

Delft Outlook

MAGAZINE OF DELFT UNIVERSITY OF TECHNOLOGY 2012 • 4

Spy in a backpack

Autonomous aircraft take over the campus

Develish dilemmas
Business and science

Leo Kouwenhoven
'Not really a eureka moment'

Alumni event
Connecting to the future

Spy in a backpack

6

10 Leo Kouwenhoven: "The best people leave to go abroad"

17 Collaborating with companies: devilish dilemmas?

22 Testing ground for bio-innovations

Coverphoto
Sam Rentmeester

Editorial staff
Frank Nuijens (editor-in-chief)
Dorine van Gorp, Katja Wijnands (managing editors)
Saskia Bongers, Tomas van Dijk, Erik Huisman,
Sam Rentmeester (image editor),
Connie van Uffelen, Jos Wassink

T (015) 278 4848
E delftoutlook@tudelft.nl

Contributing writers
Auke Herrema, Eric Verdult, Pascale Warners

Subscriptions
delftoutlook@tudelft.nl

Design & typesetting
Saskia de Been, Media Solutions TU Delft

Printing
Deltahage BV, The Hague



Contents

- 3 Delft in Brief
- 13 Column Remco de Boer
- 13 Under construction
- 14 Spotlight: subsidence in the Railway Zone
- 16 The Firm: Inventeq
- 16 The View: Peter Boelhouwer on the housing market in 2030
- 17 Life after Delft: Guido Kerbusch
- 17 Since You Asked: Colonising Mars
- 24 Hora Est, Propositions, Cartoon and Soundbites
- 25 In Person
- 26 Alumni World

Trust

During election time, scientists are enticed out of their ivory towers in order to sketch the future of Dutch science, which is why Hans Clevers, the new President of the Royal Netherlands Academy of Arts and Sciences (KNAW), appeared on the Dutch radio programme *Hoe?Zo!*, to inform politicians that the government particularly needs to invest in fundamental research. But does this mean he is against applied research? On the contrary, he stressed the importance of collaboration between universities and the business community. General universities have much to learn from the universities of technology, which he feels are doing well as far as valorisation is concerned. And yet, with this kind of collaboration, there is always a danger of conflict of interest lurking around the corner. Some 60 percent of Dutch people feel that scientists can no longer be trusted because they have become too dependent on industry. "Typically Dutch: everything done by business must be tainted," says Martin van Pernis, of TU Delft's Conflict of Interest Committee, in this edition. Fortunately however the image of the engineer is untainted in the eyes of the public, or at least the Belgian public, argues our columnist Remco de Boer. Three out of four of those people questioned would recommend becoming an engineer to friends or children. That is an election you have already won.

Frank Nuijens
Editor-in-Chief Delft Outlook

Colophon

Delft in Brief

Wanted: new UfD standard-bearer

The Delft University Fund (UfD) is dedicated to promoting talent, technology and the interests of TU Delft, by awarding grants to talented students and presenting prizes for excellent achievements. The current director will hand the organisation over to a successor. The new director will work on strengthening foundations for the future, will enhance the bond between TU Delft and its alumni, will collaborate fully with the Executive Board, and serve as the initiator and executor of new marketing initiatives directed at increasing fundraising among alumni and businesses. The prospective candidate will have affinity with TU Delft, professors and students, experience in fundraising, or commerce/marketing, and be an excellent communicator and public relations manager, both internally and externally, as well as having a practical 'getting things done' attitude. A completed engineering education is preferred. An excellent position for an experienced senior manager, for approximately three days per week. The candidate preferably resides within easy travelling distance to Delft. Interested? Please send an e-mail to: vacature@maeslunau.com stating 'Director UfD'.

Modelling the cyclist



Photo: Tomas van Dijk

The humble bicycle itself has been mathematically modelled, but how about the 160-pounds of meat balancing on top of it? PhD researcher Jodi Kooijman made a first attempt to model the cyclist. Instead of tinkering with formulas, Kooijman chose to first observe cyclists in action on specially-designed bicycles, recording their every motion and gathering data which can be used to verify the models.



Illustration: Rob Roggema

Climate planning

Architecture PhD student, Rob Roggema, has been awarded a Rubicon scholarship by NWO, the science funding organisation, which will allow him to test his ideas on climate-resilient planning over the coming two years. Roggema will conduct his research at RMIT University in Melbourne, Australia, where he will compare the drought in Australia with the rising sea levels in Groningen.. delta.tudelft.nl/25476

Atmosphere contracting

Flight data from the GOCE gravity satellite contains information about the density of the atmosphere's outermost layer. TU Delft researcher, Dr Eelco Doornbos (AE), carried out the analysis. He discovered that the atmosphere, at a height of 270 km, is about 20 percent thinner than expected. This means that satellites are able to remain in their orbits for longer periods of time. delta.tudelft.nl/25522



Photo: ESA

Prosthetic hands

According to scientists at TU Delft's 3mE faculty and at the University of Groningen, the development of so-called body-powered prosthetic hands has stagnated for the past 20 years. The researchers measured the force required to operate a number of present-day prosthetic hands and compared the results with earlier measurements dating from 1987. Their research appeared in the American Journal of Rehabilitation Research and Development. Gerwin Smit (biomechatronics & biorobotics): "The study offers a possible explanation of why over half of all people with a body-powered prosthetic hand do not use it or even wear it." This is currently being researched further in Groningen and Delft. delta.tudelft.nl/25397



Photo: Dipo



Photo: DUT Racing Team

Win for DUT

In early August, the TU Delft student members of the DUT Racing team won the overall classification in the 'electric' category of the Formula Student competition held at the Hockenheim racing circuit. Four hundred universities worldwide took part in the international design competition. The racing cars competed based on various tests, such as an acceleration test and an endurance race. No team – not even DUT Racing's closest competitor, ETH Zurich – could come close to the TU Delft team in the acceleration test. DUT Racing team covered the distance of 75 metres in 3.45 seconds, reaching a top speed of 126 kilometres per hour. It was the highest acceleration rate ever recorded at a Formula Student event.
delta.tudelft.nl/25487

Eight Vidi grants

Driving behaviour, synthetic life, seismic research: this summer, eight TU Delft scientists received Vidi grants worth 800,000 from the Netherlands Organisation for Scientific Research (NWO). Everyone occasionally regrets decisions they have taken, and this is certainly the case for people who are stuck in traffic. Dr Caspar Chorus (TPM) is working on an econometric model ('regret model') that analyses and predicts choice behaviour of people in traffic. Dr Christophe Danelon (Applied Sciences) wants to make artificial life. He is working on an artificial cell containing a minimal set of molecules for the production of proteins. Dr Deyan Draganov (CEG) is working on a technology, called seismic interferometry, which one can use to listen to the Earth's interior noise, as well as for ultrasonic imaging of frescos and paintings on boards. It is a pity for TU Delft that after receiving a Vidi grant, Dr M.A. Marijn van Huis (Applied Sciences), who is working on nanocrystals in aluminium alloys for cars and aeroplanes, decided to transfer to another university. He will continue his research at Utrecht University. Some materials are simply difficult to understand, due to their magnetic atoms interacting in a very complicated way. Dr Sander Otte (Applied Sciences) is working on such complex materials. Dr Maria Santofimia (3mE) will focus her Vidi research on the steel of the future through modifying the microstructures in the metal. Dr Marlies Goorden (Applied Sciences) is trying to make tumours more visible with radioactive tracers. And finally, Dr Martin Pinzger (EEMCS) is working on software with which teams of software developers are able to make clearer changes to...software.
delta.tudelft.nl/25482



Photo: NOAA

Smooth stormy seas

Waves topping 30 meters as wind speeds reach more than 300 kilometres per hour – those were certainly hellish flights the 'hurricane hunters' of the US oceanography research institute NOAA had flown for many years. The flights were suddenly stopped however when water was found to have flooded the engines. Consequently, the footage shot during the flights ended up on a shelf, where it remained for decades. But now this aerial heroism is garnering its just rewards. Fluid mechanical engineer, Dr Leo Holthuijsen, and his colleagues at the faculty of Civil Engineering and Geosciences, and from NOAA, have recently analysed this video footage and data collected at high altitudes using 'drop sondes' and came to the surprising conclusion that, in certain places, the ocean's surface must have been aerodynamically smooth, which contradicts the conventional models that predict an extremely rough surface. The researchers published their findings in September in the Journal of Geophysical Research. Sea foam creates a cover over the waves, whereby the wind, reaching speeds of 300 kilometres or more, rarely disturbs the water's surface. Armed with this valuable insight, research will now focus on improving wave and storm flood models.
delta.tudelft.nl/25621

Manageable debt

Be clear and set out policy over the long term. Keep to the top-sector policy, ensure that universities have sufficient funds even in times of crisis and provide students with long-term clarity concerning their grants and loans. This is a summary of the message to politicians in The Hague by Dirk Jan van den Berg, President of TU Delft's Executive Board, delivered during the opening of TU Delft's academic year on 3 September. If that costs more money than Brussels allows, then so be it. Van den Berg: "I understand the arguments against higher expenditure, but future generations will benefit more from a manageable debt and an active and living economy than from no debt and a backseat economy on the global stage."
www.delta.tudelft.nl/25578



Illustration: Lifetime City

Vertical cities

Two student teams from the faculty of Architecture won the joint first prize in the 'Vertical Cities Asia' international design competition. With their designs 'Open Ended City' and 'Lifetime City', the students made an urban design for a single square kilometre in Yongshan, a district in Seoul, South Korea. The jury found it so difficult to choose a winner that they decided to award both teams joint first place. The competition was organised by the School of Design and Environment of the National University of Singapore (NUS), with financial support from the World Future Foundation.

Delta Magazine and app

Delta, the university newspaper, has become a magazine. The first edition appeared on 30 August, 2012. The reason behind the metamorphosis is the changing media landscape and readership demand: news is spread much more quickly via the website, Twitter and Facebook than via a weekly newspaper. Therefore, alongside the online collection of news, the magazine edition of Delta will provide more in-depth information. With reports, essays and background stories on themes that concern everyone at TU Delft: campus life, remarkable people and projects, and policy matters. Delta can also be downloaded as an app from the App Store (TU Delta). In this way readers can keep up to date with the latest news at TU Delft.

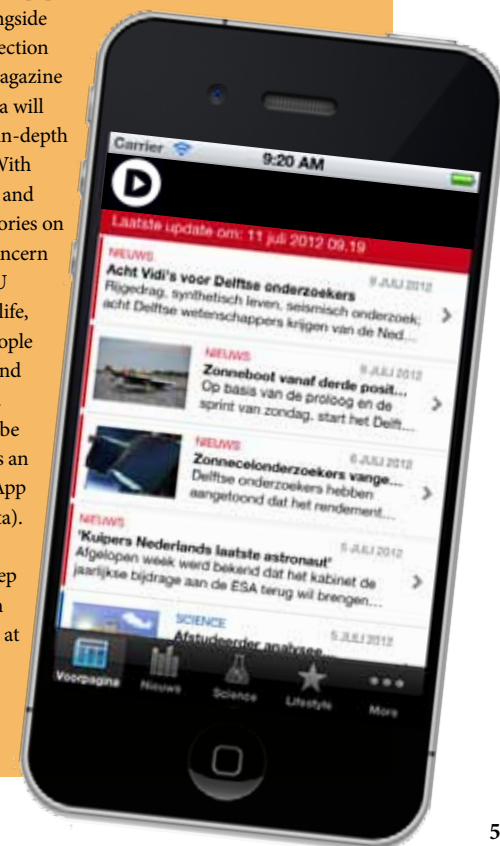


Photo: Tomas van Dijk

6,000 hours gliding

Students of the Delftsche Studenten Aeroclub (DSA) worked for months on TU, a 31 year old Janus C glider. They stripped down all of the aircraft's moving parts and checked every nut and bolt. "The aircraft had already completed 6,000 flying hours, which means that a maintenance programme was compulsory," explains AE student Gregory Spirlet. "TU can now fly for another 6,000 hours." The students, who have nine aircraft at Terlet airport near Arnhem, discussed with the manufacturer how the overhaul should be carried out. A standard protocol did not exist, as the manufacturer never expected that the aircraft would complete so many flying hours.
delta.tudelft.nl/25495

Electricity-generating window

A tinted window that generates electricity when the sun shines on it - Jan Willem Wiegman graduated on this subject this past summer. According to his supervisor, Dr Erik van der Kolk (Applied Sciences), it is possible to achieve an efficiency of 2 to 5 percent with "luminescent solar collectors". Solar panels achieve 15 percent. Wiegman is now looking for an industrial partner.
delta.tudelft.nl/25478



Illustration: Erik Verdult

Spy in a backpack

It must be able to fly in a swarm at great speeds, but also land on a ledge to survey the surroundings for hours at a time. The Atmov is the latest gadget from TU Delft's MAV-lab.

Tomas van Dijk



"Check telemetry, check altitude estimation, check waypoint..." For a moment, on a strip of grass at the Fort Stewart military base in the US state of Georgia, nothing else can be heard other than a tinny robotic voice coming from a computer. Aerospace engineering student, Dieter Castelein, laughs. "The funny

The Atmov crashes near the church

little voice is just a bit of fun," he says. The checklist itself is quite a different matter: forget something and the small aircraft Atmov (autonomous transition multi-rotor observation vehicle) will crash. Atmov is the latest technical creation from

TU Delft's MAV-lab, the micro aerial vehicle lab situated at the faculty of Aerospace Engineering (AE). PhD students and undergraduates work on aircraft that can fly autonomously, recognise and avoid obstacles, and produce images of the surrounding area. Castelein shows a short film that reveals how everything is controlled in minute detail. The Atmov takes off vertically with its wing raised. At a height of a few metres, it rotates forward at 90° and darts off horizontally, doing so almost silently, like a dragonfly. The aircraft has to fly 3 kilometres over a forest and land in a fake village where soldiers imitate an Afghan scene. For three hours, Atmov must remain in front of a church, just beyond the hotel and the football ground, observing - making video recordings - before flying back again. This was the assignment that DARPA (the

research institute of the US Army) gave to nine TU Delft aerospace engineering BSc students, and to nine other international student teams. Last May, the students had two weeks to demonstrate that they had developed the ultimate small spy plane: an aircraft that could fit in a backpack. The majority of machines taking part, including the Atmov, are of the quadcopter type, an aircraft with four motors that can take off vertically. But whereas the other quadcopters are only able to hover and slowly travel in this mode to their final destination, the Atmov does something special: it first hovers upwards before flying off like an aeroplane. "This allows us to fly much more efficiently and quickly," explains Castelein's colleague, Sander Hulsman. "The other aircraft fly to the village at 20 kilometres per hour, whereas we >>



Photomontage: Sam Rentmeester

Photomontage of the TU Delft campus with Atmov. On the left page: Swarm UAV.

fly at 70 kilometres per hour. We are also able to remain in the air for much longer.”

Duct tape

The students watch elatedly as the aircraft disappears from view. It is their third attempt. The aircraft appears to be well-programmed, flying to the village completely unassisted. “Still flying”, “doing good” are the occasional messages coming through the walkie-talkie used to keep in contact with the tracking car. At the church, the Atmov crashes. The

scary,” Hulsman adds. “Everyone took a step backwards when it took off. It weighed some 5 kilos and made a racket just like a real aeroplane. The pilot had beads of sweat on his forehead trying to keep it under control. But it crashed almost immediately, because the rotors weren’t correctly aligned and they struck each other.”

The greatest challenge for the majority of teams is communicating with the aircraft. Contact with the ground station is crucial even for many of the autonomously operating aircraft (or rather semi-autonomous aircraft), because flight calculations are made by a computer on the ground. But most of the participants lose contact due to all the trees blocking the route. One aircraft after another ends up crashing.

Atmov, however, does fly completely autonomously and is therefore unaffected by the trees. What does trouble the TU Delft students is the calibration of the motors. On the final day, the aircraft again crashes in the village. Another Atmov that the students sent up simultaneously – somewhat as a joke – disappears into a lake and has to be fished out by a fisherman. The only explanation the boys can think of for the crash is that the Atmov had an argument with a vulture. The TU Delft students finish tied for third place. The winner was a team from Middlesex University (UK) whose aircraft had six rotor blades.

Matchbox

Bart Remes, Project Manager of the MAV-lab, has great expectations for the Atmov, especially for projects in the open air. The most well-known aircraft from the lab is the wing-flapping micro aircraft, Delfly. Work on Delfly started in 2005, and the aircraft has become so miniaturised over the years that it now fits inside a matchbox. It can fly through small openings and therefore reach places where nothing or no one else could reach, which, for example, is useful for searching for victims in collapsed buildings.

In the open air, however, the Delfly is not in its element, as it cannot deal with wind. In such cases, an aircraft like Atmov offers greater possibilities. In time, Remes hopes to use this aircraft’s flying technique in many of his projects.

“Atmov is the future,” he says. “You can station these aircraft at a loading station and with a push of a button let them take off as a swarm to carry out reconnaissance missions. The aircraft that are presently being experimented with for swarm flights have to be individually catapulted into the air with elastic.”

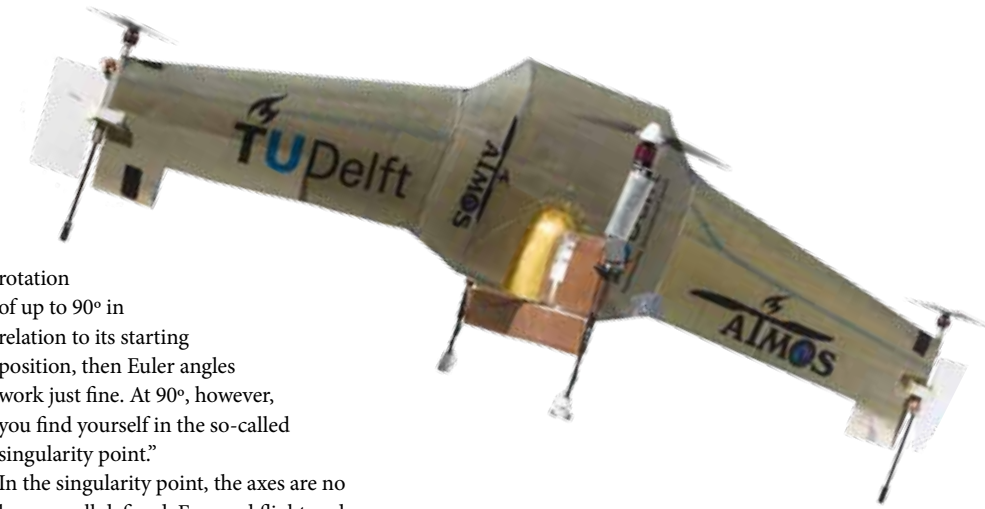
One of the running ‘swarm projects’ Remes refers to is the FireSwarm project, the concept of which involves a group of aircraft equipped with heat sensors that go in search of heathland fires. Remes: “The aircraft know each other’s position and agree upon the

direction each will take to investigate further. Initial tests have recently been carried out with the Woensdrecht fire brigade.”

Remes wants to utilise the same technique to deploy a swarm of autonomous aircraft to monitor ships in the vicinity of ports. The detection of illegal oil dumping is one of the key objectives of this so-called 3I-project (an acronym for Integrated Coastal Zone Management via Increased situational awareness through Innovations on Unmanned Aircraft Systems).

This European research project is being coordinated by Remes and his colleague, Dr Erik-Jan van Kampen, and, in addition to TU Delft, includes the French, British and Dutch port authorities and the universities of Southampton and Brest. Earlier this year, the EU granted this consortium 1.85 million euros.

There are, therefore, many possible applications for Atmov, but for now it is dealing with teething problems. This in itself is hardly surprising, as the students only devised Atmov at the beginning of the year and worked out the concept as part of the so-called AE Design Synthesis exercise. Over



rotation of up to 90° in relation to its starting position, then Euler angles work just fine. At 90°, however, you find yourself in the so-called singularity point.” In the singularity point, the axes are no longer well defined. Forward flight and backward flight are then written in the same way. Castelein: “If that point is reached, your aircraft will go completely crazy.” The students had to employ a different mathematical method: the quaternions. “Through this method, you can turn 360° without any problem,” Castelein confirms. “However, quaternions have never been used before in the open source autopilot paparazzi [the type of autopilot used by the

What kind of improvements should one be thinking of? The further miniaturisation of the electronics, for example. To illustrate this, Remes shows the Delfly’s Inertial Measurement Unit (IMU), the system that measures velocity, orientation and gravitational forces. It is barely a centimetre in size.

Most of all, the students themselves would like to see improvements in the aerodynamic design, landing gear, and autopilot software, as well as a lighter composite construction. And who knows, perhaps Atmov can learn from Delfly how to react when encountering an obstacle, such as a vulture.

‘If that point is reached, your aircraft will go completely crazy’

the course of ten weeks, the students must demonstrate in this exercise that they are capable of applying their knowledge as a team to create a design. The Delfly also resulted from a similar student project.

The clever thing about Atmov is that it can turn 90° in the air fully automatically: a meticulous manoeuvre that involves gradually changing from a hovering position to a horizontal flying position. The hovering position uses a different set of propellers than Atmov does for horizontal flight. Castelein: “There are more aircraft that can simultaneously hover and fly horizontally, but they do so far less efficiently. With these aircraft it’s actually the motors that turn 90°. That’s not very practical, seeing that hovering requires a different type of propeller than horizontal flight, owing to the fact that airflow speed varies greatly in both cases.”

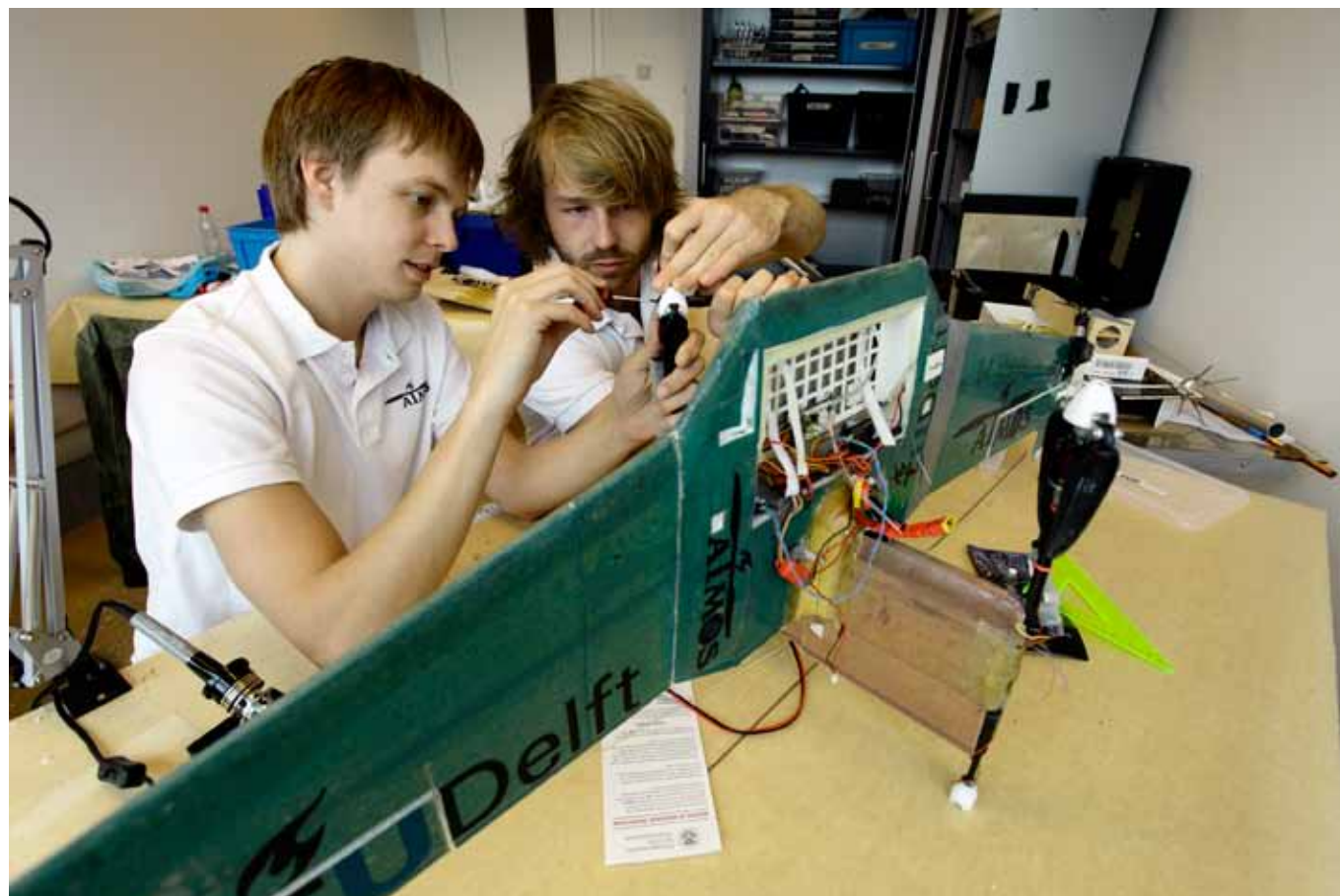
New mathematics

In order to enable the aircraft to make the transition from one propulsion program to the other, the students had to develop a completely new automatic pilot. The standard mathematical method behind autopilots makes use of so-called Euler angles. Hulsman: “If your aircraft makes a

MAV-lab, ed.]. We had to rewrite everything.” In coming years, Remes wants to use the knowledge gained with other aircraft to improve Atmov. He has submitted a grant application to STW. The project has to develop, just as it did seven years ago with Delfly. Today, five PhD students and a dozen undergraduates are working on Delfly.



Project manager Bart Remes (here with Delfly): “Atmov is the future.”



Students are working on Atmov.

'The best people leave to go abroad'

The last six months have been rather crazy for Professor Leo van Kouwenhoven (Applied Sciences). Ever since he first reported in late February that he had detected something that resembled the Majorana fermion, an elementary particle that was first predicted in 1937, his telephone has not stopped ringing.

Jos Wassink

You started your search for Majorana fermions in the summer of 2010. When did you think for the first time: 'Yes! We've found it!'?

"Actually in December, around Christmas 2011. I was sitting behind the computer with Kun [Zuo, ed.] and Vincent [Mourik, ed.]. The first peak that we had at the time ultimately turned out not to be a Majorana peak. But it did come later. It wasn't really a eureka moment, though. The signal that you receive from the Majorana isn't very specific. This means that you have to test that peak for all sorts of properties, in order to exclude other things, until you have made a reasonable case for it being a Majorana."

The first time you spoke about it was on the Caribbean Virgin Islands in February. What kind of meeting was that?

"The meeting was organised and hosted by the Simons Foundation, set up by Jim Simons, a mathematician whom I've never met but who has made an enormous amount of money on the stock exchange with mathematical sales tricks. He wants to put some of that money back into science, and especially into the mathematically oriented sciences. He wants to do something exclusive, so he invites extraordinary people to come to unusual places - that can be the North Pole or the Virgin Islands - so that in this way they might generate novel, revolutionary ideas."

Was Michael Freedman (an American mathematician with the Microsoft research group at the University of California) also present?

"He was also there, as well as people from Israel, from the Weizman Institute, and people from Harvard. Last week I heard

by chance that the man from Israel, Ady Stern, immediately went and informed his laboratory and then set to work straight away also attempting to detect Majorana fermions. They posted the results on arXiv.org. They're the first to have replicated us. He broadcast the news everywhere, which wasn't really the intention."

Was that meeting supposed to be confidential?

"To some degree, yes. I presented it as a preliminary result, in order to hear their views, advice and criticisms. Simply to see how the news would go down."

And how did it go down?

"It went down very well with some people, while others were only mildly enthusiastic. But the effect was that not only Ady Stern went on to talk about it, but also others here and there as well. So when, a few weeks later, I arrived at the March meeting [of the American Physical Society, ed.], the news was making the rounds and everyone knew that something was going to happen."

It was posted straight away on the Nature website.

"Within an hour. It happened very quickly."

What was it like when you arrived back in the Netherlands?

"When I returned, the initial furore had already died down. The first articles had appeared in de Volkskrant and NRC newspapers. Requests for all sorts of programmes came in. But we continued to give the same answer: we're very sorry, but we don't have a manuscript yet. Please wait until it has been published."

Then came the publication in Science?

"We received assistance from TU Delft public relations officer, Michel van Baal, who ensured everything was coordinated and channelled properly. After that it actually became hectic again, but now I was able to talk about it myself. It was also time to say something."

Dutch Prime Minister Mark Rutte felt that you deserved the Nobel Prize.

"He's just repeating someone else, I suppose."

What effect does such a remark have on you?

"Ah, well...not much. After all, what does Mr Rutte actually know about it? What I have enjoyed though since then is that I've met a number of people, including people from the Ministry of Education, Culture and Science - including State Secretary Zijlstra on multiple occasions. So that's all very nice, but having people say those sorts of things is a little bit embarrassing, because that's still a long way off. This takes many years. Moreover, it's not at all certain. It is looking good, and although we are convinced, that still doesn't count for the scientific community, which has only known about it for a month now. So, they still have all sorts of questions and criticisms, and will be doing verification experiments and so on. You'll first need to survive all that before it really starts to take shape."

In all the media furore, there were two messages: a stable qubit and a new elementary particle.

However, during a meeting of the Royal Netherlands Academy of Arts and Sciences in June, I also sensed a certain envy among particle physicists who themselves have been searching for >>



Photo: Sam Rentmeester

'I presented it as a preliminary result, in order to hear their views, advice and criticisms'

Majoranas for some time.

"I'm not sure about envy. They're working within that specialisation on elementary particles. Our specialisation - solid state physics - works with a collective particle that's sometimes called a quasi-particle. But I think that 'quasi-particle' is a rather unfortunate name in this context. 'Collective particle' seems a more suitable name to me. The behaviour stems from the collective behaviour of many other particles, just as the wave in a stadium is a single entity, resulting from the behaviour of thousands of spectators in the stands. Such a collective particle, however, can be extremely stable, comparable with, or even more so, than many of those elementary particles. Therefore, the neutrino particles that are also considered candidates for Majoranas are certainly not more stable than our Majorana. The question more or less is: what is a particle?"

They have a detector in a mountain in Switzerland and they wait until one naturally comes along. I got the impression that they thought differently about creating your own Majorana.

"An interesting discussion about this issue is taking place. They say: your Majorana is not elementary. I say: in that case neither

are neutrinos, as they also oscillate between different states. That's precisely what we have here: a particle that oscillates between different states."

So for you, the naturally occurring Majorana, and the Majorana in the cryostat, are not two separate things?

"They are two separate manifestations. It's clear that our Majorana occurs in a well-defined material system, in which it also remains. What's so significant in high-energy physics is that Majoranas are possible particles that can also explain dark matter. If that's actually the case, then of course it's extremely significant. Just suppose that we're able to produce a qubit, then that would also be extremely significant. But these are two different and quite separate manifestations."

Two manifestations of what precisely?

"Of the same formula: particle = antiparticle. The manifestations are quite different, but the solution lies in those Dirac equations. Both are a solution of the Dirac equation. We're searching for solutions in quite different areas. The origin, however, is the same."

I understand that you want to manipulate, mobilise and exchange the Majoranas. Those



Who is Leo Kouwenhoven?

Prof. Leo Kouwenhoven (Pijnacker 1963) studied applied physics at TU Delft and got his PhD degree cum laude in 1992. He is the group leader of the 'quantum transport group' (faculty of Applied Sciences) and program leader of the Dutch concentration group on 'Solid state quantum information processes' a ten-year national program sponsored by the Dutch National Science Foundation (FOM). He received the Spinoza Award (2007) awarded by NWO to outstanding, pioneering and inspiring scientific work and the Leermeeester prijs 2008, awarded to a TU Delft professor whose record of teaching and research excellence serve as a source of inspiration to students and PhD researchers alike.

kinds of operations.

"We have found evidence of the existence of the Majoranas, but we still do not have any information concerning their characteristics. As it's such a unique quantum particle, we also want to measure its characteristics. Only then can we say that we have a Majorana fermion. If you're still thinking about the Nobel Prize, it's essential to demonstrate those characteristics before you'll ever even be considered for it."

How many years do you think it will take to demonstrate that?

"About two or three years."

Just to come back to your visit to Prime Minister Rutte. Do you have a message for him concerning the importance of fundamental research?

"Yes, absolutely, and this is that all things we now consider to be important technology, such as the iPhone and the internet, do not come about through a policy like the top-sector policy. Those are things that have actually been developed by creative people who cannot be placed in an organisational chart for research. The most important discoveries are not the result of incremental research, but of free and curiosity-driven research. Take graphene or nanotechnology, for example. In addition, you need to have incremental, planned research in order to translate this into products."

But it doesn't lead to many surprises?

"Not often. Applied and free research should be evenly balanced. At present, about one-third of the budget from the Netherlands Organisation for Scientific Research is structurally transferred to top-sector policy areas, but that amounts to 80 to 90 percent of the freely disposable budget. That's astounding, or at least drastic for curiosity-driven research. I think that the best people choose to do that sort of research elsewhere."

Do you see that happening?

"Yes, people go to the United States, Germany, Switzerland, Denmark, and these days even to the UK. The climate for curiosity-driven research is a lot more favourable there. They don't offer twice as much for a good idea, but something of a different order of magnitude. Therefore, not 100,000 but rather a million to set up a new lab. There's simply no comparison."

What's keeping you here?

"I've been able to build my group gradually over the past years, which means that I'm now in a good position. I don't need that much more because I already have so much. And, moreover, I have ties with Microsoft that provide me with freedom of research. So I can't complain. Far from it."

Imago

Ir. Remco de Boer is a technology & science communication specialist.

Actually, it's a miracle that there are still young people who want to study technology, because engineers have a negative image. There is hardly an article about the profession in which that is not mentioned, and this view has become so ingrained that people no longer even go to the trouble of actually proving the claim. But even more striking than the ease with which it is said, is who says it. Strangely enough, this is almost always people who have their own interests at heart. The leading advocate in this is Ed Nijpels, chairman of NLEngineers. Since taking office in 2008, Nijpels has never missed an opportunity to stress the negative image: that engineers should show more courage and nerve; that engineers should receive more recognition; that engineers should be more visible. So time after time, he presents a negative image of engineers.



Photo: Sam Rentmeester

The sector was also convinced of that negative image in Belgium, until last year, that is, when the Randstad employment agency examined the appeal of 112 professions. You can guess which profession came out on top with 75.4 per cent. Precisely. Three out of four of those people questioned would recommend becoming an engineer to friends or children. "The lack of interest among young people for technology is therefore not due to a negative image," the researchers concluded. In a recent interview in Technisch Weekblad, Nijpels said he was unable to explain the difference with the Netherlands. Well, I can: there is no difference. The opinion of the Dutch regarding engineers is not radically different to the Belgians'. The negative image is a myth that is being maintained – unintentionally – by the sector itself, in order to explain why more young people are studying law and economics than technology. But there may be many causes for this. Certainly one of these is the continuous stigmatisation: if you repeat that something has a negative image often enough, in time it will also acquire one. Therefore, when the Dutch Labour Party (PvdA) decided in June to put their oar in

by advocating free technical education, it was time for a public response. And so I was given the opportunity to explain to the 600,000 Radio 1 listeners that if you differentiate technology, it actually works counterproductively. That by doing so, you are signalling that it is something quite different from 'normal' studies. That there is apparently also something wrong with it. But, above all, I said that technical studies form a very broad basis, which opens up a whole range of prospects, also outside of technology, and that there is a suitable technical study at almost every level and that career opportunities for engineers are excellent at present and will only get better in coming years. Let this be the message we pass on from now on. And if, at the same time, we could ban the word 'image', you might be surprised to see how many first-year students are knocking at the door next year.



Under construction



Photo: Sam Rentmeester

Students of the minor automotive design (faculty of Industrial Design Engineering) work on cars made of pvc pipes, tie wraps and duct tape. The minor aims to develop skills like design drawing, clay modeling and prototyping.

Housing subsidence

Subsidence is inevitable during excavation work. Although not resulting in large-scale damage, the effects of the construction of the railway tunnel in Delft are certainly evident. Data comparison from ESA radar satellites over an extended period show changes from -2 millimetres (blue) to +2 millimetres (red) each year. The yellow/green dots show minimal change. The changes are greatest adjacent to the railway tunnel. Houses on Spoorsingel are moving one way (red) and houses on Engelsestraat the other way (blue). Remote-sensing specialist, Professor Ramon Hanssen (Civil Engineering and Geosciences), sees that the houses are tilting towards the tunnel basin and believes this is caused by water abstraction for the construction work. He would however like to stress that the movement is minimal.

Satellite data: TU Delft in collaboration with www.hansjebrinker.com

Juggling

Millions of people saw how seven immense, smoking chimneys rose up out of the ground during the opening ceremony of the Olympic Games in London. Made by Inventeq.



TU Delft alumnus, Edwin van Sorge, set up Inventeq in late 2009 with Peter McKenzie, a South African performance artist. The two knew each other from a joint performance in India, where they juggled with glowsticks. In 2009, they juggled together once again, but then as part of the DJ Tiësto tour. McKenzie's nickname is 'the spanner', a moniker he picked up during his travels, when he became increasingly involved with the technical side of the entertainment industry. Van Sorge (26) meanwhile had completed a BSc in Mechanical Engineering and was following the MSc programme Management of Technology.

When having to come up with an idea for the course 'writing a business plan', his hobbies of juggling and walking on stilts converged with both of his studies. Together with McKenzie he started Inventeq, which builds machines for the entertainment industry, ranging from constructions that allow people to fly, to a collapsible shoe for an illusionist, and from seven 800-kilogram machines for the Olympic Games, to LED glowsticks for juggling that can assume all sorts of colours. Inventeq also built an aerial, LED-lit swing that has hung in various discos in the Netherlands and Belgium. The company also made flame throwers and a construction on which various bungee jumpers can perform a show simultaneously.

"We're seasoned experts, and we often build a whole show around a machine," explains Van Sorge. McKenzie was one of the bungee jumpers on the aerial platform, and both he and Van Sorge travel with their products, in order to ensure they are installed safely. Inventeq is presently working on a show with a violinist who is able to hang in a large ring.

Inventeq still consists of two employees and occasionally an internship student. Although they regularly outsource work, they must be familiar with all the various fields. It is no coincidence that Van Sorge works 60 to 70 hours per week.

In their office in a Haarlem business park, there are computers with expensive software for designing machines, an electronics workshop for soldering, and a large workshop for milling and welding. Van Sorge and McKenzie are both able to do the work themselves.

Van Sorge relates how his partner is able to design complete machines purely based on his years of experience, despite never having been to university: "In order to design, you must have a lot of experience. You have to learn what works and what doesn't. But Peter does come to me for the calculations." Van Sorge, who is also quite at home with the business operational aspects, recalls that Inventeq reached the break-even point back in 2010. Back then, he and his partner kept their heads above water by performing occasionally. Now the company has an annual turnover of 300,000 euros. "I want to consolidate," Van Sorge says. "You're either racing around or standing still. Through renting out our machines, we hope to achieve more structure. It's also nice to make large, customised strange things on the side." Within five years, Van Sorge hopes to have a number of employees working for them. (SB)

Insiders en outsiders

What will the housing market look like in 30 years' time? According to Peter Boelhouwer, professor of housing systems and director of the OTB Research Institute for the Built Environment, there is much to be positive about, such as, for example, renewed movement between the rental and owner-occupied sectors and from starter homes to more expensive houses, and that plenty of homes will be built of the right type and in the right locations to meet demand, and that the government has stopped keeping rents artificially low, and that – yes indeed – mortgage interest relief has been done away with.

It is not so much this utopian image that Prof. Boelhouwer finds interesting, but rather the question of how it will be achieved. The experts are in agreement, however. The Council for Housing, Spatial Planning and the Environment (VROM-raad), which advises the government on these issues and of which Boelhouwer was a member for five years, published a report back in 2007, titled 'Time to make choices'. Politicians however do their utmost to avoid making those choices.

The coming two or three years will be crucial, Prof. Boelhouwer says. While we are busy working on surviving the economic crisis, the housing market must nevertheless be organised for the long term. "We need to provide far fewer subsidies," the professor says. "At present, 25 to 30 billion euros is spent each year on subsidies, such as mortgage interest relief and housing benefits, even though they divide the housing market."

Prof. Boelhouwer often uses the ladder metaphor: the ideal housing market contains all the rungs on the ladder, enabling a tenant to climb to the purchase of a starter home, then on to a more expensive family home, and subsequently to a city apartment. "But now the ladder is missing a few rungs," he warns, "making it impossible to climb higher up."

Prof. Boelhouwer would like to strengthen the position of outsiders in the housing market in relation to insiders [home owners, ed.], and reduce the discrepancy between tenants and purchasers. For these two latter cases, a combined system of subsidies should be implemented, but then only for those people who

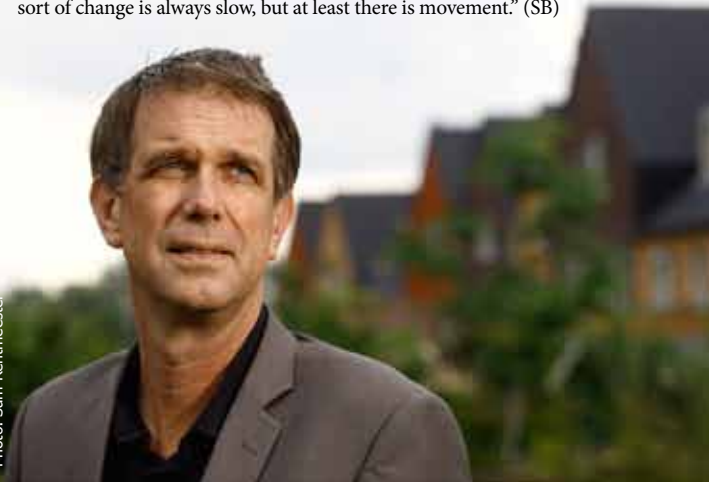
'We need to provide far fewer subsidies'

really need support. Moreover, the discrepancy between the insiders in the owner-occupied housing market and those people who want to enter it, but for whom the threshold to purchase is too high, is counterproductive. Stronger still, at present everyone has the same interests. "Now, in times of crisis, many insiders have a big problem," Prof. Boelhouwer surmises. "They see the value of their homes decreasing, but there are no buyers for them. If you help the outsiders, then you help the insiders."

If the market is to be helped out of its plight, far more houses need to be built. "Each year the shortage increases. Hundreds of thousands of people are forced to remain living with their parents, or live in 'anti-squats' or on camp sites," the professor explains, adding that the price of building land also needs to drop now that house prices are falling. "In itself, the present system is a good one. The price of land is based on the value of what is on it. House prices have fallen by 15 percent, so really the price of building ground should be reduced by 40 percent."

This means quite a few obstacles must still be removed, which could take years. Prof. Boelhouwer is nevertheless reasonably optimistic: "This sort of change is always slow, but at least there is movement." (SB)

Photo: Sam Rentmeester



Aeroplane salesman



His dream was to become a jet fighter pilot, but a pair of glasses put an end to that. Instead, Guido Kerbusch went on to sell aeroplanes for Airbus in Dubai.

As a child, Guido Kerbusch lived under the approach path to Maastricht airport. Each time an aeroplane flew over, he would run outside to see what type of aircraft it was. But because of his poor eyesight, he could not fulfil his dream of becoming a jet-fighter pilot; however, becoming an aeroplane designer was an acceptable alternative.

He started studying Aerospace Engineering at TU Delft in 1996, the year that Fokker went bankrupt. Kerbusch: "Are you sure you want to do that, people said to me. There's surely no future left in it?"

Kerbusch nevertheless persevered and graduated in November 2003 on a draft design for a flying boat: "After six months of unsuccessfully applying for work, I thought: I'll write an unsolicited letter to Airbus in Germany, France, the UK and Spain."

His letter landed on the desk of a fellow student at the Hamburg branch, who informed him that someone was leaving. Kerbusch went for an interview. The good name of TU Delft helped: he got a job with the component-support department that provides services to all Airbus customers worldwide. "An expanding business," he says. "Many components are sold to airline companies." Kerbusch travelled to Jordan, Italy, the Philippines, Hong Kong, Chile and the United States, but after two years of this he had had enough: "I spent a great deal of time travelling." At the time, a new vice-president had started at Airbus who was looking for an assistant. "I was asked to have a talk with him, and that's how I ended up on the management side," Kerbusch recalls. "I learned an enormous amount about management, project organisation, reorganisation, personnel management and finances. Very intensive, but good for my experience and network at Airbus."

After three years, Kerbusch wanted to return to working with customers and the product. He moved to Dubai for a position in the sales department. Kerbusch: "Dubai is pleasant. Very international. At every meeting with friends or customers, there are at least ten different nationalities around the table." After going on to sell aeroplanes in Saudi Arabia, the United Arab Emirates, Kuwait and Pakistan, Kerbusch has been material director for Airbus Middle East since the start of this year. He ensures that the airlines have the right components at the right place at the right time. "An exciting job: if an A380 is grounded somewhere waiting for a component, then 500 passengers have to be put up in a hotel," he says.

Now and then, when thinking about Dubai, Kerbusch thinks: where have I ended up? "But that's the way things go. If you're receptive to something, it just comes to you." And his pilot's licence? That is something he still wants to get some day, now that he has had his eyes laser-treated: "Wanting to fly, that'll never change." (CvU)

Colonising Mars

Space rover Curiosity landed unscathed on the surface of Mars, reported d e Volkskrant newspaper on 6 August. Is this the beginning of a colonisation?

Dean Professor Jacco Hoekstra (Aerospace Engineering) compares the journey to Mars with the crossing of the Atlantic Ocean in the 15th century: a perilous undertaking that over time gradually became increasingly common. The first colonists who populated the Americas arrived not long after Columbus. Why should this be different with Mars? The most distinct ideas concerning a Mars colony come from TU Delft alumnus, Bas Lansdorp, and his colleagues at Mars One. They want to organise the colonisation of Mars in the form of a reality show, which would cover the costs of the operation. The first extraterrestrial settlement is scheduled for 2023.

Prof. Hoekstra believes that the first manned mission to Mars is not so much dependent on technical developments but rather on social ones. "People are already objecting to the Curiosity mission, even though the costs involved are comparable with a single day of war in Afghanistan." Prof. Hoekstra is following the Mars mission with great interest. "It wouldn't surprise me if there has already been life on Mars," he says, adding that indications of this are the seasonal methane clouds that were detected on the planet. "They could have a volcanic origin, but the seasonality points more towards a biological origin."

The professor believes that life occurred earlier on Mars than on Earth because the Red Planet cooled off half a billion years earlier. Bacterial life would have spread from Mars to Earth by means of meteorite impacts. Those who find this far-fetched should consider that space debris from Mars travels towards the sun and intersects with the Earth's path. Each year, 500 kilograms of material from Mars continues to fall on Earth in the form of dust and meteorites.

"I sometimes say, maybe we are Martians ourselves," Prof.

'Maybe we are Martians ourselves'

Hoekstra adds. The theory that life from Mars developed further on Earth is supported by the accelerated development of life so shortly after the cooling down process, and by the fact that the oldest bacteria on Earth, the Archaea, are immune to cosmic radiation and meteorite impacts. If they had indeed originated in a pool on Earth, the mystery is why they have those qualities, but this is not the case if they had originated elsewhere.

Prof. Hoekstra is curious whether the DNA of possible life on Mars fits in with the genealogy on Earth. That would add significant pieces to the great puzzle of our origin. According to the professor, the first people to land on Mars should therefore be researchers who would go in search of Martian fossils and their genes. (JW)

Devilish dilemmas

To receive funding for research, universities must collaborate more with private companies. How will this affect confidence in science? Are research results still actually reliable if the research is financed by companies?

Connie van Uffelen

During his first week as Director of Research at the Netherlands Cancer Institute-Antoni van Leeuwenhoek Hospital, Professor Piet Borst was presented with a contract for research into a new medication. Being as diligent as he was, he discovered in the small print a stipulation stating that industry could decide that the research results would not be published.

Prof. Borst demanded that the stipulation be removed, otherwise he would not sign the contract. "That caused great commotion," he recalls. "This was in 1983, when it was quite normal for every contract between industry and academic institutions to contain strict provisions restricting publication rights." Prof. Borst found it inconceivable and encountered enormous resistance among colleagues. "The doctors said: 'Come on Piet, what are you worried about? Everyone is doing it. They're decent people we're collaborating with: they're really not going to impede us when it comes to publishing.' I thought: 'Well, in that case, why not scrap that provision?' It took months to sort it out." By this, the now 77-year-old professor, who

still works in the lab, simply wants to say that if you dig your heels in, industry will eventually capitulate. "The last 30 years have seen drastic changes on this issue. It might still occur occasionally in the Netherlands, but not in the US, I believe. Nowadays, it's treated far more professionally within academic institutions."

Distrust

And yet a great deal of distrust still exists when science and industry are combined. The 2010 Eurobarometer survey of public opinion regarding science and technology indicates that some 60 percent of Dutch people feel that scientists can no longer be trusted because they have become too dependent on industry. Moreover, 50 percent are wary of the involvement of private funding in scientific research, as this would result in a tainted image.

"It's the perpetual story facing fundamental research," says Martin van Pernis. As the former chairman of the board of Siemens Netherlands, he was invited to become chairman of TU Delft's Conflict of Interest

Committee (see box). "There's a remarkable *idée fixe* that there's a major difference between targeted development and fundamental research, but the one cannot exist without the other," he says. "I'm not at all afraid that bringing in more private funding will mean there will be less fundamental research."

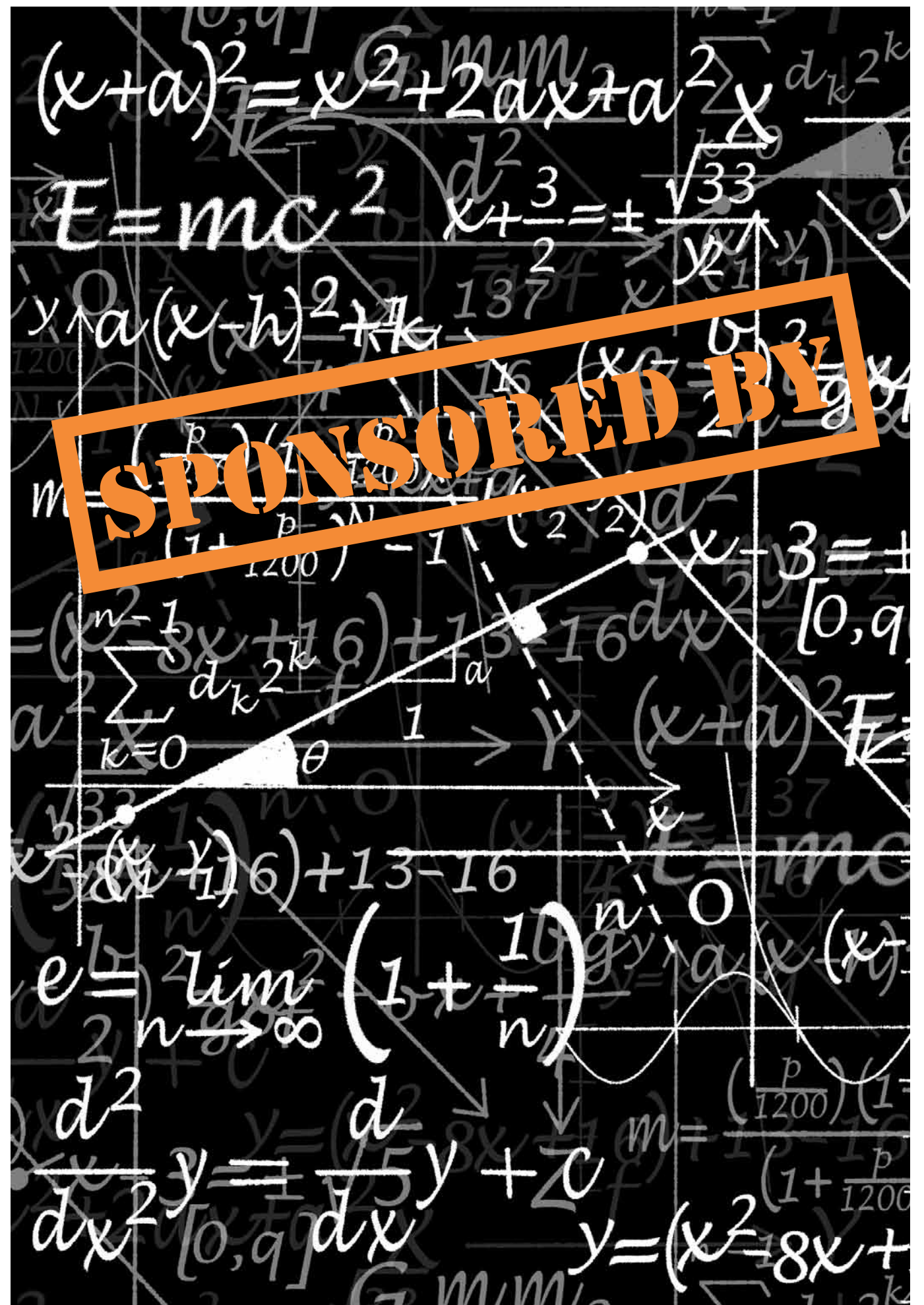
According to Van Pernis, Germans are far more technology-minded. "In Wolfsburg, there's an enormous Volkswagen complex. One in five Germans has a new car delivered there, and the whole family goes to pick it up. There's a hotel included, and they are given a guided tour of a Volkswagen museum. In this way, you generate a huge attachment to that technology."

Van Pernis does not believe that the Netherlands is such an industrial country. "We're no longer able to get a real picture of industry," he says. "You're more likely to distrust something you don't know about, which is why companies should communicate much more. On the other hand, scientists shouldn't claim that they've lost their freedom when a company gets involved. Nonsense."

Prof. Borst points out that in a large number of research studies it has been established that industry-funded medicine trials delivered more positive results than when the research was funded by public money. "That doesn't mean that industry is out trying to con anyone," he says, "it's just a natural inclination to think your own product is better than it is." Dependency

The friction is not only there with industry.

'The scientist is the one who announces the research results'



‘Sixty percent of Dutch people feel that scientists can no longer be trusted because they have become too dependent on the industry’

“All policy research in the Netherlands is heavily dependent on government commissions,” Prof. Borst explains. “And government is no better than industry, because government is often only looking to justify the decisions it has taken or is planning to take.”

Impossible

This was apparent in a 2010 study into political decision-making regarding Amsterdam Airport Schiphol. TU Delft’s Menno Huys and Dr Jan Anne Annema concluded that the Ministry of Transport, Public Works and Water Management had repeatedly “prevented, selectively rewritten or selectively used” disagreeable research results on the effects of growth at Schiphol. Eight years prior to this, TU Delft’s Professor Guus Berkhout had resigned as chairman of a commission investigating the noise pollution around Schiphol. The professor felt that the then State Secretary had made it impossible for him to continue his work independently. “An example of an upright person who says that if you let yourself be bullied by ministerial funding it will lead to scientific judgement being compromised,” says Jeroen van den Hoven, a professor of ethics and

chairman of the Scientific and Academic Integrity Committee at TU Delft. Sincerity is the only way to win over trust, according to Prof. Van den Hoven. “Transparency. Show that you’re really trying to do the right thing. This is something we’ve now made a start on at TU Delft by making secondary employment activities public.” The Netherlands Cancer Institute applies the principle that doctors may never serve as consultants for pharmaceutical companies, Prof. Borst says. “And, in my day, if it were necessary for the basic research, the money that was paid for this went back into the institute.”

Dependency

It is important for the university that knowledge be used effectively, says Paul Althuis, of the TU Delft Valorisation Centre: “That’s what we’re judged on. It’s true that a degree of dependency is involved towards another party, but that’s actually no different to what has been occurring for many years now. Industry has always been on the lookout for interesting knowledge.” Althuis does not share the concern expressed in the Eurobarometer survey. He does not believe industry determines what the

universities must do. “You can stand up for yourself,” he says. “You can also say: ‘We’re not going to do it. That’s an important fact.’”

Agreements

Therefore, according to Althuis, no problems should arise at all, as long as clear agreements are made with the companies. For this, TU Delft applies the Guideline for Contract Activities. One of the principles in the guideline is the Netherlands Code of Conduct for Scientific Practice of the Association of Universities in the Netherlands, which is now being tightened as a result of the research fraud committed by ex-professor of social psychology, Diederik Stapel.

The code of conduct contains five principles: meticulousness, reliability, verifiability, impartiality and independence. The code of conduct prescribes that scientists perform their work in academic freedom and independence. And moreover states: “the hypothesis is scientifically interesting, not only with regards to the specific interests of the commissioning party. The method employed is scientifically responsible. The commissioning party has no influence whatsoever over the research results.” According to the code of conduct, assignments must contribute demonstrably to scientific education and research. “It is always clear who the commissioning party is of a scientific activity, what the relationship is between the executor and the commissioning party, and whether possible advisory roles or other connections exist. The publication of scientific research results is safeguarded.” The code of conduct poses a number of dilemmas to stimulate discussion. For example: how much influence can a commissioning party have on the hypothesis of a study? And on the proposed method of approach? Can a commissioning party adjust the execution of the research and if so when? Or during the reporting?

When it concerns the hypothesis, Prof. Van den Hoven believes the situation is clear: the commissioning party wants to know what is going on and is therefore principally responsible. “We, on the other hand, must ensure, of course, that we carry out real contract research, with the emphasis on research,” he explains. “That’s why commissioning parties specifically come to us: it’s about how research is actually conducted. After all, that’s something we’re experts in.”

The way in which reporting is done is also down to the university, Prof. Van den Hoven says: “The scientist is the one who announces



Volkswagen in Wolfsburg (Germany). According to Martin van Pernis, German people are more technology minded.

the research results. The moment you start watering things down is the moment you cut into the very core of your own credibility.” How then can you prevent a company from influencing results when it is paying a PhD student? Van Pernis remains unconvinced: “In that case, you don’t have to conduct the research. This might be the impression one has of the corporate community, but that’s of no use to anyone. Typically Dutch: everything done by business must be tainted. Just take a look at the traffic sign indicating an industrial area: it shows a smelly, smoking factory. We’re making it very clear that we don’t actually think much of industry.”

Integrity

Van Pernis allows students to contribute to the improvement of a product or technology, under the agreement that the company pays for their studies and subsequently hires them to continue further. “The terms would have to be agreed upon with the universities in question,” he says. “It would then depend on the individual’s integrity and his or her environment whether everything is done above board.” Prof. Van den Hoven has experienced in a situation in which a PhD student was on a company’s part-time payroll and the company subsequently compelled the student to do all sorts of odd jobs. “That’s not in the student’s interest,” says the ethics professor. “In which case, I would pull the plug on it and find another way of paying the PhD student.”

‘Government is no better than industry’

The scientific interest always takes precedence in the impartiality principle, argues the Netherlands Code of Conduct for Scientific Practice. Dilemma: what should be done if researchers would like to make money on a patent that requires further research to be conducted within their own institution? Is this acceptable or should an independent body (a limited company or something similar) be established?

“If they want to make money purely for themselves, I’d say: that mustn’t take place within TU Delft,” says Prof. Van den Hoven. “Then you should do it via a start-up or your own company and apply for a reduction in working time at TU Delft. These sorts of things are very common here.”

Prof. Van den Hoven offers as an example the robotic hands that can help picking fruit and vegetables: “One of the conditions for setting up your own company is that TU Delft is finished with the research and is in accordance; the scientific publications have been realised and it only concerns utilising the social benefits of the robotic hand. It might be able to make a great deal of money. By participating in that company, TU Delft

might be able to finance fundamental robotics research.”

Prof. Van den Hoven believes that what is important is that it is documented somewhere: “As long as agreements are made: who is responsible for it, who takes decisions on the resources, what about student projects? The devil is in the details.” But does the scientist in question actually want to be tied to those rules? “That’s part of your responsibilities,” Prof. Van den Hoven argues. “Otherwise, we’ll need to have a firm talk with that scientist. During your annual performance interview, you must declare your secondary employment activities and sign the form. If certain activities are withheld, you’ll be committing forgery.”

This article appeared previously in Delta. Additional information has been included about the Conflict of Interest Committee and the TU Delft Valorisation Centre. See www.delta.tudelft.nl/25188



Photo: Lacquey

An industrial gripper developed by a private company, elaborating on a prototype developed at TU Delft.

Testing ground for bio-innovations

Scaled-up research is difficult to execute due to the amount of expensive equipment necessary for an individual party. DSM, CSM/Purac and TU Delft have therefore set up a consortium for research into biotechnological processes. With support from the EU and the Ministry of Economic Affairs, some 100 million euros is being invested in a pilot facility at the DSM site in Delft. The scale of the facility is unique in the world. The Bioprocess Pilot Facility (BPF) opened just before the summer. Meanwhile, the first customers are starting to use it. For more information: www.bpf.eu

A

Testing processes on a large scale

A new bioprocess that works in the laboratory cannot simply be scaled up to an industrial scale. Processes will behave differently in an industrial setting than under laboratory conditions. BPF has been specially designed for research into the scaling up of bioprocesses. Here, researchers can identify and remedy scaling-up problems. The scale of the process in the BPF is 10 to 100 times smaller than in industrial production.

EXAMPLE OF TEST PROCESS: BIOETHANOL

1 Pretreatment

Vegetable waste is prepared as raw material for fermentation.

1A Steam explosion

A steam explosion breaks down plant structures **1** (material is placed under high pressure before the pressure is released). This releases complex sugars **2** and enables enzymes to reach them.

1B Hydrolysis

Enzymes **3** convert complex sugars into simple sugars. **4** Micro-organisms can only feed on simple sugars.

Starting material:
Biomass
e.g. 500 kg straw.

EXAMPLE OF SCALING-UP TEST

Size of chips

Woodchips are pumped as slurry **5** in an industrial process. If the woodchips are too small, they stick together and block up the pipes. If the chips are too big, the micro-organisms will be unable to extract all the raw materials during fermentation. The optimum size of woodchips has to be tested on a realistic scale.

B Markt research

In the BPF, products are made (with quality assurance) for market research (food) and clinical studies (medicines). Quantities vary between 1 and 100 kg.

tough plant structures **1**

Expansion
A hydrolysis boiler of 10 m³ is planned.

2 complex sugars

3 enzymes

4

EXAMPLE OF SCALING-UP TEST

Mixing methode

Acidity is regulated by adding acid **6** during fermentation. Mixing a few drops of acid in a laboratory flask is straightforward, but when a jet of acid is being injected into a large reactor drum, it will take some time before it is well-mixed. The acidity level will increase locally, causing micro-organisms to produce undesirable by-products. The optimum mixing method can only be tested on a large scale.

6 acid
(e.g. sulphuric acid)

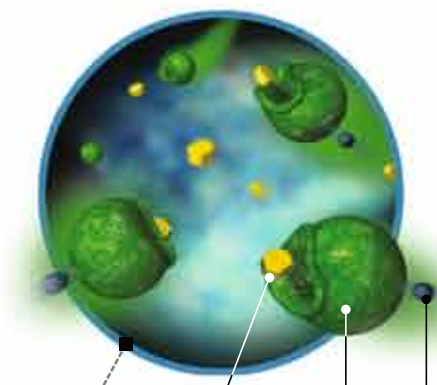
4 m³

2

4 simple sugar

7 micro organisms

finished product



2 Fermentation

Micro-organisms **7** feed on sugars, which makes them grow (the first phase). In the second phase, the micro-organisms convert sugars into finished products like bioethanol. The transition from the first to the second phase is determined by adapting the concentration of nutrients, for example, or by adding or leaving out oxygen.

Modular system

BPF has a broad selection of equipment for the treatment and processing of biological materials. Users build their own process by connecting modules of various sizes.



PRODUCT

*** Bioethanol**
Bioethanol is a replacement for petrol. The EU demands that a minimum of 10% of all car fuel be derived from renewable sources by 2020.

C

Education & research

Under the supervision of operators, course participants can gain experience and carry out research on large-scale processes.

3 Reprocessing/purification

The fermentation mixture **8** (micro-organisms, sugars, nutrients, finished product and water) is pumped to the reprocessing facility and connected to mobile equipment. The objective is to isolate the finished product from the mixture.

3A Filtration and distillation

All biomass is removed through filtration **9**. Then, about 100 kg of ethanol is produced through distillation **10** of 2.5 m³ of a water-ethanol mixture (5% ethanol).

EXAMPLE OF TEST PROCESS: BIOPLASTICS

3B Crystallisation and filtration **11 12**

Up to and including fermentation, the process for bioplastics is identical to that for bioethanol. In the fermentation phase, the micro-organisms and process conditions are different because a different finished product is being made. Other final processing steps are necessary for reprocessing the monomer.



PRODUCT

* Bioplastics

A synthetic polymer is made elsewhere from the 50 kg of monomer. Examples of products made from this polymer are biodegradable organic-waste bags and plant pots.

illustration & text: Erik Verdult
www.kennisinbeeld.nl © 2012

Propositions

Entrepreneurs exaggerate, scientists underestimate, engineers design.

Gandart Van Raemdonck, aerospace engineer

The quality of science is less threatened by fraud than by the pressure to publish.

Marc Harleman, maritime engineer

The best designs are often made by the biggest egos.

Thomas De Nucci, maritime engineer

An ordered desk is no prerequisite for good science.

Jan Mol, physical engineer

True innovators are not hindered by experience.

M.J. van der Horst, electrical engineer

While curiosity is the fundamental drive behind science, the fundamental drive behind technology is desire.

Yu Bi, electrical engineer

Science and politics make a dangerous mix.

Ataollah Abdollahi Kakroodi, civil engineer

Proposition

For the advancement of science, it is wrong to be right.

Catherine M. Chiong Meza

Defence

"Theoretically it is only possible to falsify hypotheses. If someone finds 'proof' of his hypothesis, he could never exclude the possibility that there is another cause of the effect than the one assumed in his theory. Statistical tests are also based on this principle.

Therefore, our knowledge can only progress if we dare to challenge the existing theories, i.e. if we dare to prove we are wrong. In practice there have been many cases in which the existing theory eventually had to make way for a new theory, often after a fierce 'battle'. One could for example think of the theories in physics: from Copernicus to Einstein.

Believing that we are right does not serve science: if the existing theories would have never been tested, we would still believe that the earth is at the centre of the universe".

Soundbites

"It's necessary to explain why speed limits apply. If you explain why it's necessary, people will be inclined to follow the advice."

Professor of Transport, Infrastructure and Logistics, Prof. Ben Immers in Algemeen Dagblad.

"After a decade of cutbacks in inspection services, it's about time the government realises that monitoring the chemical industry costs money."

Professor of Safety Science and Disaster Abatement, Prof. Ben Ale in de Volkskrant

"How can you actually say that a development stops? People will always be born who are more intelligent than the present generation. It might take some time, but it will surely happen."

Joris Melkert, lecturer in aerospace technology, responding in Trouw to Benno Baksteen, pilot and air-safety expert, who believes that the limit in aviation has been reached with the Airbus A380.

"Universities operate in an international competition. Among other things, they compete with each other for student enrolments. A well-made film trailer of a course of lectures on YouTube, with a high number of views, can enhance the lecturer's image and that of the institution."

Leon Huijbers, spiritual father of College Rama, in de Volkskrant.



'Religion and people who adhere to it will always exist unless science gives a definitive answer to the existential questions of mankind'

Faith Göncü, material engineer



TU Delft alumnus **Wiebe Draijer** has been appointed chairman of the Social and Economic Council of the Netherlands (SER) as of 1 September. Draijer studied Mechanical Engineering at TU Delft from 1983 to 1989. In 1990 he went to work at McKinsey & Company, where he was director until his recent appointment. Draijer succeeds Alexander Rinnooy Kan.



Teun Klapwijk, a professor at the Kavli Institute of Nanoscience, was a joint recipient, together with Øystein Fisher (University of Geneva) and Herbert Mook (Oak Ridge National Laboratory), of the prestigious Heike Kamerlingh Onnes Prize for his experiments in the field of superconductivity.



Villa 4.0, designed by Prof. **Dick van Gameren** (Architecture), has been chosen 'Building of the Year 2012' by the Royal Institute of Dutch Architects (BNA). According to the jury, Van Gameren transformed the simple 1967 bungalow into "an example of sustainability that connects magnificently with its environment".



On 7 September, professor of sustainable design, **Prabhu Kandachar**, bade farewell to TU Delft with the symposium 'Beyond Design'. Prof. Kandachar, who had worked at the faculty of Industrial Design Engineering since 1995, was particularly interested in the social side of sustainability and linked technical innovations to social aspects.



Geophysicist and planetary scientist, Dr **Bert Vermeersen**, will conduct research at the Royal Netherlands Institute for Sea Research (NIOZ) on the island of Texel over the next five years. His research will focus on global and regional sea level variations resulting from ice-cap melting, changes in gravity and the reaction of the solid Earth and the Earth's rotation.



Rob Roggema (Architecture) has been awarded a Rubicon grant for his proposal to research Swarm Planning. Swarm Planning is a planning approach in which dynamism plays the leading role and external changes govern spatial planning. Roggema will spend two years at the RMIT University's School of Architecture and Design in Australia.



Ena Voûte is the new dean of the faculty of Industrial Design Engineering (IDE), as of 1 September 2012. She will therefore be returning to the faculty where she studied. Voûte developed brand and marketing strategies for Unilever, managed the launch of the product-comparison website Independer.nl and was responsible for the Philips Wake-up Light.



The décolleté purse of IDE student, **Hiske Elferink**, won the Hema Design Competition's public award. The décolleté purse can accommodate a card, some small change and banknotes without it being visible. The purse is attached to a bra strap. Earlier, Tessa Soukoka (also from the IDE faculty) won the Hema jury prize.



Prof. **Frans van der Helm** (3mE) was the recipient of two prizes in recent months. And significant ones as well: the STW technology foundation awarded him the title of Simon Stevin Master 2012 for his pioneering work in biorobotics and biomechanics. The Simon Stevin Master prize is the biggest prize for technical-scientific research in the Netherlands. With the prize, Prof. Van der Helm also received 500,000 euros for research.

In early September, Prof. Van der Helm was also awarded the UfD Leermester Prize 2012. The TU Delft University Fund awards this prize to those who excel in education and research. The prize enables Prof. Van der Helm and a partner to spend a two-month sabbatical abroad in order to make and

strengthen contacts there, while giving guest lectures and deepening his insights in his field of study. The research of Prof. Van der Helm and his team is unique in the world, because it focuses primarily on the way in which the nerve centre responds to certain muscular strength. Prof. Van der Helm's prize consists of 15,000 euros in prize money, a certificate and a silver medal.

Alumni Event: Celebrating the past, connecting to the future

170 years TU Delft, that's worth celebrating! And we would like to celebrate that anniversary with you. We would therefore like to invite you to Delft on 12 October for an evening full of innovation, inspiration, information and education. Meet former fellow students and make new contacts. Experience the TU Delft of the past and present.

The Alumni Event will be very inspiring. Prof. Mark van Loosdrecht, winner of the prestigious Lee Kuan Yew water price, will explain how his Annamox technology can

purify water in a biological and energy-efficient way. Prof. Leo Kouwenhoven tells about the Majorana particles he discovered (see also the interview on page 10). Further on, we invite you to the world of today's students: their Dreamteams, their sports and their entrepreneurship.

We hope to meet you on Friday 12 October from 16:00 hrs until 22:00 hrs in the Aula of TU Delft. You can sign up at:
www.tudelft.nl/alumnievent2012



Programme on 12 October

We start the day in the Auditorium of the Aula with a varied programme in which the diversity of TU Delft is highlighted.

Central programme:

- Presentation by Prof. Leo Kouwenhoven on his research into Majorana fermions
- Presentation by Prof. Mark van Loosdrecht on the Annamox technology for water purification (see also interview page 10)
- What are the Dreamteams?
- What is YES!Delft?
- Olympic athletes of TU Delft
- Alumnus of the Year election

Following the central programme, there will be drinks and dinner, where there will be ample time to catch up with former and new study friends.

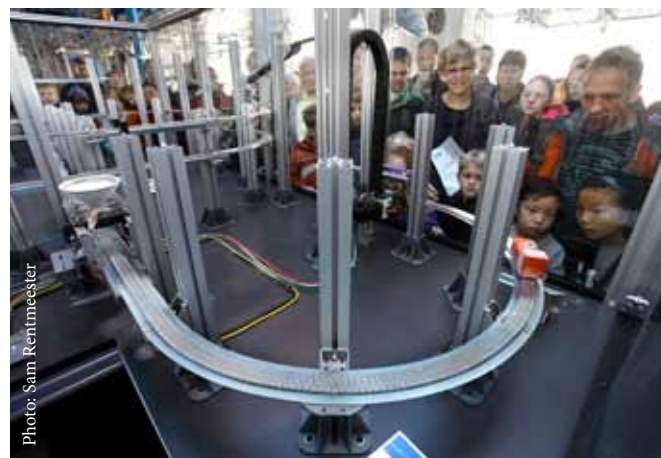
In the evening, buses will depart to three evening locations: The Dreamhall, YES!Delft and the Science Centre:

- Reading: 'How can IT provide a boost to the transport sector and international trade?' by Prof. Yao-Hua Tan
- Mini-lecture: 'What is design? - An answer from the informatics perspective', by Dr Michael S. Bittermann
- Presentation: 'Tribler makes peer2peer offline internet traffic possible', by Johan Pouwelse
- Experience the balance stimulator yourself - 'a neurosimulator that enables Parkinson's disease to be kept under control or the blind to see again', by Martijn van Dongen and Mark Stoopman

For more information, the complete programme and for registration, please go to
www.tudelft.nl/alumnievent2012



Prof. Mark van Loosdrecht presents his Annamox-technology for water purification.



What is presently going on in the old mining technology building?

'This year rowing was central'

Achieving gold at the Olympic Games in London, and finding a coating for boats to reduce drag in water - that was the dream and ambition of PhD student, Arnoud Greidanus, precisely one year ago. The combination of his PhD research and rowing at a top level resulted in him being awarded the title 'Alumnus of the Year' in 2011.

How has he fared since then?

"In the last few months rowing was central," Greidanus explains. "During this Olympic year, I trained about 12 to 13 times a week. I was one of the eight rowers who were selected for the Olympic Games in London. Then, at the beginning of 2012, when it transpired that I couldn't go to London and

that dream wouldn't be fulfilled, it was a huge disappointment. From that moment on, the World Championships in Bulgaria became my primary goal. Coming in seven-hundredth of a second behind gold, I won the silver medal."

Piece of seaweed

With all his attention on rowing, it was difficult for Greidanus to achieve his goals for his PhD research this year. After the 'Dutch Four' lost in the semi-finals of the Olympic Games in Beijing, Greidanus used the probable cause of this as his inspiration for his research. "A piece of seaweed stuck to the boat, causing a 10-second lag. If something

so small has such a great impact, then a small positive modification might also have a great effect. My goal is to develop a coating for the Olympic Games in Rio de Janeiro that reduces the drag of the water on the boat. In addition to competitive rowing, this would also be useful for shipping and aviation, and in the processing industry, where fluids are transported through pipelines."

Top-level sport climate

The title of 'Alumnus of the Year' comes with a prize of 2,500 euros, which Greidanus was free to spend as he wanted. An additional 7,500 euros could be earmarked for research at TU Delft. He is using this money for his PhD research and additional research connected to this. "In Australia, they've already made huge advances in sports

'A piece of seaweed stuck to the boat, causing a 10-second lag'

innovation and science. My goal is to spend a few months on an internship with the Australian Institute of Sport. I'd like to gain some knowledge and experience there and carry out field tests with the coating I hope to develop in coming years." The title of 'Alumnus of the Year' not only brought prize money with it, but also a lot of publicity. "This was beneficial for the general discussion relating to top-level sport and top-level sports science. And, as such, it is an important step towards a top-level sport climate in the Netherlands."



Arnoud Greidanus was Alumnus of the year 2011/2012.



Visit the Dreamhall to meet the dreamteams.



- 110 Bedrijven
- 70 miljoen geïnvesteerd vermogen
- 26 miljoen jaarlijks geïnvesteerd vermogen
- Epyon Power, Senz Umbrellas, Ampelmann Operations

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

Kluyverweg 1
nl-2629 HS Delft
Telephone +31 15 278 2058

Applied Earth Sciences

Mijnbouwstraat 120
nl-2628 RX Delft
Telephone +31 15 278 1423

Applied Physics

Lorentzweg 1
nl-2628 CJ Delft
Telephone +31 15 278 7774

Architecture

Berlageweg 1
nl-2628 CR Delft
Telephone +31 15 278 4184

Chemical Technology & Bioprocess Technology

Julianalaan 136
nl-2628 BL Delft
Telephone +31 15 278 2667

Civil Engineering

Stevinweg 1
nl-2628 CN Delft
Telephone +31 15 278 5440

electrical engineering

Mekelweg 4
nl-2628 CD Delft
Telephone +31 15 278 4568

Geodetic Engineering

Kluyverweg 1
nl-2629 HS Delft
Telephone +31 15 278 3289

Industrial Design

Landbergstraat 15
nl-2628 CE Delft
Telephone +31 15 278 4750

Life Science & Technology

Julianalaan 67
2628 BC Delft
Telephone +31 15 278 8271

Marine Technology

Mekelweg 2
nl-2628 CD Delft
Telephone +31 15 278 6666

Materials Science

Mekelweg 2
nl-2628 CD Delft
Telephone +31 15 278 6666

Mechanical Engineering

Mekelweg 2
nl-2628 CD Delft
Telephone +31 15 278 6666

Computer Science

Mekelweg 4
nl-2628 CD Delft
Telephone +31 15 278 4568

Applied Mathematics

Mekelweg 4
nl-2628 CD Delft
Telephone +31 15 278 4568

Technology, Policy & Management

Jaffalaan 5
nl-2628 BX Delft
Telephone +31 15 278 7100

Multidisciplinary Centres

Adhesion Institute
Kluyverweg 1
nl-2629 HS Delft
Telephone +31 15 278 5353

Biotechnological Sciences Delft Leiden (bsdl)

Julianalaan 67
nl-2628 BC Delft
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)

Kluyverweg 1
nl-2629 HS Delft
Telephone +31 15 278 5460

Netherlands Institute for Metals Research (NIMR)

Mekelweg 2
nl-2628 CD Delft
Telephone +31 15 278 2535
Fax +31 15 278 2591

Wind Energy Research Group

Kluyverweg 1
nl-2629 HS Delft
Telephone +31 15 278 5170

Reactor Institute Delft

Mekelweg 15
nl-2629 JB Delft
Telephone +31 15 278 5052

OTB Research Institute for Housing, Urban and Mobility Studies

Jaffalaan 9
nl-2628 BX Delft
Telephone +31 15 278 3005

Open Building Working group (obom)

Berlageweg 1
nl-2628 CR Delft
Telephone +31 15 278 5400

Delft Institute for Microelectronics and Submicron-technology (dimes)

Feldmannweg 17
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

Mekelweg 2
nl-2628 CD Delft
Telephone +31 15 278 3216

Netherlands Schools for Advanced Studies in Construction

Stevinweg 1
nl-2628 CN Delft
Telephone +31 15 278 3332

TU Delft

P.O. Box 139

2600 AC Delft

The Netherlands

telephone +31-15 278 9111

telefax +31-15 278 6522

Advanced School for Computing & Imaging

Mekelweg 4
nl-2628 CD Delft
Telephone +31 15 278 8032

Trail Research School

Kluyverweg 4
p.o. box 5017
nl-2629 HT Delft
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