2008 Beijing Olympics, he watched from the sidelines as the Dutch lightweight coxless four was knocked out by a piece of seaweed sticking to its boat. That inspired him to devote his doctoral studies to finding a coating to reduce friction between shell and water, making the boat faster. His work is at the interface between hydrodynamics and chemical technology. But the tiny differences, which can mean bronze rather than gold, are still too small to measure, as current techniques are too inaccurate. "We're using the demands made by top-level sport as the standard to refine our measuring methods," says Westerweel. The Olympic athletes of 2016 should benefit from Greidanus' research, and it may potentially help the shipping and aviation industries to reduce their fuel costs.

Rough surfaces reduce drag and so have also



Drag reduction: research at the interface between hydrodynamics and chemical technology.

been used in competition swimwear, reducing the energy required to race. But the use of technologically developed swimsuits proved controversial. "The swimming federation banned them," explains Bregman, "because it felt that the competition would be all about the best swimsuit rather than the fastest swimmer." Frustrating? "You're always looking for what the rules allow. That's different in every sport. In some sailing classes the boats are provided, so there's nothing you can change." One of Westerweel's recent projects with Bachelor's students showed that slightly cupping your hands when swimming produces faster times: "The top swimmers were really interested when we showed the results at the lab in Eindhoven. They now train with flat paddles, but we're going to make some lightly curved ones. The new technique improves the energy generated by some three to five percent."

## 'The federation banned technologically advanced swimwear'

### Comfy in your boat

Dr Arjen Jansen, manager of the Sport Products applied research programme, sees prospects for sailing wear that adapts to conditions on the water, that could stop the wind feeling alternately cold and warm depending upon the direction of travel which can affect the sailor's focus. Wind tunnel testing was performed to find out how important clothing is. Jansen has announced that the Dutch sailing teams at the London Olympics will be using a new product co-designed with Magic Marine. "But my lips are sealed," he says. "A confidentiality agreement applies until the Games. The product will make sailing more comfortable, so the crews

stay focused." And it's an invisible addition to the sailors' clothing. "Even if it only improves their performance by 1 percent, that could give them crucial metres." After the Games, the product will be launched commercially. "That's the goal of this project," Jansen asserts, "to result in economic activity." Last year TU Delft introduced a Sports Innovation minor led by Jansen. One of the first projects was for a well-known footwear brand, aimed at finding a quick way of removing water from shoes. "For trail runners," he explains. "They spend hours running cross country and traversing streams. Then it's great to have shoes that dry out fast."

### Sporting scientists

Many more TU Delft scientists are now active in sports innovation. Dr Leo Veldhuis, lecturer in Aerodynamics at the Faculty of Aerospace Engineering and an enthusiastic cyclist, was involved in work on the special ribbed "go-faster stripes" on the Dutch skaters' suits at the 1998 Winter Olympics in Nagano. Borrowing technology from the aircraft industry, these directed air flow. Today, the same roughness is integrated in the suit material itself. But Veldhuis believes there is yet more potential in other sports, such as tennis, sailing and football. Anywhere where aerodynamics plays a role. "Increasing the friction between the racket and the ball in tennis," he says, "means you can give the ball more spin." Prof. Dr Frans van der Helm, professor of Biomechanics and Biometrics at TU Delft and a Human Movement Sciences graduate of VU University Amsterdam, is studying how we control our muscles to produce movement, research which could help Parkinson's sufferers, for instance. His department is also studying the ideal blade curvature for a speed skate, and developing a manoeuvrable wheelchair and improved prostheses for use in disability sports. Together with The Hague University of Applied Sciences and VU University Amsterdam, TU Delft is planning a new centre for adapted sports in The Hague, including a sports technology field

lab to provide an ideal facility for research and development of know-how. The research group led by Dr Ir. Johan Molenbroek, a senior lecturer in Applied Ergonomics and Design, is working on special "sliding" tracksuit bottoms for use in sitting volleyball. "Now they are using trousers from Zeeman, a discount clothing chain," says Anoek van Vlaardingen. "Cheap, but they wear out fast. The new prototypes are still being tested, so it's unclear whether the team will be wearing them at the London Paralympics." Molenbroek also teaches a special course on head protection. Under his guidance, a protective mask with a wide field of vision has been developed for hockey players, as they have to see what is happening on the pitch. Yet another useful innovation – provided the hockey federation approves its use.



Test with sailing clothes in the windtunnel.



## Taxi in the air

Turn up at your local airport and fly off within 15 minutes, in your own private plane. Despite the crisis, TU Delft graduate Stefaan Ghijs of Fly Aeolus is confident that his air taxi service will catch on.



Introducing a concept new to Europe, for a clientèle which has never before considered private charter flying. Stefaan Ghijs, 31, is certainly not afraid of a challenge! Using small Cirrus CR22 aircraft, he can fly his customers anywhere in north-western Europe. Carrying up to three passengers, the planes are able to use as many as 1600 airfields in the region. As a result, Fly Aeolus reckons it can cut typical journey times by half. And with prices well below those charged by business jet operators, the service should appeal to a new market: the top end of the small and medium-sized business sector. The Fly Aeolus “fleet” consists of privately-owned aircraft whose owners

*‘The trick has lain in building a list of planes we can lease within five or six hours’*

want to make money from them when they would otherwise be idle. “We currently have seven machines in our database,” says Ghijs. “Two in the Netherlands, two in Belgium and one each in the UK, Germany and France. The trick has lain in building a list of planes we can lease within five or six hours. That took us a very long time.” Fly Aeolus also has a database of pilots it can call upon at short notice to operate its services. Ghijs studied Aerospace Engineering at Delft, completing his degree in 2006 while working at Stork-Fokker. For his final course before graduating, he wrote a business plan. Thanks to a combination of some luck and a lot of confidence on the part of his then supervisor, this eventually resulted in Fly Aeolus opening its first office in Antwerp in 2009. A second, at Rotterdam Airport, followed earlier this year. Not the best of timing for a business heavily reliant upon confidence in the economy. Although things were not as bad in 2010 and 2011 as they are now, says Ghijs. “Because of that, we started active marketing in 2011. And we have now made our first flights. By the end of the year, we expect to be flying twenty hours a month. I’d rather grow faster, but the crisis is against us.” Despite that, Fly Aeolus is receiving more and more requests for quotes. And so Ghijs is continuing to invest in booking tools for the iPad and smartphones. The money for that comes from the monthly aviation management training courses he gives around the world on behalf of IATA, the International Air Transport Association. Fly Aeolus’ turnover in 2011 was just short of €100,000. This year, with four employees, the company hopes to break the six-figure mark. Once the crisis is over, Ghijs wants to have 15 to 17 planes in the air within five years. “You have to keep going,” he says. “You have to believe in your product, be open to criticism and diversify. And have some luck. We’ve managed to secure a grant from the European Union because personal aviation could well be the next step in the world of flight.” (SB)

[www.flyaeolus.nl](http://www.flyaeolus.nl)

## The road to 2020

A university with highly regarded, sometimes world leading research in more than 40 fields. With an eye for what is going on in the world, and a commitment to helping solve its problems. A university located right next to a bustling business park full of companies that live off R&D. Where the teaching is directly related to the research, and where internet-based education allows some of its students to live on the other side of the world. Which also welcomes people who have been building a professional career for years, to help them keep their know-how up to date. And which works closely with other educational and research institutions, with all levels of government and with business in its region.

That is where the future of TU Delft lies – if Dirk Jan van den Berg has anything to do with it, at least. As President of the university, he has recently overseen the compilation of its new institutional plan, the ‘Road Map for 2020’. But this is not his vision alone. All Delft staff, students and partners were given the opportunity to contribute their ideas for the future.

As Van den Berg has stressed repeatedly, the Road Map is not a radical break with the current situation. “TU Delft is a very well-respected,

*‘Everything we promise in the brochures really does happen’*

broad-based university,” he says. “You can study any form of engineering here. And everything we promise in the brochures really does happen, thanks not least to our extensive research infrastructure. Delft is already an attractive and complete academic entity. We want to keep it that way, and to strengthen it.”

Sometimes that requires patience. “Through good, focused investment, we want to extend the number of world-class research domains here. You can’t do that just by pushing a button. You have to build such fields deliberately over time, just as we’ve already done with Bionanoscience.” In which fields will Delft be aiming to lead the world? It is still too early to say with certainty, according to Van den Berg. “The faculties have until this autumn to compile their own road maps. I don’t want to pre-empt them.”

But he is prepared to share his ideas about the student of the future. They will be far more mobile than they are now. Many of those who come to Delft to take a BSc stay on for their Master’s. “There’s nothing wrong with that model, but the range of alternatives is increasing.” One very promising option is digital education. “Open access has already achieved a lot, but it has not yet been translated into an educational model which will work on a large scale. That’s something we’re looking for, though, because we want to be a preferred supplier of higher education on the internet.” (SB)

Photo: Sam Rentmeester



## Writer in the city

Jan van der Mast began writing while a student of Urbanism. First diaries and plays, and later novels as well. His latest, ‘De kleine Keizer’, was published in April and is based upon the life of famous midge Gerrit Keizer.



Jan van der Mast had a shining architectural career ahead of him. In 1989 he graduated under Joan Busquets in Barcelona, on an urban planning programme called ‘Centro Direccional’. While there, he lived in La Pedrera, a building designed by Gaudí and a Unesco World Heritage site. “Even the Dutch government’s chief architect called me, wanting to take a look round.” But architecture was not the only thing on Van der Mast’s mind in Barcelona. He was also working on a play to be performed in The Hague, an adaptation of the novel ‘The Master and Margarita’ by Russian author Mikhail Bulgakov. That led to a dilemma, he recalls. “Suddenly you’ve graduated and you’re at a crossroads. What next? I could have become a designer in Ypenburg, but my first play, ‘Dood van een sardien’ [Death of a Sardine] was also a success and was nominated for the Dutch-Flemish Playwriting Award.”

*‘Architecture taught me to observe’*

His girlfriend advised him to follow his heart: “Never mind the money, we’ll worry about that later.” So Van der Mast chose writing. He finds human relationships far more interesting than dividing up land or making sure that housing blocks catch the sun. “Although that’s fun, too,” he says. “Architecture is an enjoyable subject. And it taught me to observe.” That’s a skill he’s put to good use in fulfilling his literary ambition. His first novel, ‘Films, vaders & neuzen’ (Films, Fathers and Noses) appeared in 1994 and received good reviews. Relating the quest for the ideal father, it was nominated for the Dutch Literary Debut Prize, alongside works by Anna Enquist and Arnon Grunberg. Enquist won. “Grunberg was way behind, and so was I,” laughs Van der Mast. Artist and industrial design tutor Mark van Huystee approached Van der Mast, asking him to take part in the project Crossing Delft. Van Huystee produces three-metre long panoramas on the street, attracting plenty of comment from passersby, while Van der Mast writes the stories behind them. He also pens columns, blogs, essays, librettos and radio plays, the latter including a piece about the Siamese twins Chang and Eng. While researching them, he discovered that the pair had appeared at the Hague Fair in 1837. There are clear parallels between their story and the subject of Van der Mast’s new novel. The diminutive Gerrit Keizer (1874-1946) was shown at fairgrounds as a “freak of nature” from the age of six. But after enjoying success in London, Paris, Berlin and New York under the stage name Prince Mignon, his adventure foundered at the World’s Fair in Chicago. Van der Mast has created a compelling novel from this story and has already been contacted by director Marijke Jongbloed about a documentary on Keizer. Hardly surprising: Van der Mast’s style is visually evocative. Even in his architectural days, he was fascinated by images and photography. “And now,” he says, “I try to create pictures for the reader.” (CvU)

## Rise of the sexbots

Robots as aid in housekeeping, robots to cuddle with, as fighting machines or to have sex with. According to the think tank Rathenau Institute, the dawn of the robots is coming.

‘Robots everywhere’ is the title of the report presented by the Rathenau Institute last week. Delft robotic expert, Professor Pieter Jonker (MMME faculty), contributed to the report. In an article in NRC Handelsblad he says that soon, owing to the aging of the population, there will be no escaping social robots. But will robots be advanced enough to be completely autonomous and thus really able to take care of us? “Let me start by saying that you should consider robots as sidekicks, like Snowy is for Tintin or Robin for Batman. The robot will act as a help. It can keep an eye on an elderly person, if it is able to pick up objects it can do the housekeeping, and it can also serve as a moving agenda and memory aid,” says Prof. Jonker, who believes that in a few years his robotic laboratory will have such a robot ready for the elderly care. Their forerunner now is Robbie, a robot on wheels that – in a short video Jonker shows – acts as a doctor’s assistant, welcoming patients and fetching coffee.

*Robbie welcomes his patients and fetches coffee*

Robbie has quite some artificial intelligence in him. He can recognize faces, objects and voices. And he can learn to recognize new objects. Other robots Jonker and his colleagues are working on – walking and running robots – have the capability to learn new movements. “Ultimately we want to make a walking robot for care-giving,” he adds. “For this we should combine the different types of robots we have in the lab. But the walking bots are still not stable enough. You don’t want situations in which elderly persons have to redress the robot.” And what about the dangers? Some time ago there was quite an aggressive robot, a soccer-playing robot that almost kicked a photographer lying on the ground. He mistook his head for the ball. Prof. Jonker laughs: “Yes but that was about ten years ago. The software for recognition is much more sophisticated now. Developments are going fast. With the booming smart phone and tablet industry, processors are becoming smaller and more powerful.” The Rathenau Institute is afraid that people will become socially isolated if they are surrounded solely by robots, especially if we will also see the rise of the sexbots. “I’m not too worried about that. What is good about it is that you can with common decency exchange partners,” Prf. Jonker says, laughing. “You just exchange robots. No but seriously, with robots it’s just like with everything else which keeps people busy. I have spent days in a row reading books or doing computer programming. And then at a certain point I realised that I should go out and mingle with people. With robots it will be just the same.” (TvD)



# Repairing DNA

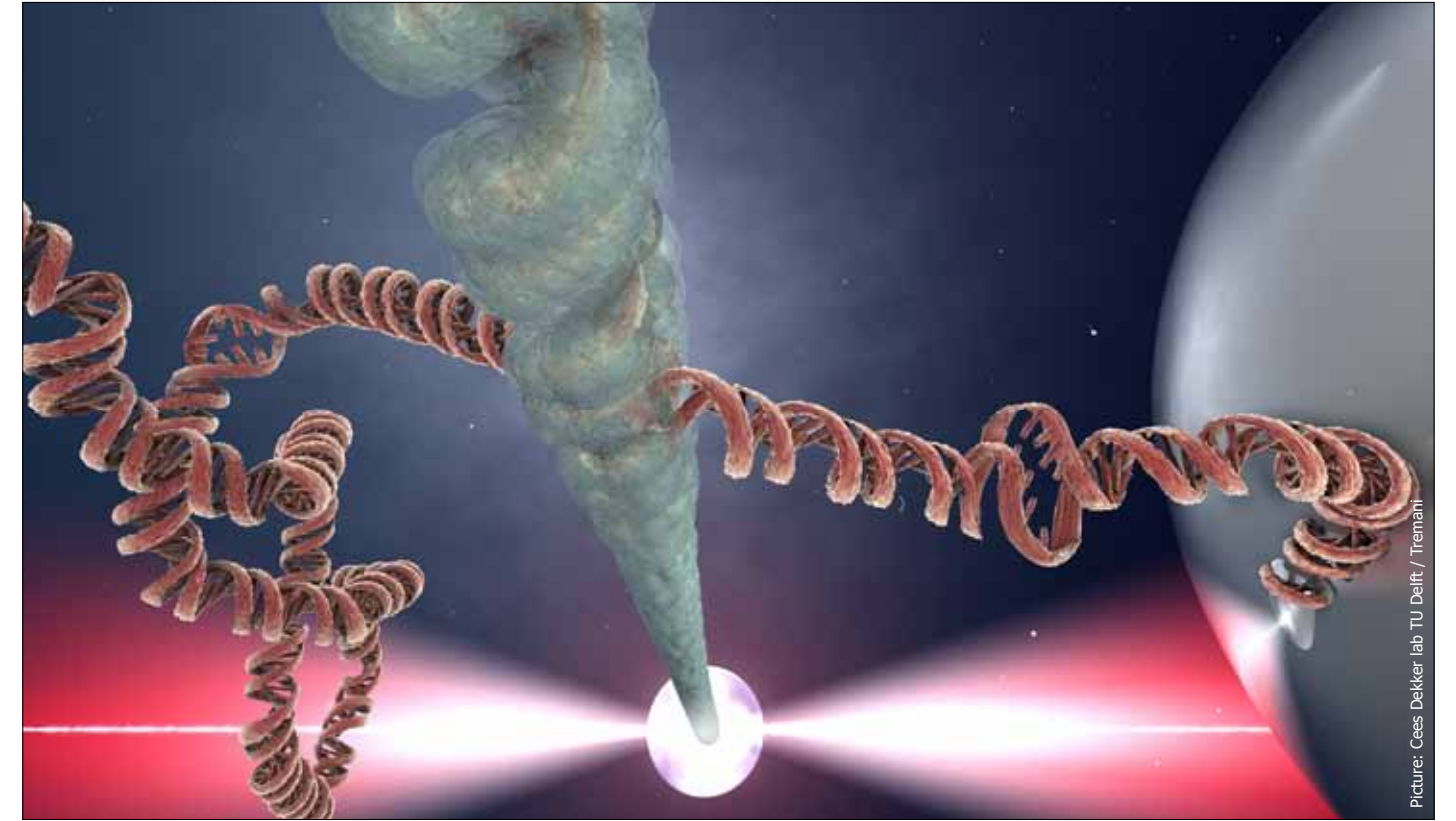
*Thousands of DNA molecules break inside our bodies every day. Professor Cees Dekker's Bionanoscience research group has shown how the loose ends get back together.*

*Tomas van Dijk*



Cees Dekker: 'Nobody knows how the coils move through the DNA, that's a very complicated process.'

Photo: Sam Rentmeester



Contact point between a RecA protein DNA molecule (the 'broken end', vertical) and a DNA molecule (horizontal).

Picture: Cees Dekker lab TU Delft / Tremahi

Two DNA molecules rubbing against one another in search of their own likeness: the image with the press release announcing the latest breakthrough by the department of Bionanoscience at TU Delft shows an important step in the process our genetic material uses to repair itself. When a strand of DNA breaks – and that happens regularly, by accident – the broken end starts looking for an identical molecular sequence to use as the template for its repair. That may be a recently copied piece of DNA or the second chromosome (we have two copies of each chromosome).

By reproducing this process in the laboratory, Professor Cees Dekker's team has worked out how the strands know where to link up in order to trigger the repair mechanism. That required some impressive technological tricks. Using magnetic and optical tweezers, the researchers manipulated two individual DNA molecules, rubbing them together and pulling them apart while at the same time measuring the forces attracting them one to the other. The result of all this pushing and pulling of DNA was published in the May edition of the journal *Molecular Cell*. The lead author of the article, "Mechanism of homology recognition in DNA recombination from dual molecule experiments", is Dr Iwijn de Vlaminc, a postdoctoral researcher now at Stanford University in California.

"The basic outline of the repair mechanism has been known to science for a while," explains Dekker. "But now, for the first time, we've seen

what exactly happens when the two molecules come together."

It was long thought that the broken fragment of DNA actively sought out a repair template, using the so-called RecA protein, which attaches itself to the damaged strand, forming a long filament. That, it was believed, recognises its surroundings for the right template DNA and, when a match is found, makes sure that the two strands intertwine briefly but intricately, rather like a zip being closed.

## Truly remarkable

According to Prof. Dekker and his colleagues, the zip analogy and the notion that RecA protein plays a role in the process are correct. But the encounters between strands of DNA are fortuitous, not deliberately looked for. "It's the many random parallel collisions which ensure that the right match is eventually found," says the professor. "It all happens very fast – within five minutes or so. And that in a vast ocean containing billions of fragments of DNA. Truly remarkable."

The breakthrough has made waves in its field. "This is an extremely interesting paper with some breathtaking technological tours de force," says Professor Jan Hoeijmakers, a DNA repair expert at Erasmus University in Rotterdam, who played no part in the Delft research. "It provides us with a nanolevel insight into the most important step in homologous DNA recombination."

Since such recombination also occurs during

the creation of reproductive cells, Prof. Hoeijmakers believes that the latest discovery is "important to our understanding of genetic diversity and evolution". Moreover, the technology developed during this research has a second potential application: it can be used to partially unravel the DNA double-helix, or to tighten it. How much the molecules in a strand are "wound" has been shown to be an important factor in the recognition process under investigation. The bionanotechnologists are working hard to improve their unravelling and unravelling skills. "Nobody knows how the coils move through the DNA," says Prof. Dekker, during a tour of his laboratory. "That's a very complicated process. You can probably best imagine it by picturing an old-fashioned coiled telephone cord."

If such a cord has tighter coils at a particular point and you want to move them up or down the length of the wire, you have keep pulling and twisting them this way and that – a real effort, as the professor tries to demonstrate with his hands, turning and waving them in all directions.

In the background, hundreds of tiny spheres are also twisting and turning, on one of the lab's computer screens. They are DNA molecules, attached at one end to a sheet of glass and the other to a minute plastic ball fitted with pieces of metal so that they can be steered magnetically.

The actual specimen is a couple of metres away, under a microscope. As well as a

focusing knob, the microscope has a second control to adjust the magnetic field. This is actually a fairly simple video microscopy set-up, says Prof. Dekker, which he first copied from a research group in Paris in the late 1990s and has since improved.

"The twisting movements you can see on the screen are Brownian motion [caused by the DNA colliding with water molecules – ed.]. We

## 'The DNA strings come together through chance encounters'

can make them smaller by using the magnetic field to tighten the DNA coil. In this way we're able to measure the mechanical properties of the DNA. And we can investigate how those properties change if we add a particular protein – one involved in the formation of (extra tight) supercoils, for instance. In other words, we are watching the actual interaction between molecules."

It was with apparatus like this that the bionanotechnologists conducted their experiments on DNA molecules and the RecA protein. Only for that they used one more tool: a laser. It served as a kind of optical tweezer, allowing them to manipulate the plastic balls with much greater precision. The balls were held at the meeting point of two laser beams. The biggest challenge involved in this task was

attaching the balls and the protein to the DNA. To achieve that, the team exploited the fluid mechanical properties of a laminar flow and, as it were, "went angling".

## Tour de force

"That was a tour de force," says Prof. Dekker. He draws a quick sketch. "Look, if you have a laminar flow of liquid here, then you can make different substances and even objects flow inside and along with it, in parallel. And because the flow is laminar, they don't mix. You let the plastic balls flow here, at the top, with protein that attaches to DNA affixed to them. In the middle you have the RecA protein, and at the bottom more balls. To make the specimen, you then draw a piece of DNA across the flow, at right angles to it. That's how we assembled it. A bit of pulling at the DNA molecule and... ah, there we have it. The first ball was attached. After that we pulled it further through the flow, with the RecA protein."

Prof. Dekker's only slight regret is that he did not manage to publish the results in *Nature*. "That's what we were originally aiming for," he admits.

During his follow-up work on supercoils, Prof. Dekker hopes to be able to watch the dynamics of the molecular processes live. "For this research we're using an extra magnet, to pull the DNA molecules horizontally. And adding a dye to the protein that forms the supercoils, so that we can see where they are and how they move through the DNA."

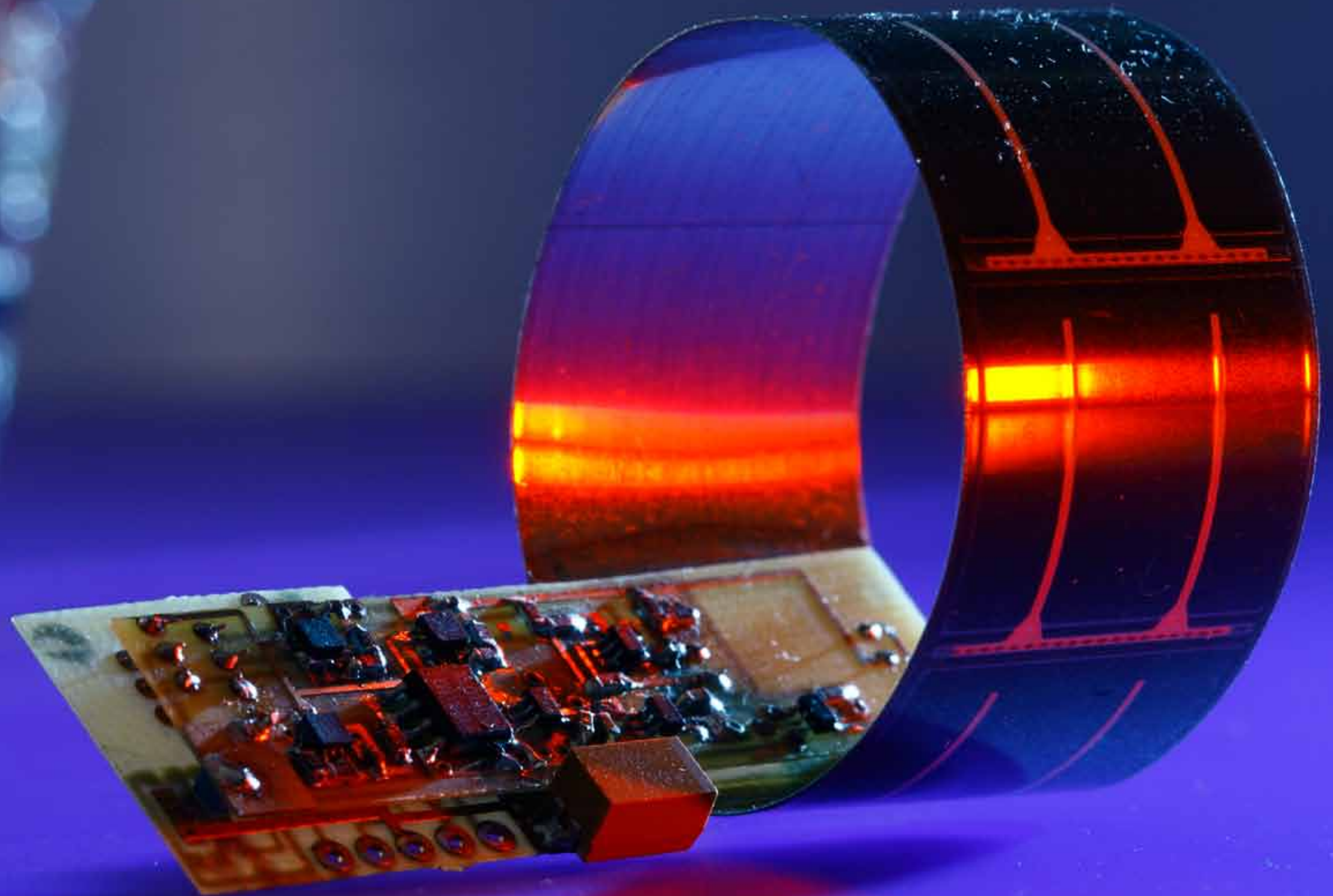
Meanwhile, recently appointed postdoctoral researcher Hugo Snippert – recruited by Prof. Dekker from geneticist Hans Clevers' renowned laboratory at the Hubrecht Institute in Utrecht – is going to repeat the experiments with the RecA protein, but this time in living bacteria cells.

The professor beams at the thought. He can already see the next major publications in front of him.

*Just prior to Delft Outlook going to press, researchers from the bionanoscience section published another much-talked about article, this time about an instrument they developed that is capable of precisely measuring the rotations in individual DNA molecules. Xander Janssen et al, Electromagnetic Torque Tweezers: A Versatile Approach for Measurement of Single-Molecule Twist and Torque. Nano Letters (2012)*



Goodbye batteries! These small wireless receivers with built-in solar cells use the sun's energy to power themselves. That makes them compact and self-supporting. They were developed by Dr Mina Danesh, earning her a PhD from the Faculty of Electrical Engineering, Mathematics and Computer Science this May. The idea is that they can be used to create wireless system networks, which have potential security and environmental or industrial process monitoring applications. And perhaps medical ones, too, in the future. According to Danesh, the same principle could also be applied to nanosensors – to monitor the pressure of fluid in the human eye, for instance.





# 'The railway is falling apart'

The NS and Prorail were frequently targets of his criticism. But the newly retired railways expert, Professor Ingo Hansen, was also often enraged by other Delft showpieces, such as the Superbus. "As a scientist, you have to say what you think."

*Tomas van Dijk*

Prorail and the NS are too focused on short-term profit; that is what Professor Ingo Hansen has warned for many years now. Shortly after his farewell speech (on 9 March), two trains collided with each other near Amsterdam Central Station, resulting in one fatality. According to Prof. Hansen, however, the accident could have been prevented if the European Rail Traffic Management System (ERTMS) was in place. Earlier this year the professor was commissioned by the Dutch government to write a report about the system, entitled 'Innovatie op het spoor en mogelijkheden van ERTMS in Nederland' ('Innovation on the railway and possibilities for ERTMS in the Netherlands').

*It sounds cynical, but one could hardly imagine a better case for your argument.*

(Sighs) "This discussion about the ERTMS has been going on for ten years now. Many European countries are now investing heavily in this system. But NS and Prorail want to wait until all the specifications for the most recent version of the software are known. This is an excuse. From a business economics perspective, in the short-term they have an interest in not introducing it if the government doesn't make any additional funds available."

*When I inquired, soon after this accident, whether or not this system would now be implemented, you answered that you feared "one death was not enough". And now you say: "In 1962, it took the train accident at Harmelen, in which 93 people died, before the ATB [Automatische Trein Beïnvloeding, the Dutch automatic train control system, ed.] was introduced." But in Parliament, on June 8, Minister Schultz van Haagen (Infrastructure and the Environment) said that the government was working on it. The plan calls for the entire Dutch railway will get the ERTMS between now and the next ten years.*

"That is a surprising decision by the minister

and the Cabinet. Apparently, the arguments that I and my colleague, Dr Rob Goverde, put forward in our recent report were persuasive. That said, the minister did not make any extra funding available in the investment budget."

*What makes ERTMS so much better than ATB and the improved-ATB version?*

"The ERTMS monitors the brake retardation of all trains, including the brake retardation of trains travelling slower than 40 kph [unlike the ATB, ed.]. It intervenes before a train can pass a stop signal. The security system is also less static than the ATB, as it continuously monitors the speed and positioning of all trains and sends commands to the drivers."

*The ERTMS also makes it possible to have shorter gaps between trains and therefore allows for increased capacity. This brings us nicely to another tricky issue: train punctuality. Remarkably enough, in 2009 you still seemed very optimistic about this.*

"Soon it will be a thing of the past for your intercity to get caught behind a slow train," you stated back then.

"That was very optimistic. The point I wanted to make was that my colleagues and I are working on a series of instruments that allow us to predict trains' working times to the accuracy of a second. With this, you'd be able to get rid of the unnecessary disruption that trains experience from each other."

*You could say it's your life's work. In 2009, you decided to pursue your work on that system within the NWO programme on Sustainable Accessibility of the Randstad.*

"Yes, and that was the reason for the interview [in the NWO's Popular Annual Report, ed.] in which I made that statement about the slow train. The statement must be seen in that context."

*But is it really possible that in future the NS will run on time and that chugging along behind slow trains will become a thing of the past?*

"One of our most striking findings is that an intercity train that has to stop for a slow train ahead can incur two to three minutes of delay, just like that. And this happens systematically, while it's completely unnecessary. If the intercity train knows precisely when the vehicle ahead has got out of the way, it can adjust its speed earlier, it no longer comes to a halt nor does it have to wait for the green signal from the train controller. Moreover, if train controllers use a system that supports decision-making, they can make well-considered choices when conflicts arise at complex junctions."

*Wouldn't such a train controller need to have much more information about every train?*

"Of course, the system needs to take the trains' working characteristics into account. Okay, so you don't know the exact weight of the train in advance; after all, you don't know how many passengers are on board. And you don't know exactly how much head wind there is. But you can build up historical databases and make probability calculations."

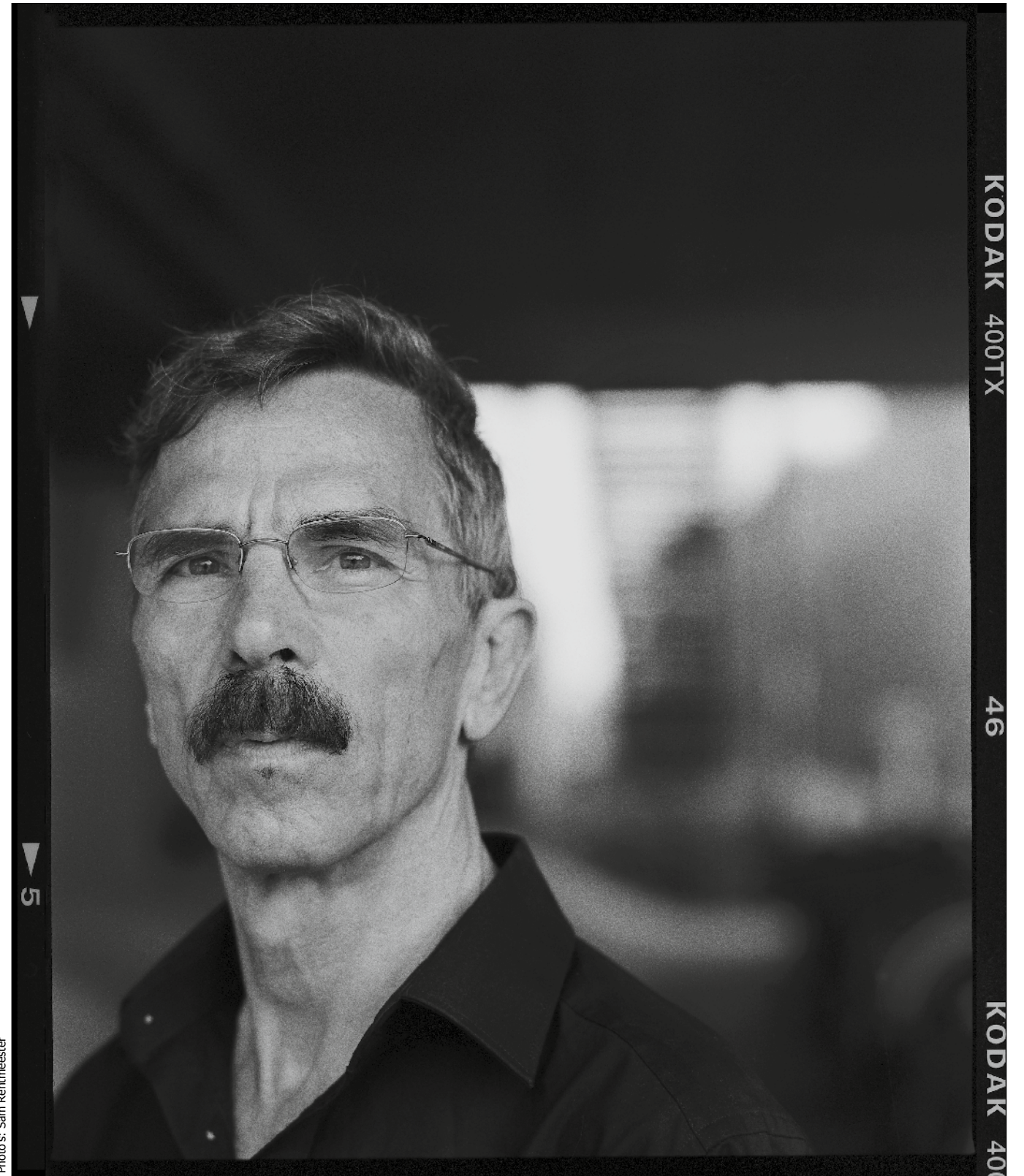
*Don't drivers do anything already?*

"Of course, a driver will know from experience what they might best do, but it could all be much more precise."

*There's a lot to it, but the principle sounds simple. It's a bit like the new approach to driving, where you don't rush up to a red light at full speed either.*

"Yes, but you must also exploit the seconds that you have at the margins of the schedule. With new ICT techniques and GPS equipment, you can follow trains accurately to the second. But the problem is that the NS and Prorail only work with full minutes in their schedule. At present the NS doesn't know how

Photo's: Sam Rente-meester



'I think that scientists have a duty to let the truth be known'



much margin it has. When I discussed this with the NS ten years ago, they told me that they had to oversee the logistics of the trains throughout the whole of the Netherlands, and that they couldn't be occupied with seconds."

*You, Prorail and the NS haven't really hit it off.*

"The collaboration isn't going as we'd like. Prorail have never allowed us to do a shadow run of our system. And the NS thinks that our approach is over-precise."

*Nothing will ever come of it, then?*

"At present, the government is too lax in its dealings with them. They're fulfilling the performance criteria and performance indicators that they themselves proposed, and which the government approved. At present 93% of trains are delayed by less than five minutes, making them 'on time.'"

*Yet your own research has shown that things aren't set up so badly here in the Netherlands. For example, together with Switzerland's, the Dutch railways are the most intensively used in Europe.*

*And concerning punctuality, the Netherlands scores the best in Europe, after Switzerland.*

"If you want to encourage environmentally friendly transport, then you must have a strategy for sustainable transport, and not be content with the current situation. What's more, other countries are investing heavily in the ERTMS, so we're in danger of lagging behind."

*You feel the NS and Prorail are short-sighted.*

"Yes. The railway is falling apart. For the Dutch House of Representatives, I compared the rail systems of six countries: the Netherlands, Belgium, Denmark, Switzerland, Sweden and Japan. Apart from Japan, the railway networks of these countries are of a comparable size. For every train kilometre that's run, the Netherlands spends the least on management and maintenance. I would imagine that the probability of critical parts of the infrastructure failing, such as points and overhead wires, has increased over the last five years, along with the time needed to repair faults. But Prorail doesn't report on this; they keep it quiet."

*Will you continue your research after retirement?*

"If Prorail, the NS or the government ask for advice, then I will give it. What I'd prefer would be to continue working with colleagues from this department [Transport and Planning, CEG, ed.]. Right now I'm chiefly occupied with organising conferences."

*In Delta, you regularly wrote passionate arguments on diverse subjects, ranging from the Joint Strike Fighter (JSF) to the plans for a tramline through the campus and, of course, Wubbo Ockels' Superbus.*

"Yes, the Superbus," sighs Hansen. He picks up a thick pile of papers – newspaper cuttings, reports and letters – that he has lying ready

on his desk. "Superbuses that can travel at 250 kph, be sustainable and just as safe as trains. That's just not possible."

*In 2007, you wrote a report entitled 'Pitfalls for the Superbus', in which you wiped the floor with the Superbus concept. Not everyone thanked you for that. And perhaps somewhat understandably, Ockels is able to really enthuse people. If he brings in millions in subsidies, isn't that a good thing?*

"No, I don't think so. In the end, he received 11 million euros to develop a prototype for an idea that was not technically feasible. I find it surprising that most of my fellow professors did not really dare to speak up."

*Hansen leafs through the stack and takes out a letter.*

"And then this letter", he continues indignantly. "The then chairman of the Board of Governors, Hans van Luijk, and the bosses of Shell, TNO and Fokker, wrote this letter to the minister indicating their support for the Superbus. Not one of them has an understanding of these sorts of issues."

*You were personally concerned that things were being put forward at TU Delft that didn't add up, in your opinion.*

"I am annoyed by the fact that members of the Board of Governors do not consult the expertise they have in their own ranks before deciding on something that is in the public interest. If someone contradicts my scientifically grounded opinion, then I will speak up. I think that scientists have a duty to let the truth be known."

*In 2002, you wanted a debate at TU Delft on the JSF. The reason for this was the fact that the then dean of the Faculty of Aerospace Engineering, De Jong, put the case for participation in the JSF project in an open letter to the Dutch Parliament.*

"It is incomprehensible that the Board of Governors allowed a dean to lobby for the purchase of a fighter plane."

*You've made a lot of enemies.*

"Yes, that's true. I think that professors should make use of their knowledge and freedom. When I started out at TU Delft, the director of the Trail research school said to me after a committee meeting, 'You really say what you think'. I was a bit shocked by that. I think that scientists should always say what they think."

*Could that also be the reason why the collaboration with the NS and Prorail has not gone well?*

"I'm not trying to win them over. If they don't like my ideas, then that's up to them. For the rest, the contact with project managers at Prorail and the NS is quite good, but at higher levels, there are people who don't have the right expertise."

## Gold-medal wheelie bins

Will it be gold and glory or abject failure? Without great technical backup, today's Olympic athlete has no chance. And by that I don't mean the coach on the sidelines, but all the engineers and designers working behind the scenes to help the modern sportsman perform just a fraction of a percentage better.

The same old examples, trotted out time and again, are usually the ones which interest me the least. Yes, a shark suit that lets you swim a little higher in the water will make you go faster. That's just a simple question of hydrodynamics. What I find far more fascinating are the discoveries that work on the athlete's psyche.

Photo: Sam Rentmeester



**Tonie Mudde** is a science journalist and columnist for the newspaper de Volkskrant. Between 1996 and 2002 he studied Aerospace Engineering at TU Delft.

Last year I visited the Flik-Flak Hall in Den Bosch for the presentation of a video system which starts recording automatically as soon as a gymnast begins their jump. Almost as soon as they land, slow-motion pictures of the exercise are shown on a screen in the hall. I saw young boys and girls around eight years of age watching attentively even as they were queuing for their next turn, taking in the instructions from their trainer. Compare that with the old situation. Talented young gymnasts wasted so much time waiting for tapes to be rewound and cued up that their whole rhythm was broken. Now it's jump, watch, jump, in one smooth sequence, with no disruption to the flow of training.

Also fascinating, although slightly more dubious, are the ice baths which hordes of athletes will once again be taking at this year's Olympics. The idea is that these help their muscles recover faster after a strenuous performance. Two TU Delft graduates have developed this IcyDip, requiring just a tap and a power socket to set up a freezing plunge. The portable baths look pretty cool, too, and they are certainly a great

improvement over the old situation: world-class athletes desperately scouring venues for enough ice cubes to fill a wheelie bin, then jumping in with them. And I'm not joking – it really was like that before the IcyDip came along! It doesn't matter that Dutch research organisation TNO has found no link between ice baths and muscle recovery. New products like this can still have a crucial placebo effect. Just imagine the psychological effect on your competitors when you produce your futuristic IcyDip with its ergonomic hand grips, while they're clambering into old wheelie bins. That's 1-0 to you before the starting pistol even sounds!



## Under Construction



Photo: Sam Rentmeester

For the new web-TV programme, Braindrops, biotechnologist Mark van Loosdrecht and presenter Desiree Hoving will be discussing water-purification technology in the TV studio at TU Delft. This year, to commemorate the university's 170th anniversary, Delft Outlook will be recording three programmes on the theme of water. Braindrops can be watched via [www.lustrum.tudelft.nl](http://www.lustrum.tudelft.nl).

## Who is Ingo Hansen

Professor Ingo Hansen (b.1946) gave his farewell speech on 9 March, looking back on a research career spanning 18 years at the Department of Transport & Planning. For 15 years, he has been conducting research into rail safety and on making the organisation of rail traffic as efficient as possible. Prof. Hansen collaborated on the parliamentary report by the Temporary Committee on railway maintenance and innovation (the Kuiken Committee), which was published in February. According to the Committee, at least 1.4 million euros that had been intended for rail maintenance in recent years has been spent on other areas. Prof. Hansen is also president of the International Association of Railway Operations Research and editor-in-chief of the Journal of Rail Transport Planning & Management.

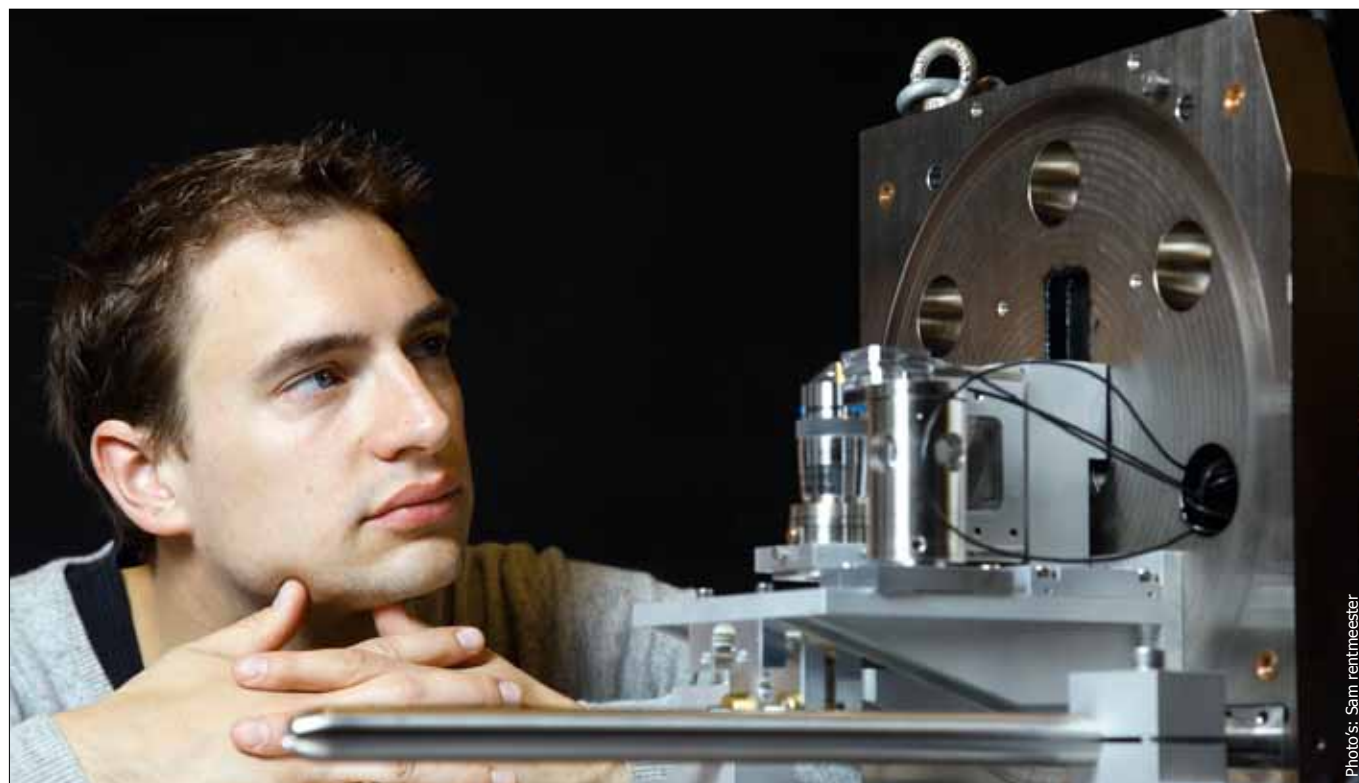




# Microscope sees double

Some 350 years after Antonie van Leeuwenhoek's landmark invention, Delft has made another breakthrough in microscopy with a single device which combines optical and electron techniques.

Jos Wassink



Photo's: Sam rentmeester

Sander den Hoedt: "We think it's important that operating the Secom feels familiar."

The Secom combination microscope – Secom stands for "scanning electron confocal optical microscope" – could well be the ideal tool to unravel the molecular mysteries of the living cell. Which proteins play what role in cellular existence, and where does the signal to produce them come from? A better understanding of these processes will provide us with more fundamental knowledge about life itself, says Adriaan Houtsmuller, professor of Functional Cellular Anatomy at Erasmus Medical Centre, Rotterdam. But more than that it could help us to expose the secrets of diseases like cancer and conditions of old age, such as Parkinson's and Alzheimer's. Optical microscopy has made significant advances in the past ten to fifteen years, says Houtsmuller, thanks to the discovery of fluorescent proteins. The first of these to be

found was the green GFP, in jellyfish. Once its gene had been isolated, scientists could attach that – and variants in other colours – to the gene of a protein they wanted to study. "All of a sudden," the professor explains, "we no longer had to colour cells. Now they do it themselves. In this way, he continues, specific molecules can be tracked as they move around a cell. Indeed, several can be followed at once by using clever combinations of multicoloured markers and lasers. It is hardly surprising, then, that the discoverers of GFP were rewarded with the Nobel Prize for Chemistry in 2008.

## Journey through a cell

Nonetheless, fluorescence microscopy has its limitations. Whilst certain molecules are visible on their journey through a cell, the

rest of the picture is dark. And, at only 1-10 nanometres (millionths of a millimetre) across, important structures, like those that molecules attach themselves to, are dozens or even hundreds of times too small to be seen under an optical microscope. For an electron microscope, capturing images on such a tiny scale is no problem. But because it requires a vacuum to do so, showing living cells is. And in any case the electron bundle transfers so much energy that it would instantly electrocute a living cell. This quandary brings us to the field of correlative microscopy: a set of ingenious techniques for combining the images from fluorescence and electron microscopes to display both biological action and the structure of cell components. For example, you could place the same specimen under

two different microscopes and then try to superimpose the resulting images in Photoshop. But in practice it is extremely difficult to find exactly the same section of the sample twice. So-called "workflow solutions" attempt to overcome this obstacle by using a kind of grid, visible in both images, to locate the target by its co-ordinates. Zeiss has developed a specimen holder capable of finding the same point under two microscopes with great precision. Alternative solutions from Utrecht University and FEI involve moving the sample into the electron microscope from a small, built-in optical device, in such a way that the same section is imaged both times. Brave attempts every one, that is for sure, but ultimately all rather make do and mend.

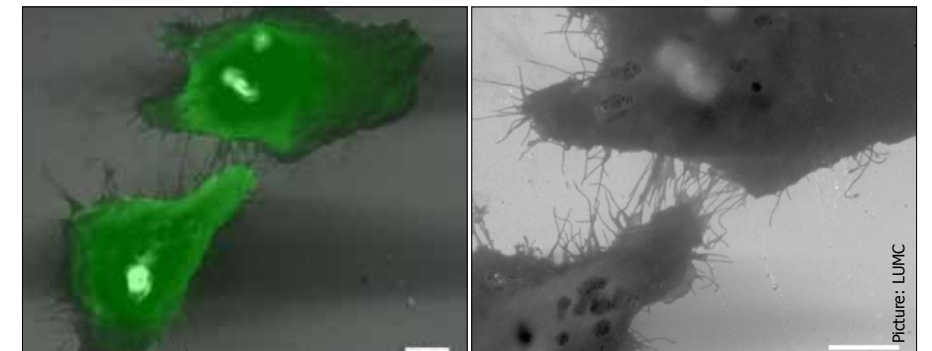
The new Delft solution is different, though. The Secom combination microscope is the brainchild of lauded electron microscope expert and innovator, Professor Peter Kruit, of the Faculty of Applied Sciences, and in 2000

*'Brave attempts every one, but ultimately all rather make do and mend'*

one of the founders of successful university spin-off Mapper. He has developed the Secom system jointly with Dr Jacob Hoogenboom, a man with an impressive track record in optical microscopy, and PhD student Christiaan Zonneville. Their solution combines optical and electron microscopy in a single unit, which can be retrofitted to virtually any existing scanning electron microscope (SEM). In a vacuum, a SEM emits electrons that scan the surface of the subject sample in fine detail. The actual image is reconstructed from the



Dr Jacob Hoogenboom has an impressive track record in optical microscopy.



Fluorescence recording is done using a 100x objective with a vacuum-compatible immersion oil and LED illumination of 480nm. Fluorescence comes from Alexa488, which is found in the protein Actin. The electron microscope image is taken at 20keV with a secondary electron detector, which particularly renders the structure of the cell visible. These are adenocarcinoma cells from the intestine.

pattern formed by the reflected electrons. It is important that the entire electronic imaging process take place directly above the specimen, because that allows for the positioning of an optical lens underneath, with a connection for focus adjustment, and a glass window fitted to let in light. This entire unit is fixed to the inside of the vacuum chamber door, with the optical microscope controlled from the outside.

## Delmic

TU Delft graduate Sander den Hoedt, who obtained his MSc under Prof. Kruit's supervision – and also studied law as well as technology – has recently begun marketing the system through his new company, Delmic (Delft Microscopy). "We think it's important that operating the Secom feels familiar," he says, "particularly for optical microscopists. In a sense, this means that Delmic is turning the situation on its head: extending the electron microscope means that first and foremost it now has to work properly as an optical one. By placing the lens inside the vacuum chamber, the optical and electronic images coincide as closely as possible – in time as well as space. Mechanically, the lens has to be aligned with an accuracy of no more than 10 micrometres, so that the electron bundle can be beamed smoothly into the optical field of vision. Eventually, with the help of software, Delmic hopes to be able to match the two images to within 10 nanometres of one another.

In practice, you would then be able to track a fluorescent protein visually through a living cell until it attaches to something, at which point you switch over to electronic imaging to see the structure in question at high resolution. Den Hoedt calls this "microscopy plus", or "on-demand electron microscopy". The cell, which has to be in a vacuum-proof holder for the technique to work, dies at the point of switchover. But as it perishes it produces a unique image. As an example, Hoogenboom produces an electron microscope photograph showing tentacles – invisible optically – on the outer wall of a cell.

These are thought to play an important role in the spread of cancer cells through the body. "This sort of microscopy can help unravel the basics of the molecular machinery inside a cell," says Prof. Houtsmuller, a Rotterdam cellular anatomist who has recently begun taking an interest in the vaguely foot-like membranes used by some cells to "sense" their surroundings. "How," he wonders, "does a cell feel that it's coming under pressure? And how do these foot-like membranes let the nucleus know that it should, say, be producing more stress fibres?" Prof. Houtsmuller has a feeling that cell biology is entering a new era – one in which the combination microscope should come in very useful.

Yet even this innovation has fundamental limitations. Most notably, the electron bundle only retains its high resolution up to a depth of about 100 nanometres. If we consider a cell with a diameter of 20 micrometres as like an apple, that means that the electrons penetrate no further than the skin. This is why most studies so far have focused upon the cell membrane and the passage of substances through it. Delmic, which recently sold its first microscope, is currently working on the smooth integration of electronic and optical images. Up until now, these have appeared on separate screens. For traditional microscopists, that should open the way to the wonderful world of electrons.

## Further information

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Sander den Hoedt LLM  
info@delmic.com



# Eleven cities Solar Boat Challenge

TU Delft students are participating for the fourth time in the world championship solar boat race in Friesland, which begins on 8 July. Expectations are high because the TU Delft students were world champions in 2006 and 2008. In 2010, the solar boat was equipped with hydrofoils for the first time. Unfortunately, the hydrofoils caused the boat to rise so far out of the water at top speed that it tilted and only achieved a third place. The big question is whether this year's new boat is fast enough to beat the competition. This infographic describes the technologies that the TU Delft team hope will help them win the race. For more information, see [www.deltalloydsolarboat.nl](http://www.deltalloydsolarboat.nl)

## Student team

The Delta Lloyd Solar Boat Team consists of twenty students who work together for a year to design and build a racing boat. When the boat was assembled in June, it was not yet known which of two candidates would actually pilot the boat. A condition of the race is that the pilot must weigh at least 70 kg.

## Steering system

When the pilot turns the carbon steering wheel, a steering mechanism consisting of a cable and pulleys causes the motor including pod, gearbox and propeller to swivel and change direction. The boat does not have a rudder.

## G Batteries

If the solar panels generate more energy than needed to power the motor, the surplus energy can be stored. This energy is used in overcast weather and when the boat needs to reach top speed during the final sprint of the race. The maximum storage capacity is 1 kWh (= 3.6 MJ). The TU Delft solar-powered boat carries 7.1 kg of lithium-ion batteries on board (the maximum permitted weight for this type of battery). The solar panels charge the battery in less than thirty minutes. A special battery management system measures all voltages, currents and temperatures and ensures that the batteries are never overcharged or run down too low. In the event of the batteries catching fire, fire extinguishers are activated automatically.

## A Lightweight hull

The hull is made of carbon fibres to keep weight to a minimum. The deck is made of glass fibre because carbon conducts electricity. The relatively weak hull is reinforced with ribs and beams. Only when the deck is fastened to the hull, a stiff box structure is created. The shape of the hull flares out above the waterline to provide sufficient surface area for the solar cells. The hull (47 kg) has four hoisting eyes to enable the boat to be lifted out of the water. During the course of the Solar Challenge, the boat must be lifted out of the water in some places to pass obstacles.

## B Propeller drive

The motor, gearbox and motor controller are supplied as a unit (pod, 3.3 kg) in a streamlined underwater housing. The aluminium motor (maximum output power 4 kW) has been specially modified by the German manufacturer to work with the low battery voltage of 43.2 Vte. The rules require this low voltage because of the wet environment.

## C Propeller

The aluminium propeller **1** (diameter 34 cm) is specially designed for the solar-powered boat with hydrofoils. At the most important speed, the propeller achieves a theoretical efficiency of 84%.

rotatable hydrofoils

Pod

Motor including gearbox and controller.

Fire extinguisher

8 MPPT controllers

## Advantage

The battery system consists of 156 individual cells: 13 parallel battery units, each consisting of 12 cells connected in series. Thanks to this innovative arrangement, the TU Delft team expects their 7.1 kg set of batteries to have a greater capacity than the 1 kW assumed in the rules. They hope to use this loophole in the rules to achieve higher speeds than the other teams.

## D Rear hydrofoil

Originally, the plan was to have a single large rear hydrofoil this year. Due to a lack of time during the hull construction, a decision was taken to once again use the T structure used in 2010 – two foils mounted on each side of the motor pod. The angle of the hydrofoils can be individually adjusted using two actuators **2** at the rear of the pod. If the boat begins to tilt during the race, due to a strong side wind, for example, the boat can be righted by setting the foils at different angles.

## Hydrofoil in 2010

The solar-powered boat was first equipped with hydrofoils in 2010 **3**. At speeds above 12 km/h the foils generate enough lift to raise the boat out of the water. This reduces resistance and permits a higher speed to be reached at a given rpm. During the race, the hull rose out of the water completely. This meant that the boat was only supported by point **4** of the V-shaped hydrofoil and it became unstable and tilted over. In order to avoid this occurring, the boat had to be kept below its top speed and finished third (average speed 16.7 km/h).

## Top speeds

Top speed without hydrofoils  
25 km/h

Top speed with hydrofoils  
36 km/h

Head Mounted Display

3 hydrofoil design 2010

5

7

4

Solar cells  
2,928 triple-junction solar cells

## Technical data for the boat

L x W x H  
5.93 x 1.80 x 0.35 m

Draught  
10 cm

Total weight  
135 kg

## F Solar panels

Solar panels are the only source of energy permitted on the boats. The maximum power the panels are permitted to generate is 1750 Wp (watt-peak). The deck of the boat is covered with 2928 gallium-arsenide triple-junction solar cells (7.92 m<sup>2</sup>). The cells have an average efficiency of 21.9%. The power generated by the solar cells is passed to the batteries via MPPT electronic controllers **8**. These MPPT units ensure that the maximum power is obtained from the solar cells and stored in the batteries.

## Energy Solar Challenge

The Delft Team is competing in the top class of the Dong Energy Solar Challenge (8 to 14 July 2012). The race follows the route of the legendary Dutch ice skating event the "Elfstedentocht" (the Eleven Cities Tour). The route is divided into sections. The boat that achieves the best total time over the six days of the race (in 2010 the winning time was 11 hours and 25 minutes) is the world champion solar-powered boat in 2012.

Dank aan Roel Stein (Delft Solar Team) voor basis-3Dmodel

illustrations and text: Eric Verdult  
[www.kennisinbeeld.nl](http://www.kennisinbeeld.nl) © 2012



## Propositions

It is easier for a stupid man to understand Einstein's theories than for a lazy man to get a PhD

**Lei Zu,**  
space technology engineer

Perfection is finding the right balance

**Roeland de Kat,**  
space technology engineer

Zeeuwen are not saving every penny when it comes to de-poldering the Hedwigepolder

**Jasper Dijkstra,**  
civil engineer

Rich people are not always happy

Happy people are always rich

**N. Trifunović,**  
civil engineer

Engineers have to be careful not to turn aircraft spherical cows

**Michiel Straathof,**  
space technology engineer

Dutch people take their time in their offices, but are always in a hurry on the road

**O.V. Pischans'ky,**  
elektrotechnical engineer

## Proposition

The main problem when setting up and opening a new airline network is the availability of the resources needed to operate other than the financial resources

**Rafael Bernardo Carmona Benítez,** logistics and transport engineer

## Defence

You can have great ideas for setting up a new airline network based on a sound business plan, but this doesn't guarantee your airline will actually be a success. The mathematical models I describe in my doctoral thesis, titled 'The design of a large scale airline network' require that you enter the number of aircraft that you want to use and the number of pilots that you need. However, purchasing an aeroplane is not like purchasing a car. After placing your order, it takes years before they are actually delivered to you. And pilots aren't always in ready supply either. In other words, your success will largely depend on the degree in which you can get hold of these resources.

## Sound Bites

'Making technical degree programmes free isn't the instant solution to meeting the need for more high-calibre engineers. The way to do this is to invest more in technical courses so that we can continue to guarantee their quality without having to introduce a numerus fixus.'

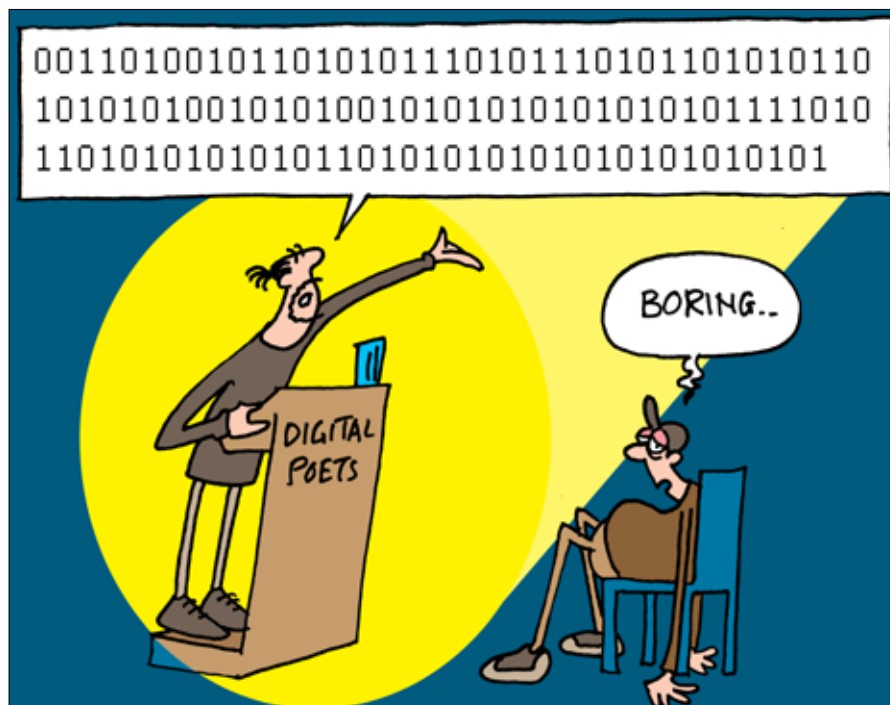
*Mark Lammerts, Director of Marketing & Communication, in Trouw*

'The teaching sessions were partly about me. They wanted to know everything about me. How a theatre production is put together, what my life is like, and what you should do with your life. They also talked to me about what they do. They're studying really difficult subjects. It's true that a student knows everything about testing firefly embryos. I think I learned more from them than vice versa.'

*Cultural professor Youp van 't Hek in Algemeen Dagblad*

'I'm afraid that socially useful games will never be as popular as games designed purely for enjoyment and entertainment. Escapism is one of the main reasons for gaming: you want to get away from the problems of the real world for a while. It's simply a fact that you can do that more easily by shooting in World of Warcraft than by playing a game about energy conservation.'

*Industrial design engineer Daphne Geelen in de Volkskrant*



*The probability that 20-year-old digital information will no longer be readable is a lot smaller than the probability that somebody will actually want to read it*

**Loubna Bouarfa,**  
biomechanics



The Executive Board has appointed Dr **Theun Baller** dean of the 3mE faculty with effect from 1 July 2012. Baller studied physics at the University of Amsterdam and obtained his PhD for fundamental process research at the University of Twente. Since January this year he has been Open Innovation Program Manager at TU Delft.



In the autumn of this year, opera director **Floris Visser** will take over from cabaret performer Youp van 't Hek as TU Delft Cultural Professor. In November he will also direct 'Carmen', a joint production combining international top talent from the world of opera and the student music society Krashna Musika.



Prof. **Mike Jetten**, professor by special appointment in Environmental Biotechnology at the Faculty of Applied Sciences, has been awarded a Spinoza Prize for his work on micro-organisms. Prof. Jetten, professor of Ecological Microbiology at Radboud University Nijmegen, specialises in slow-growing anaerobic bacteria. The Spinoza Prize, incorporating an award of 2.5 million euros, is the highest scientific award in the Netherlands.



**Anka Mulder**, Director of Education and Secretary General of TU Delft, has been ranked nineteenth on the list of the '100 Most Creative People in Business 2012', a ranking compiled by the American business magazine, Fast Company. The ranking is in recognition of her work as President of the OpenCourseWare Consortium.



Bionanoscientist Prof. **Cees Dekker** has been awarded the ISNSCE Nanoscience Prize 2012. The award is presented annually by the International Society of Nanoscale Science, Engineering, and Computation. Prof. Dekker received the prize in recognition of his "outstanding discoveries and contributions to the field of (biomolecular) nanoscale science and nanotechnology".



Associate Professor of Transport and Logistics (TPM), Dr **Caspar Chorus**, has been awarded a Vidi grant of 800,000 euros by NWO, the science funding organisation. NWO awards these grants to researchers who have demonstrated the ability to develop innovative ideas. The grant allows Chorus to continue working in the coming years on his 'regret model'.



Coastal visionary and Delft alumnus **Ronald Waterman** has been awarded the Piet Kamps Prize by the VVD (People's Party for Freedom and Democracy) in Delft. The prize is awarded to a person living or working in Delft who is or has been active in society and has made a significant contribution to the city's development.



**Ijsbrand Haagsma** has been appointed secretary of the 3TU Federation, of which TU Delft is a member, with effect from 1 June. He will be responsible for the strategic development, direction and coordination of all the activities undertaken within the federation of the three universities of technology. Haagsma joined TU Delft in 1992 and has since held various positions.



Three TU Delft professors were awarded honours on 27 April. Prof. **Alfred Kleinknecht**, professor of Economics and Innovation (TPM), was made a Knight in the Order of Oranje-Nassau "for his contribution to science and his



commitment to and efforts on behalf of Dutch society". Prof. Kleinknecht regularly expresses his unvarnished views on economic matters through various media. Prof. **Mick Eekhout**, professor of Product Development (Arch.), was made



a Knight in the Order of the Dutch Lion. This honour was also bestowed upon Prof. **Pieter Kruit**, professor of Theoretical and Applied Physics (Applied Sciences). Professors Eekhout and Kruit also received their honours for their commitment to science and society. Prof. Kruit was described as a "figurehead for the university community". Prof. Eekhout was praised for his "pioneering role in the teaching of building technology, and above all in research in that field".



# Space for 'sensemaking'

Acda & De Munnik used to sing, 'Life is what happens while you're making other plans'. This is confirmed by the conclusions that Leentje Volker draws in her PhD research on the factors that play a role in the selection of architects. Volker is a post-doctoral researcher in the Energy and Industry section (TPM). Her PhD research was selected from 62 entries to be nominated for the NWO Boekman Dissertation Prize 2012. The competition is open to students from Dutch universities whose dissertations focus on the societal context and administrative environment of culture and the arts. Volker advocates that decisions on selecting an architect for public building projects should allow for what she refers to as 'sensemaking': "Think in terms of progressive insights, intuition and a holistic perspective. EU legislation leaves little room for that. I suggest using these rules to define the playing field, then creating space within it for the things you can't determine in advance." To support that process, she provides practical recommendations for policymakers. On 6 June it was announced that, unfortunately, Volker had not won the prize. The winning dissertation was by Amanda Brandellero of the University of Amsterdam.



Photo: Sam Rentmeester

Leentje Volker advocates intuition and a holistic perspective.

## Multidisciplinary cooperation

The Human Power Team Delft & Amsterdam are the winners of the UfD-E.ON Teamwork Prize, which is awarded to a team of students and staff who have worked together on a unique and outstanding achievement. The Human Power team designed and built the Velox, an aerodynamic recumbent bicycle (see the Infographic in Delft Outlook 2011-5). Because the athlete is just as important as the machine when it comes to setting a record, the TU students worked with students from the Movement Sciences department at VU University Amsterdam. They selected and trained four top-level athletes. Team leader Paul Denissen: "In June, we will make our first attempt at an hour record. After the summer, the whole team of 15 students and four cyclists will go to Nevada for the record sprint. We'll be competing against teams from Italy, France, Canada and California." The jury praised the team's multidisciplinary cooperation, and in recognition of this awarded the first prize of 10,000 euros. Three incentive prizes of 2,000 euros each were also awarded.

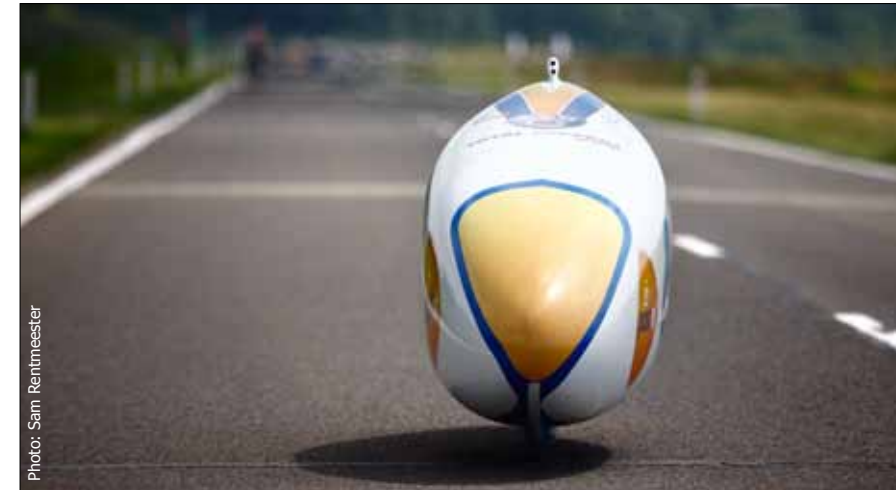


Photo: Sam Rentmeester

TU-students worked together with VU students on a outstanding achievement.

## TU students win business plan competition



Photo: Sam Rentmeester

Tomas de Leeuw and his company Sunuru supply an application that makes the installation process more flexible.

Three students from TU Delft recently won the worldwide CleanTech Challenge 2012, a business plan competition held annually by the London Business School. "About 40 groups took part in the preselection in the Netherlands," explains Thomas de Leeuw. He studied mechanical engineering and set up the Sunuru company with the help of YesDelft. His company supplies an application that makes the installation process for solar panels simpler and more flexible. In

addition, the panels generate 20 to 40 percent more energy. De Leeuw, together with Joost Schulze (IDE) and Natasha Gosteva (TPM), presented the Sunuru business plan during the preselection for the CleanTech Challenge. When they were declared the winners of this round, they then travelled to London to compete against other teams from Europe, China and the US. "We were asked whom Sunuru is dependent upon for the successful launch of our solar panels. In 24 hours we put together a presentation that we then presented to the jury, which was made up of investors and executives from multinationals. The rationale for our business plan was rewarded with a prize of 10,000 pounds, which we are using for a pilot project at Schiphol Airport. We are installing our solar panels there, and comparing the current they generate with that of a standard installation. Within a few weeks we're already seeing how much extra current we can generate."

### Agenda

27 July to 12 August 2012  
London Summer Olympics

25 August 2012

Seppe Airshow L&R. Aircraft and helicopter shows.

31 August 2012

Deadline for the Alumnus of the Year election.

3 September 2012

Deadline for UfD Marina van Damme scholarship. See: [www.universiteitsfonds.tudelft.nl](http://www.universiteitsfonds.tudelft.nl) or send an e-mail to: [ufonds@tudelft.nl](mailto:ufonds@tudelft.nl)

7 September 2012

Symposium, including valedictory address by Prof. Prabhu Kandachar: 'Beyond Design - inclusive innovations and well-being'. [www.io.tudelft.nl/beyonddesign](http://www.io.tudelft.nl/beyonddesign)

12 October 2012

Alumni Event

## Wanted: Alumnus of the Year

TU Delft is proud of its alumni, many of whom make unique contributions to the fields of science, technology, innovation and entre-prenurship, and serve as sources of inspiration to others. The UfD is now searching for new candidates for the Alumnus of the Year election. In addition to a memento, the winner will receive two prizes: the sum of 2,500 euros, to be spent as the winner wishes, and the sum of 7,500 euros, to be spent on a Delft research project of the winner's choice. Do you know a suitable candidate for the award? Or perhaps you feel you qualify for the title of Alumnus of the Year? Submit your nomination before 1 September via [www.universiteitsfonds.tudelft.nl](http://www.universiteitsfonds.tudelft.nl).

## New prize for Dreamteams

In late October the University Fund Delft (UfD) will present the UfD Dream Team Prize for the first time. The prize is awarded to the Dreamteam that wants to recognise a member's special contribution to the team. The team wins a trophy and a monetary prize; the Dreamteam member wins a memento. Alumni are welcome to attend the award ceremony. The date and venue for the ceremony are still to be announced. The Dreamteams work on student projects, such as DUTracing Formula Student, Greenchoice Forze Formula Zero and the Delta Lloyd Solar Boat.

## TU Delft Alumni Event 2012 Celebrating the past, sampling the future

Come tot Delft on Friday, 12 October, for an evening full of innovation, inspiration, information and education. Make new contacts. Meet old friends. Touch base with TU Delft and taste the future of technology. Further information: [www.tudelft.nl/alumnivevent2012](http://www.tudelft.nl/alumnivevent2012)



Photo: TU Delft

## Researching the deep subsurface

"If we want to treat our planet properly, geothermics is a logical choice," says Floris Veeger, student of Applied Earth Sciences. He won second prize in the UfD-EBN Geo Energy Master Award, a competition that rewards sustainable graduation research into the deep subsurface. Veeger was awarded 4,000 euros for his research into the possibilities for re-using existing oil and gas wells for extracting geothermal energy. In cooperation with Brabant Water, TNO and WE&P, he studied the various types of wells and their usability and

up a lot of space. All these properties make geothermics one of the most sustainable and environmentally friendly alternatives to the more conventional energy sources." Veeger concluded that there are indeed possibilities for using existing wells for geothermal energy. He is now conducting further research into this for Brabant Water, and he is working with oil and gas companies to explore possibilities for setting up a pilot project.

### Flow dynamics and drilling fluid

The first prize of 6,500 euros went to Vipul Khosla (Chemical Engineering). His research focused on flow dynamics in bored wells. He studied how coatings on the inside of gas pipes can increase production during gas extraction, so that gas reservoirs can be used more intensively for sourcing gas. The third prize went to Andrea van Overveldt (Petroleum Engineering). She won 2,000 euros for her research into the composition of drilling fluids. Her research method is new and leads to improved drilling results, enabling more efficient use of costly drilling fluids. She used a CT scanner in an experiment to measure and visualise what happens in rock when drilling fluid penetrates it. The jury found that her research makes an important scientific contribution to the improvement of drilling fluids.

*'There are no waste products, and the above-ground installations don't take up a lot of space'*

availability. "In the Netherlands, there are more than 2,200 wells for oil and gas exploration and production," Veeger explains. "I looked into whether the wells that are no longer used for that purpose could now be used to extract geothermal energy. It's a sustainable energy source that makes use of heat from inside the Earth. Hot water is pumped up from deep layers of the Earth and can be used to heat houses, glasshouses and industrial premises. When the water has cooled, it is pumped back into the Earth further away." According to Veeger, geothermics offer many advantages: "No greenhouse gases are emitted when it is extracted, there are no waste products, and the above-ground installations don't take



## who & where

Delft University of Technology has eight faculties, each of which is engaged in education and research in one or more disciplines. The University was founded in 1842 by King William II. With 13,000 students, 2,800 scientific staff members and 2,000 technical and administrative employees, it is the largest university of technology in The Netherlands.

### Disciplines

#### Aerospace Engineering

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nl-2629 HS Delft  
Telephone +31 15 278 2058

#### Applied Earth Sciences

Mijnbouwstraat 120  
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Telephone +31 15 278 1423

#### Applied Physics

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#### Architecture

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#### Chemical Technology & Bioprocess Technology

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nl-2628 BL Delft  
Telephone +31 15 278 2667

#### Civil Engineering

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Telephone +31 15 278 5440

#### electrical engineering

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#### Geodetic Engineering

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#### Industrial Design

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#### Life Science & Technology

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#### Marine Technology

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Telephone +31 15 278 6666

#### Materials Science

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Telephone +31 15 278 6666

#### Mechanical Engineering

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#### Computer Science

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#### Applied Mathematics

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Telephone +31 15 278 4568

#### Technology, Policy & Management

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nl-2628 BX Delft  
Telephone +31 15 278 7100

#### Multidisciplinary Centres

**Adhesion Institute**  
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Telephone +31 15 278 5353

#### Biotechnological Sciences Delft Leiden (bsdl)

Julianalaan 67  
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Telephone +31 15 278 5140/2342

#### Centre for International Co-operation and Appropriate Technology (cicat)

Mekelweg 2  
nl-2628 CD Delft  
Telephone +31 15 278 3612

#### Centre for Transportation Engineering

Stevinweg 1  
nl-2628 CN Delft  
Telephone +31 15 278 6634

#### Dutch Institute of Systems & Control (DISC)

Mekelweg 2  
nl-2628 CD Delft  
Telephone +31 15 278 7884

#### Koiter Institute Delft (Institute for Engineering Mechanics)

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nl-2629 HS Delft  
Telephone +31 15 278 5460

#### Netherlands Institute for Metals Research (NIMR)

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Telephone +31 15 278 2535  
Fax +31 15 278 2591

#### Wind Energy Research Group

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nl-2629 HS Delft  
Telephone +31 15 278 5170

#### Reactor Institute Delft

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nl-2629 JB Delft  
Telephone +31 15 278 5052

#### OTB Research Institute for Housing, Urban and Mobility Studies

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nl-2628 BX Delft  
Telephone +31 15 278 3005

#### Open Building Working group (obom)

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nl-2628 CR Delft  
Telephone +31 15 278 5400

#### Delft Institute for Microelectronics and Submicron-technology (dimes)

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nl-2628 CT Delft  
Telephone +31 15 278 3868

#### Interduct Delft University Clean Technology Institute

Rotterdamseweg 145  
nl-2628 AL Delft  
Telephone +31 15 278 7233

#### J.M. Burgerscentrum

**Centre for Fluid Mechanics**  
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#### Netherlands Schools for Advanced Studies in Construction

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**2600 AC Delft**

**The Netherlands**

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**telefax +31-15 278 6522**

#### Advanced School for Computing & Imaging

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#### Trail Research School

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Telephone +31 15 278 6046

#### Central Library

Delft University of Technology Library (dutl) supplies information and provides services, particularly in the area of the technical sciences.

It comprises a central library and twelve sub-faculty libraries housed at the respective sub-faculties and institutes. The dutl is intended for students and staff at the Delft University of Technology. However, as the task of the library is to provide scientific and technical information at a national level, its facilities are also available to the general public. As well as all areas of technology and natural sciences, the library also contains a general collection in the social sciences, economics etc. This relates not only to books or periodicals, but also to standards, reports, reference works and congress proceedings.

Literature not in the collection or not on hand can be obtained through Delft University's Central Library from other libraries in the Netherlands or abroad.

For further information:

#### Delft University Central Library

Prometheusplein 1  
p.o. box 98  
nl-2600 MG Delft  
Telephone +31 15 278 5678

#### Delft University Press

**IOS Press**  
Nieuwe Hemweg 6B  
nl-1013 bg Amsterdam  
www.iospress.nl  
Telephone +31 20 688 33 55  
Fax +31 20 620 34 19  
E-mail order@iospress.nl

### Information

General information:

#### Information office

p.o. box 5  
nl-2600 AA Delft  
Telephone +31 15 278 5404

Information on facilities for foreign students:

#### Student Advisory Office

Jaffalaan 9a  
nl-2628 BX Delft  
Telephone +31 15 278 4670

Liaison between business and research:

#### Liaison Office

Mekelweg 2  
nl-2628 BX Delft  
Telephone +31 15 278 1500

Information on research fellowships:

Mrs. M.Y.M. Spiekerman-Middelplaats  
Stevinweg 1  
nl-2628 CN Delft  
Telephone +31 15 278 3773

General information on university education in the Netherlands:

#### Min. of Education, Science & Culture Central Information Dpt.

p.o. box 16375  
nl-2500 BJ Den Haag  
Telephone +31 70 412 3456

#### (Post Graduate) Courses

##### Delft TopTech

(vocational courses)

Mekelweg 2  
p.o. box 612  
nl-2600 AP Delft  
Telephone +31 15 278 8019  
Fax +31 15 278 1009  
www.delft-toptech.nl

#### Institute for Biotechnology Studies Delft Leiden (bsdl)

Julianalaan 67  
nl-2628 BC Delft  
Telephone +31 15 278 2355

#### For information on courses in the Dutch language:

##### Language Laboratory

Jaffalaan 5  
nl-2628 BZ Delft  
Telephone +31 15 278 4124